# Planetary Defense Neg

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# A2: Inherency

## Programs Now

### NASA already has a NEO contingency plan

Green 7

[Testimony of James Green, Science Mission Directorate, NASA HQ, “Congressional Hearings on NEO Survey Programs ,” November 10, 2007 , http://nai.arc.nasa.gov/impact/news\_detail.cfm?ID=178]

NASA has an NEO contingency notification plan to be utilized in the very unlikely event an object is detected with significant probability of impacting the Earth. The plan establishes procedures between the detection sites, the Minor Planet Center, the NASA NEO Program Office at JPL, and NASA Headquarters to first quickly verify and validate the data and orbit on the object of interest, and then up- channel confirmed information in a timely manner to the NASA Administrator. These procedures were first exercised with the discovery of the object now known as Apophis, which was found in December 2004 in a hazardous orbit but determined to not have a significant probability of impacting the Earth in the near-term. NASA will continue to refine this internal contingency plan, and begin work with other US government agencies and institutions when directed.

### We are working towards planetary defense in the status quo

O’Connor 11

( Dr. Tom O’ Connor, May 23 2011, Planetary Defense, <http://www.drtomoconnor.com/2010/2010lect07a.htm>) PS

The first step in planetary defense is detection.  An early-warning system is necessary.  Since 1992, NASA has been tasked to map at least 90% of all near-Earth objects.  To date, a number of different programs are involved in this task, all falling under the umbrella of what is called the*Spaceguard Project*(see website: [Spaceguard Central Node](http://spaceguard.esa.int/)).  Although the Spaceguard Project started off as an American entity, subsequent Spaceguard associations or foundations have formed in many countries, all supporting the idea of discovering and studying near-Earth objects.  Several universities around the world also have near-Earth object study centers.  An example is the*Near Earth Asteroid Tracking*([**NEAT**](http://neat.jpl.nasa.gov/)) program which is part of both NASA and the Jet Propulsion Laboratory and uses an Air Force telescope in Hawaii and the Mt. Palomar telescope in California.  NASA and the Air Force have also teamed up in the [LINEAR Project](http://www.ll.mit.edu/LINEAR).  In addition, all branches of the military (and many other agencies) are involved in space surveillance.  Proposals to expand the  Spaceguard Project have been mostly rejected.  NASA, for example, only spends $4 million on the project, but the magnitude of risk merits a much larger budget.  Twenty-five (25) early warning sites currently exist, as represented in the map below: There are also a number of projects to search for extra-terrestrial life.  The most well-known of these are the SETI (*Search for Extra-Terrestrial Intelligence*) projects.  Basically, they work by listening for radio signals from outer space with radio telescopes, omnidirectional antenna, and parabolic reflectors.  From 1963 to 1998, the largest of the SETI radio telescopes was the Big Ear, located on the campus of Ohio State University.  In 1977, it picked up a 72-second signal (called "the Wow signal") on the 1420 MHz frequency apparently from somewhere in the [Sagittarius constellation](http://www.astronomical.org/portal/modules/wfsection/article.php?articleid=72).  The source of the "Wow" signal has never been heard from again, even though astronomers have looked for it dozens of times.  To astronomers like Melia (2007), Sagittarius is interesting because it is where the galactic center lies (the rotational center of the Milky Way), a supermassive black hole existing in the exact center (the nearest one to Earth), and another black hole co-existing nearby.  To physicists like Thorne (1995) and Hawking et. al. (2003), black holes are interesting for two reasons: one, going through them may lead to another dimension; and two, harnessing their power around the event horizon (the area surrounding a black hole) may allow rapid "wormhole" space travel as well as the possibility of time travel.

# A2: Asteroid Advantage

## Asteroids Not Coming 1/3

### Dangerous asteroids are not coming anytime soon

The Washington Post ‘97

[The Washington Post (February 18, 1997), The Augustine Chronicle, “Killer Asteroids not coming soon, experts say”

<http://chronicle.augusta.com/stories/1997/02/18/tec_204218.shtml>]

The Earth is no stranger to encounters with space rocks. But happily for humanity, the big chunks of space rock are far outnumbered by smaller ones that swarm around Earth's path. And those large enough to make it through the atmosphere tend to land in the vast oceans or in uninhabited lands. In fact, every hour a ton of micrometeorite dust hits the Earth. Every few hours a baseball-sized lump survives intact all the way to Earth's surface. Some objects hit the upper atmosphere and bounce back out into space. Some tumble into view with unnerving suddenness - like the object at least 1,000 feet in diameter that appeared suddenly last May and took five days to cross the sky not much farther away than the moon's orbit. Based on what scientists know now, the odds that an object at least a mile in diameter will smash into Earth in the next century are slightly less than 1 in 1,000. The resulting damage would depend on the object's size, velocity, the location of impact and other variables. It could happen centuries from now, thousands of centuries from now or next month. There is no way to predict absolutely, even once scientists have completed their survey of detectable nearby objects, because interlopers from deep space could sweep in unexpectedly at any time. Even so, scientists estimate that the probability that any individual will be killed by a doomsday rock is about the same as the chance of getting killed on a commercial air flight - just under one in a million per year, according to David Morrison, director of space at NASA's Ames Research Center. The individual risk is that high only because the fatalities from just one such impact could number in the hundreds of millions or more.

### Risk of an asteroid collision is too minute to calculate

Young ’02

[Kelly, “Chances extremely slim for head-on collision”, Sept 1, lexis FLORIDA TODAY (Brevard County, FL)

A November study published in the Astronomical Journal showed the odds of this planet being hit with a civilization-ending asteroid in the next 100 years are about one in 5,000. This is less likely than scientists had previously calculated.  Spread out over millions of years, astronomical odds of being killed by an asteroid can be difficult to comprehend.  "We're talking about probabilities people don't get," said Clark Chapman, institute scientist for Southwest Research Institute in Boulder, Colo. "We're not wired to understand these low probabilities, which is why state lotteries are so successful."  For the record, each time a Floridian buys a state lottery ticket, he has a one in 23 million chance of winning the jackpot.  In comparison, your lifetime odds of dying from an injury are just one in 23, according to a 1998 report by the National Safety Council.  The Sloan Digital Sky Survey has software that robotically scans the skies for asteroids and found that the solar system houses about 700,000 asteroids big enough to wipe out Earth life.  Earlier estimates were three times that figure.  Here is how astronomers assign risk to an approaching object like an asteroid or comet:  When they spot a new asteroid, they try to observe it for as long as they can. Based upon the swath the asteroid cuts across the sky in about five minutes, astronomers try to estimate what its orbit is. But because they've only seen the orbit once, the orbit is fairly uncertain and may change as they make more observations.  "The more observations you have the better determined the orbit is in some distant date in the future," Scotti said.  If they find that its orbit around the sun may one day intersect Earth's path, then the astronomers have to figure out whether they would ever be at the same place at the same time, which could result in tsunamis, climate change or just an all-out mass extinction.  "This hazard is one element of a whole panoply of risks and hazards that people are walking around facing these days, from carcinogens, from terrorists," Chapman said. "There should be more education, informal education like through science journalism, and formal education, like through science classes" to teach people how they should respond when hearing about such hazards.  Obviously, many things in our daily lives are risky. The National Center for Statistics and Analysis reported that people faced a one-in-6,761 chance of being killed on U.S. roads in 2001. That's just for one year. The asteroid risk of one-in-5,000 is spread out over 100 years.  And besides, there's actually a chance people could survive the space rock onslaught.  Ben Affleck did.

Asteroids Not Coming 2/3

### Collision unlikely in the squo

The Daily Telegraph ’02

[“Miscalculating Armageddon”, July 31, lexis]

EARTH will be spared the catastrophe of being hit by an asteroid in 2019, NASA said yesterday.  Latest observations by scientists show the asteroid, dubbed 2002 NT7, also should steer clear of Earth in 2060.   Australian astronomer Vince Ford last week suggested the asteroid be hit with a nuclear weapon to throw it off-course and away from Earth.  There were fears the 4km diameter asteroid could plummet to Earth and cause mayhem, including tidal waves.  However, NASA now says it can rule out any impact with Earth in 2019 and again in 2060.  "After processing recent observations this past weekend, scientists with NASA's Near Earth Object Program office can now rule out any impact possibility," NASA said on its website.

### The risk of asteroids hitting earth has declined with the discover of new NEOs

Britt ‘05

[Robert Roy Britt(January 6, 2005), Life Science, “The Odds of Dying—Changing Risk Factors” <http://www.livescience.com/3780-odds-dying.html>]

Perceptions of risk factors can change over time simply because more is learned. The chances of an Earth-impacting asteroid killing you have dropped dramatically, for example, from about 1-in-20,000 in 1994 to something like 1-in-200,000 or 1-in-500,000 today. The new numbers -- their range reflecting the need for further research -- were offered up last week by Clark Chapman of the Southwest Research Institute and David Morrison at NASA's Ames Research Center. Why such a dramatic downgrade? Active intervention. "A significant part of it is that we have now discovered, in the last dozen years, a good fraction of the largest, most deadly asteroids and found that they won't hit the Earth," Chapman told LiveScience. Also, projections of the destruction a large space rock would cause have been revised downward a bit. Finally, since Earth is two-thirds water, asteroid risks include the possibility of an impact-induced tsunami. And Chapman says asteroid-generated tsunamis may not be as deadly as once presumed. Others contend the odds of death-by-asteroid are still about 1-in-50,000, until the remaining handful of expected large asteroids are found and determined not to be a near-term threat.

### There is no evidence for a NEO collision and we would have plenty of notice to take necessary actions

Benett 10

[James Bennett, Prof of Economics @ George Mason, “The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors,” p. 168-169]

Cooler heads intervened. Donald Yeomans of the Jet Propulsion Laboratory said, “The comet will pass no closer to the Earth than 60 lunar distances [14 million miles] on August 5, 2126. There is no evidence for a threat from Swift-Tuttle in 2126 nor from any other known comet or asteroid in the next 200 years.”96 Even Brian Marsden concurred. He retracted his prediction, though he held out the possibility that in the year 3034 the comet could come within a million miles of Earth. Surveying this very false and very loud alarm, Sally Stephens, writing in the journal of the Astronomical Society of the Pacific, observed, “Marsden’s prediction, and later retraction, of a possible collision between the Earth and the comet highlight the fact that we will most likely have century-long warnings of any potential collision, based on calculations of orbits of known and newly discovered asteroids and comets. Plenty of time to decide what to do.”97

Asteroids Not Coming 3/3

### The risk of an asteroid strike is zero, there is just a scholarly bias for the extreme

Benett 10

[James Bennett, Prof of Economics @ George Mason, “The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors,” p. 157-158]

We should here acknowledge, without necessarily casting aspersions on any of the papers discussed in this chapter, the tendency of scientific journals to publish sexy articles. (Sexy, at least, by the decidedly unsexy standards of scientific journals.) Writing in the Public Library of Science, Neal S. Young of the National Institutes of Health, John P.A. Ioannidis of the Biomedical Research Institute in Greece, and Omar Al-Ubaydli of George Mason University applied what economists call the “winner’s curse” of auction theory to scientific publishing. Just as the winner in, say, an auction of oil drilling rights is the firm that has made the highest estimation — often overestimation — of a reserve’s size and capacity, so those papers that are selected for publication in the elite journals of science are often those with the most “extreme, spectacular results.”63 These papers may make headlines in the mainstream press, which leads to greater political pressure to fund projects and programs congruent with these extreme findings. As The Economist put it in an article presenting the argument of Young, Ioannidis, and Al-Ubaydli, “Hundreds of thousands of scientific researchers are hired, promoted and funded according not only to how much work they produce, but also where it gets published.” Column inches in journals such as Nature and Science are coveted; authors understand full well that studies with spectacular results are more likely to be published than are those that will not lead to a wire story. The problem, though, is that these flashy papers with dramatic results often “turn out to be false.”64 In a 2005 paper in the Journal of the American Medical Association, Dr. Ioannidis found that “of the 49 most-cited papers on the effectiveness of medical interventions, published in highly visible journals in 1990–2004… a quarter of the randomised trials and five of six nonrandomised studies had already been contradicted or found to have been exaggerated by 2005.” Thus, those who pay the price of the winner’s curse in scientific research are those, whether sick patients or beggared taxpayers, who are forced to either submit to or fund specious science, medical or otherwise. The trio of authors call the implications of this finding “dire,” pointing to a 2008 paper in the New England Journal of Medicine showing that “almost all trials” of anti-depressant medicines that had had positive results had been published, while almost all trials of anti-depressants that had come up with negative results “remained either unpublished or were published with the results presented so that they would appear ‘positive.’” Young, Ioannidis, and Al-Ubaydli conclude that “science is hard work with limited rewards and only occasional successes. Its interest and importance should speak for themselves, without hyperbole.” Elite journals, conscious of the need to attract attention and stay relevant, cutting edge, and avoid the curse of stodginess, are prone to publish gross exaggeration and findings of dubious merit. When lawmakers and grant-givers take their cues from these journals, as they do, those tax dollars ostensibly devoted to the pursuit of pure science and the application of scientific research are diverted down unprofitable, even impossible channels. The charlatans make names for themselves, projects of questionable merit grow fat on the public purse, and the disconnect between what is real and what subsidy-seekers tell us is real gets ever wider.65 The matter, or manipulation, of odds in regards to a collision between a space rock and Earth would do Jimmy the Greek proud. As Michael B. Gerrard writes in Risk Analysis in an article assessing the relative allocation of public funds to hazardous waste site cleanup and protection against killer comets and asteroids, “Asteroids and comets are… the ultimate example of a low-probability/high-consequence event: no one in recorded human history is confirmed to have ever died from one.” Gerrard writes that “several billion people” will die as the result of an impact “at some time in the coming half million years,” although that half-million year time-frame is considerably shorter than the generally accepted extinction-event period.66 The expected deaths from a collision with an asteroid of, say, one kilometer or more in diameter are so huge that by jacking up the tiny possibility of such an event even a little bit the annual death rate of this never-beforeexperienced disaster exceeds deaths in plane crashes, earthquakes, and other actual real live dangers. Death rates from outlandish or unusual causes are fairly steady across the years. About 120 Americans die in airplane crashes annually, and about 90 more die of lightning strikes. Perhaps five might die in garage-door opener accidents. The total number of deaths in any given year by asteroid or meteor impact is zero — holding constant since the dawn of recorded time.

## Status Quo Solves Detection

### **Structurally there is adequate warning**

Oberg, 98

[James Oberg, “ASTEROID DEFLECTION & THE FUTURE OF HUMAN INTERVENTION IN THE EARTH'S BIOSPHERE,” Futures Focus Day Symposium sponsored by Commander-in-Chief, US Space Command Colorado Springs, Colorado July 23, 1998 , http://abob.libs.uga.edu/bobk/oberg.html]

Among all the dangers that nature has dished out for Earth, there's a silver lining to the asteroid impact threat. The most likely objects to hit Earth are in orbits that repeatedly pass close enough to Earth to be spotted, tracked, and catalogued far in advance. Their orbital inclinations are close -- ten or twenty degrees off, at most -- and their orbital periods are within a factor of two of Earth's. These objects constitute 99% or more of the impact threat, because the eccentric comets and deep-space interlopers -- while they exist -- usually have only one shot at Earth as they pass through the inner solar system. In contrast, these "NEO's" keep making passes again and again and again UNTIL they hit, or are flung clear by a very close approach.

### **Multiple programs for tracking NEOs in the status quo**

O’Connor 11

[Dr. Tom O’ Connor, May 23 2011, Planetary Defense, <http://www.drtomoconnor.com/2010/2010lect07a.htm>]

The first step in planetary defense is detection.  An early-warning system is necessary.  Since 1992, NASA has been tasked to map at least 90% of all near-Earth objects.  To date, a number of different programs are involved in this task, all falling under the umbrella of what is called the*Spaceguard Project*(see website: [Spaceguard Central Node](http://spaceguard.esa.int/)).  Although the Spaceguard Project started off as an American entity, subsequent Spaceguard associations or foundations have formed in many countries, all supporting the idea of discovering and studying near-Earth objects.  Several universities around the world also have near-Earth object study centers.  An example is the*Near Earth Asteroid Tracking*([**NEAT**](http://neat.jpl.nasa.gov/)) program which is part of both NASA and the Jet Propulsion Laboratory and uses an Air Force telescope in Hawaii and the Mt. Palomar telescope in California.  NASA and the Air Force have also teamed up in the [LINEAR Project](http://www.ll.mit.edu/LINEAR).  In addition, all branches of the military (and many other agencies) are involved in space surveillance.  Proposals to expand the  Spaceguard Project have been mostly rejected.  NASA, for example, only spends $4 million on the project, but the magnitude of risk merits a much larger budget.  Twenty-five (25) early warning sites currently exist, as represented in the map below:

### **The US already cooperates internationally on asteroid detection**

National Research Council 10

[National Research Council, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategiesand Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences, “Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies” 2010, Google Books]

Recognizing that impacts from near-Earth objects represent a hazard to humanity, the United States, the European Union. Japan, and other countries cooperatively organized to identify, track, and study NEOs in an effort termed "Spaceguard." From this organization, a nonprofit group named the Spaceguard Foundation was created to coordinate NEO detection and studies: it is currently located at the European Space Agency's (ESA's) Centre for Earth Observation (ESRIN) in Frascati. Italy. The United States input to this collective effort comprises three aspects: telescopic search efforts to find NEOs, the Minor Planet Center (MPC) at the Harvard-Smithsonian Center for Astrophysics, and the NASA NEO Program Office at the Jet Propulsion Laboratory. Existing, retired, and proposed telescopic systems for the U.S. NEO searches are detailed below. Other telescopic survey, detec­tion, and characterization efforts are conducted worldwide and work synergistically with U.S. telescopic searches (e.g.. Asiago-DLR Asteroid Survey, jointly operated by the University of Padua and the German Aerospace Center [DLR|. Campo Imperatore Near-Earth Object Survey at Rome Observatory; and the Bisei Spaceguard Center of the Japanese Spaceguard Association). To date, the U.S. search effort has been the major contributor to the number of known NEOs. The functions of the two U.S. data- and information-gathering offices, the MPC and the NEO Program Office, are complementary. A European data- and information-gathering office, the Near-Earth Objects Dynamic Site (NEODyS) is maintained at the University of Pisa in Italy, with a mirror site at the University of Valladolid in Spain. These three services are described below.

## Status Quo Solves Mitigation 1/3

### ****Early warning means deflection tech will be ready in time****

**British National Space Centre ‘2k**

(British National Space Centre, Report of the Task Force on Potentially Hazardous Near Earth Objects, <http://www.spacecentre.co.uk/neo/report.html>)

A number of possible mechanisms have been considered for deflecting or breaking up potentially hazardous Near Earth Objects; most would require the use of a spacecraft with some means of transferring energy or momentum to the object, for example by kinetic energy transfer (by heavy projectiles carried on the spacecraft or by causing a collision between asteroids), by chemical or nuclear explosives, or even by mounting "sails" on the object to harness the Sun's radiation pressure. Some of these mechanisms are more realistic than others. Given warnings of decades or centuries, new technological developments would almost certainly emerge. The Task Force believes that studies should now be set in hand on an international basis to look into the practical possibilities of deflection.

### **With years of warning tech will fill in to prevent collision**

Bridges 4

[Andrew Bridges, Science Writer, “Scientists call for strategyto fend off space rocks,” MSNBC, 2/23/2004,

http://www.msnbc.msn.com/id/4356390/ns/technology\_and\_science-space/t/scientists-call-strategyto-fend-space-rocks/]

Rep. Dana Rohrabacher, R-Calif., introduced a bill this month to bolster NASA spending on the search for near-Earth asteroids 100 yards or more across. Even something of that size, were it to strike, say, the Pacific Ocean, could generate a tsunami capable of destroying the major cities along the West Coast, Ailor said. Advertise | AdChoices Early detection of an inbound asteroid could provide years to decades of warning — enough time to mount a mission to push it off course, Ailor said. Slowing an asteroid down by even a few inches a second could change its trajectory enough to prevent its ever crossing paths with the Earth. Earth moves in space the equivalent of its own diameter in just six minutes. So to move an Earth-bound asteroid off target, it would be enough to delay its arrival time by six minutes, allowing it to sweep past harmlessly, Morrison said.

### Asteroid deflection is no problem

StarChild ’99

[July 1999, “Question,” http://starchild.gsfc.nasa.gov/docs/StarChild/questions/question11.html]

If astronomers find such an object, there would be plenty of time to track it, measure its orbitprecisely**,** and plan a system for deflecting itfrom its current orbital path. There would be no great hurry and no great panic. It would be a project for all the world's nations to take part in. Because we will have found it long before it actually intersects the Earth's orbit, it probably would take only a small push (perhaps from chemical rockets we land on the surface of the asteroid) to divert it from a threatening path.

Status Quo Solves Mitigation 2/3

### European Don Quijote meeting will solve asteroid mitigation research and testing

ESA 9

[European Space Agency, “Don Quijote concept,” 2009, http://www.esa.int/SPECIALS/NEO/SEMZRZNVGJE\_0.html]

ESA's Don Quijote is an asteroid deflection precursor mission concept, designed to assess and validate the technology that one day could be used to deflect an asteroid threatening the Earth... Overview ESA's Don Quijote mission concept consists of two spacecraft which are to be launched in separate interplanetary trajectories: \* An Orbiter spacecraft, called Sancho After arriving to the target asteroid and be inserted into an orbit around it, it will measure with great accuracy its position, shape, mass, and gravity field for several months before and after the impact of the second spacecraft. In addition, the Orbiter will operate as a backup data relay for transferring all the data collected by the Impactor during approach and image the impact from a safe parking position. It will also investigate the surface composition of the asteroid and, after completion of the primary objective, carry out the ASP-DeX. \* An Impactor spacecraft, named Hidalgo After following a very different route from that of the Orbiter, the spacecraft will Impact an asteroid of approximately 500 m diameter at a relative speed of about 10 km/s. This spacecraft will demonstrate the ability to autonomously hit the target asteroid based on onboard high-resolution camera. (download the mission sequence animation, 10.6 Mb) Mission objectives The primary objective of the Don Quijote concept is to impact the target Near-Earth Asteroid (NEA) and to be able to determine the deflection resulting from the impact. To achieve this, it will measure with extreme accuracy the asteroid's position in space before and after impact. There is also a secondary objective, involving the so-called Autonomous Surface Package Deployment Engineering eXperiment (ASP-DeX). In this experiment a small device, an Autonomous Surface Package or ASP, would be released from the Orbiter spacecraft while it's on orbit about the asteroid. It would then passively free-fall towards the asteroid surface after its release, and touchdown within a certain distance of a target landmark, most likely the crater resulting from the impact of the Hidalgo spacecraft. In addition, part of the mission secondary goals are to and study the asteroid's surface chemical composition and the characterization of the thermal and mechanical properties of the asteroid surface.

### **Don Quijote could be launched by 2013**

ESA 9

[European Space Agency, “Don Quijote concept,” 2009, http://www.esa.int/SPECIALS/NEO/SEMZRZNVGJE\_0.html]

“Flexible Option” Design Scenario In order to provide the most flexible design, capable of reaching multiple targets, an electric propulsion architecture was selected. For the same launcher/upper stage configuration as in the “Cheap Option”, over 10 targets were identified complying with a set of engineering constraints such as size, trajectory type and the feasibility of the radio science experiment (RSE). Among these Apophis was selected as it represents the perfect candidate for the Sancho mission: obtaining a very precise orbit determination of this object might be absolute necessary one day in order to rule out a possible Earth impact in 2036. Apophis characteristics Parameter Value Absolute Magnitude (H) 19.6 Density Unknown, 2.00 gr/cm^3 assumed Diameter 270±30 m Mass 2.06\*1011 kg (spherical) Semi-major Axis 0.922261 AU Perihelion 0.7461 AU Aphelion 1.0985 AU Orbital Period 323.5 days Eccentricity 0.191059 Inclination 3.331 deg Next observation October 2009 A spiral trajectory with long periods of thrusting was found which takes over two years for the spacecraft to rendezvous with Apophis. The main characteristics of the trajectory are shown in the table below. Shorter interplanetary transfers are possible, however, there is an engineering constraint which limits the power available to the propulsion system. In return this meant the solar array size was constrained, which also brought with it benefits in the form of a smaller mass, smaller disturbances from solar radiation when orbiting around the asteroid and a simpler attitude control design. Flexible Option Trajectory Characteristics Parameter Value Departure Date 2013/4/1 Vinf 3.16 km/s Initial Mass 390 kg Total ΔV 390 m/s Arrival Date 2015/5/11 Arrival Mass 368 kg

Status Quo Solves Mitigation 3/3

### In the event of a catastrophic asteroid, the world would overcome any obstacle to prevent colission

Mitchell, No date

[William F. Mitchell, CEO NEO Safety Foundation, “FINANCING A PLANETARY DEFENSE SYSTEM,” Aero, No Date Given,

http://www.aero.org/conferences/planetarydefense/2007papers/P5-3--Mitchell-Paper.pdf]

If officials from the Spaceguard Survey announced tomorrow that the three kilometer long asteroid 4179 Toutatis had encountered an unexplained course change and there was a 99.9 percent chance of an impact with our planet on Sept 28, 2008 and the estimated impact zone would be somewhere off the eastern sea coast of the United States…. financing a planetary defense system would not be a problem. World governments would essentially stop what they were doing and make prevention of this imminent catastrophic event their most important priority. Budgetary constraints would no longer be an issue. Virtually overnight a multi-trillion dollar world defense industry would turn its attention to diverting or eliminating this threat. NASA, ESA and all the other world space organizations would focus their capabilities on a defense plan. Massive worldwide efforts, resources and commitments would be dedicated to saving the Planet. Defensive commitments from countries approaching those in both World Wars would not be surprising.Many political issues important today would vanish:

• Using money from every area of the Federal Budget would be tolerated.

• There would be no sacred cows, not even Social Security.

• Emergency tax increases to fund the defense effort would be accepted by the public.

• Use of nuclear power and explosives to mitigate the threat would be automatically considered a plausible option.

• Great loss of life in manned space flight efforts would be considered a justifiable sacrifice if necessary.

• Unproven manned and unmanned space vehicles would be rushed into service.

All of the most important world issues of the day - world hunger, poverty, genocides, curing cancer, and heart disease - would abruptly pale in comparison to this fortuitous threat of world annihilation. Even the multi-billion dollar war on terror would take a back seat to this event.

## **Status Quo Solves Detection & Mitigation**

### Status quo observations give us time to deflect the NEO or colonize space

Britt ’08

[Robert Roy Britt, Live Science, 8-7-2008, “Will an Asteroid Hit Earth?” http://www.livescience.com/mysteries/070116\_asteroid\_hit.html]

But no, a continent-destroying asteroid is not likely to hit during your lifetime. Most of 1,100 or so that could do the job have been found. And none are on their way**.** Okay, there is one mid-sized rock—called Apophis—that has a small chance of striking Earth in 2036 and wreaking some regional havoc. But astronomers are watching it and, if future observations reveal it really could hit us, scientists are confident they can devise a mission to deflect it. And if all else fails, some futurists suggests, humanity could simply set up shop elsewhere.

### There are already programs in place to track and deflect asteroids

Science Daily ’08

[Science Daily, 1-30-2008, “Could An Asteroid Hit Planet Earth,” http://www.sciencedaily.com/releases/2008/01/080129212723.htm]

Target Earth will focus on a variety of NEO projects supported by The Planetary Society, including the Apophis Mission Design Competition, the Gene Shoemaker Near Earth Object Grants, NEO mission advocacy, and a one-hour HD TV “Daily Planet” special on asteroids being produced by Discovery Canada. In mid-to late February, the Society will announce the winners of the Apophis Mission Design Competition, which invited participants to compete for $50,000 in prizes by designing a mission to rendezvous with and "tag" a potentially dangerous near-Earth asteroid. The competition received 37 mission proposals from 19 countries on 6 continents. Tagging may be necessary to track an asteroid accurately enough to determine whether it will impact Earth, thus helping space agencies to decide whether to mount a deflection mission to alter its orbit. Apophis is an approximately 400-meter NEO, which will come closer to Earth in 2029 than the orbit of our geostationary satellites – close enough to be visible to the naked eye. If Apophis passes through a several hundred-meter wide "keyhole" in 2029, it will impact Earth in 2036. While current estimates rate the probability of impact as very low**,** Apophis is being used as an example to enable design of a broader type of mission to any potentially dangerous asteroid. "Target Earth encompasses The Planetary Society’s three-pronged approach to NEO research,” said Director of Projects Bruce Betts. "We fund researchers who discover and track asteroids, advocate greater NEO research funding by the government, and help spur the development of possible ways to avert disaster should a potentially dangerous asteroid be discovered."

## **Nuclear War Outweighs Asteroids 1/2**

### Nuclear war more likely than asteroid collision

Glass ’02

[Diane, Atlanta-Journal Constitution, 7/21, http://209.157.64.200/focus/f-news/738774/posts]

Nuclear winter may not be imminent -- or even possible -- but physicists are more concerned with the threat of nuclear war than with asteroids and alien invasions. Physics professor and cosmologist Tony Rothman notes that, when you gaze into deep space, "the farther you look, the farther you look back in time." So while moviegoers clench their teeth in anticipation at scenes of world destruction, Rothman's knowledge of the past allows him to see humor in the questionable science of movies such as "Armageddon."    Although there is a chance of an asteroid hitting Earth, the possibility is as remote as Pluto. "But maybe we are due," Rothman teases.    OK, the Earth isn't going to be pounded to dust by errant space dreck. But what about the end of the universe? The sun will burn out in five billion years, which would be our death if we were still in the galaxy, he explains. "If we're living around some other star, then we might escape until that one goes. Once they're all gone, unless life evolves to a point that it doesn't need heat, that's it. There has been some speculation . . . that life could conceivably slow its metabolism to live near absolute zero, but things would probably be pretty boring. It might take millions of years to have a thought."    Paul Halpern, physicist and author of "Countdown to Apocalypse," concurs that cosmological catastrophe is unlikely. Nuclear disarmament and how we treat the earth are foremost in Halpern's mind as ingredients for human disaster, not cosmological clashes. Humans are the likely catalysts of their own demise. "We need more Martin Luther Kings and Ghandis, who promote non-violence," he suggests.

### Nuclear war would do as much damage as an asteroid

M2 PRESSWIRE ’02

[“FRIENDS OF THE EARTH SYDNEY”, Sept 4, lexis]

It is quite right to be concerned over the potential for catastrophe from weapons of mass destruction. These weapons, and nuclear weapons in particular must be eliminated if the human race is to survive, and the governments of the world have been legally committed to doing so for over 30 years. But who really has these weapons? The facts are that the US and Russia will maintain arsenals whose use would create an impact equivalent to that of a large asteroid indefinitely, with somewhat smaller arsenals held by the UK, China, France, Israel, India, and Pakistan. Of these, India and Pakistan were recently on the very brink of a real nuclear exchange last may and June, and Israel is now threatening to use nuclear weapons - against Iraq. When last Thursday, the US did a subcritical nuclear test, Iraq did not call for regime change in Washington or threaten to invade Nevada."

**Nuclear War Outweighs Asteroids 2/2**

### The risk of nuclear war must be weighed against the low probability of an asteroid impact

Weissman, 94

[Paul R. Weissman, “The Comet and Asteroid Impact Hazard in Perspective” Submitted to Hazards Of Comet and Asteroid Impacts, University of Arizona Press, 1994, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.38.3259]

The hazard posed by impacts of comets and asteroids is not the only problem facing society. Currently identified ecological problems include overpopulation, global warming, global cooling and climate change (from volcanic aerosols), ozone Furthermore, there are human problems such as malnutrition, depletion, and deforrestation. disease (in particular, but not only, AIDS), and pollution, and political problems such as nuclear proliferation and ethnic strife. Additionally, some areas of technical investigation, such as earthquake prediction, have substantial potential for preventing substantial loss of life and/or economic damage. These lists are not meant to be all-inclusive, but rather provide a sample of the global questions facing modern society. All of these hazards place demands on governments for solutions, and for the resources to achieve those solutions. Many of the hazards are interrelated, in both positive and negative ways. For example, deforrestation provides land for growing food and for allowing population growth. On the other hand, malnutrition and disease serve as a check on overpopulation, though certainly not a very humane one. What priority then should be given to the impact hazard problem? Is it more important than all of these other hazards? Potentially, very large impacts, comparable to the late Cretaceous event, could result in massive global starvation. But such events have a mean frequency of once every 50 million years. Smaller impacts may still result in sufficient climatic change to cause global crop failure and famines. If one uses the estimate of Toon et al. (this volume) then that threshold occurs for impacts of objects 1 to 2.2 km in diameter, or with frequencies of about once every 1.1 x 1@ to 5 x 10S years. Among the hazards listed above, only two likely have the potential for massive, near-term loss of life on a global scale: nuclear war and AIDS. The threat of nuclear annihilation has decreased substantially in recent years as a result of the end of Cold War. However many nations still possess nuclear weapons and others are attempting to obtain them. Some of the present or potential nuclear-capable nations are in what would be considered “trouble spots”, e.g., the Middle East, and so there is heightened potential for nuclear incidents, with unknown consequences. Each of these two hazards clearly demand immediate and substantial attention and resources. Each has received substantial resources, both in the United States and in other developed countries. Given the immediate nature of these threats, it is entirely logical that they have priority over the impact hazard.

### Nuclear war outweighs the non-existent threat from NEO collision

Benett 10

[James Bennett, Prof of Economics @ George Mason, “The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors,” p. 168-169]

Given that there “is no known incident of a major crater-forming impact in recorded human history,” argues P.R. Weissman of the Jet Propulsion Laboratory, and since “the credibility of the impact hazard” is justifiably low with the public and governmental decision-makers, we ought to defer the development of a defensive system until such time as technological advances permit us to do so at a reasonable cost.55 There is also, he points out — at the risk of being called chauvinist, no doubt, by the more feverish Earth-savers — the “pragmatic and/or parochial” fact that the United States accounts for 6.4 percent of the total land mass of the Earth, and only 1.9 percent of the total area, including water.56 Thus anything short of a civilization-ending asteroid would be exceedingly unlikely to hit the U.S. By contrast, such threats as infectious diseases and nuclear war present a more real and immediate danger to Americans, and to earthlings in general. Perhaps money would be better spent addressing those matters?

## **A2: Asteroids » Extinction**

### Asteroids won’t cause extinction, too minor

Gorman ’03

[Discover Magazine Staff Writer (Rachael Moeller, “Discover Data: Extinction Trends: No Need to Fear the Asteroids?” February 1, <http://discovermagazine.com/2003/feb/breaknumbers>, accessed on July 14, 2008]

Based on evidence that an asteroid impact helped to reduce the dinosaurs to dust 65 million years ago, scientists have reasoned that other large impacts might produce similar extinctions**—**and that humans could be next on the hit list.But John Alroy of the University of California at Santa Barbara finds that life may be surprisingly resilient. He examined the size and ages of major craters in North America and compared them with the mammalian fossil record over the past 65 million years. Contrary to the predictions of one prominent extinction model, known as Raup's Kill Curve, Alroy could detect no correlation between impact size and the rate of extinction(above). He argues that life is far more tenacious than some scientists make it out to be. Furthermore,mass extinctions are very unusual, he says, and are rarely caused by a single catastrophic event. They are much more likely to result from slower, less dramatic processes such as species migration, climate change, competition, and disease.

### We’ve found all of the asteroids large enough to cause extinction – no threat

Morrison 6

[David Morrison, Working Group on Near Earth Objects, International Astronomical Union, “Asteroid and comet impacts: the ultimate environmental catastrophe,” 2006, http://rsta.royalsocietypublishing.org/content/364/1845/2041.full]

The survey results have already transformed our understanding of the impact threat. If we focus on asteroids larger than 2 km, which is the nominal size for a global catastrophe, then we are already nearly 90 per cent complete. For 5 km diameters, which may be near the threshold for an extinction event, we are complete today. Thus, astronomers have already assured us that we are not due for an extinction-level impact from an asteroid within the next century. Barring a very unlikely strike by a large comet, we are not about to go the way of the dinosaurs. Thus, the rest of this paper focuses on the more frequent impacts by sub-kilometre asteroids, which are still big enough to destroy a large city or a small country, or to devastate a coastline, with possibly world-altering economic and social consequences.

## A2: Asteroids » Nuclear War

### Failsafes and other monitoring measures check accidental nuclear war

Rosenkrantz 5

[Steven Rosenkrantz, Foreign Affairs Officer, Office of Strategic and Theater Defenses, Bureau of Arms Control, “Weapons of mass destruction: an encyclopedia of worldwide policy, technology, and history,” 2005, p.1-2]

Since the dawn of the nuclear era, substantial thought and effort have gone into preventing accidental and inadvertent nuclear war. Nuclear powers have attempted to construct the most reliable technology and procedures for command and control of nuclear weapons, including robust, fail-safe early warning systems for verifying attacks. The United States and the Soviet Union also maintained secure second-strike capabilities to reduce their own incentives to launch a preemptive strike against each other during crisis situations or out of fear of a surprise attack. The two nuclear superpowers worked bilaterally to foster strategic stability by means of arms control and confidence-building measures and agreements. Several confidence-building agreements were negotiated between the two-superpowers to reduce the risk of an accidental nuclear war: the 1971 Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War, the 1972 Agreement on the Prevention of Incidents on and over the High Seas, and the 1973 Agreement on the Prevention of Nuclear War. Following the end of the Cold War, the United States and the Russian Federation have continued to offer unilateral initiatives and to negotiate bilateral agreements on dealerting and detargeting some of their nuclear forces to further reduce the likelihood of a catastrophic nuclear accident. They have concluded agreements on providing each other with notifications in the event of ballistic missile launches or other types of military activities that could possibly be misunderstood or misconstrued by the other party.

### CP TEXT: The United States federal government should establish a near earth object warning center to assess and release the data regarding impending collisions to all interested parties with regards to the prevention of accidental nuclear miscalculation.

Bosker 2

[Staff Sgt. A.J., “Near-Earth Objects Pose Threat, General Says,” SpaceDaily, Sep 17, 2002, http://www.spacedaily.com/news/deepimpact-02s.html]

Worden suggested that a NEO warning center be established that can assess and release this data as soon as possible to all interested parties while ensuring sensitive data is safeguarded. He recommended to the commission that a natural impact warning clearinghouse could be formed by adding no more than 10 people to current U.S. Space Command early warning centers. This organization would catalog and provide credible warning information on future NEO impact problems, as well as rapidly provide information on the nature of an impact. In order for this clearinghouse to provide accurate information, NEOs must first be detected, cataloged and their orbits defined. Current ground-based systems are already cataloging large kilometer-sized objects but have a difficult time finding smaller NEOs. Most sail by the earth unnoticed until they have passed, he said.

## A2: Apophis

### Low probability of collision and the status quo solves

Bryner 11

[Michelle, “Russians: 2036 Killer Asteroid Collision: NASA Unimpressed,” February 4, 2011, CBS News (story originally appeared on Space.com), http://www.cbsnews.com/8301-501465\_162-20030674-501465.html]

In 2004, NASA scientists announced that there was a chance that Apophis, an asteroid larger than two football fields, could smash into Earth in 2029. A few additional observations and some number-crunching later, astronomers noted that the chance of the planet-killer hitting Earth in 2029 was nearly zilch. Now, reports out of Russia say that scientists there estimate Apophis will collide with Earth on April 13, 2036. These reports conflict on the probability of such a doomsday event, but the question remains: How scared should we be? “Technically, they’re correct, there is a chance in 2036 [that Apophis will hit Earth]," said Donald Yeomans, head of NASA’s Near-Earth Object Program Office. However, that chance is just 1-in-250,000, Yeomans said. The Russian scientists are basing their predictions of a collision on the chance that the 900-foot-long (270 meters) Apophis will travel through what’s called a gravitational keyhole as it passes by Earth in 2029. The gravitational keyhole they mention is a precise region in space, only slightly larger than the asteroid itself, in which the effect of Earth's gravity is such that it could tweak Apophis' path. “The situation is that in 2029, April 13, [Apophis] flies very close to the Earth, within five Earth radii, so that will be quite an event, but we’ve already ruled out the possibility of it hitting at that time,” Yeomans told Life’s Little Mysteries. “On the other hand, if it goes through what we call a keyhole during that close Earth approach … then it will indeed be perturbed just right so that it will come back and smack Earth on April 13, 2036,” Yeomans said. The chances of the asteroid going through the keyhole, which is tiny compared to the asteroid, are “minuscule,” Yeomans added. The more likely scenario is this: Apophis will make a fairly close approach to Earth in late 2012 and early 2013, and will be extensively observed with ground-based optical telescopes and radar systems. If it seems to be heading on a destructive path, NASA will devise the scheme and machinery necessary to change the asteroid’s orbit, decreasing the probability of a collision in 2036 to zero, Yeomans said. There are several ways to change an asteroid’s orbit, the simplest of which is to run a spacecraft into the hurtling rock. This technology was used on July 4, 2005, when Deep Impact smashed into the comet Tempel 1.

### More evidence - low risk of collision or NASA innovation solves

Speigel 11

[Lee, Contributor, “Russian Scientists Say Asteroid on Collision Course With Earth,” AOL News, Feb 10, 2011, http://www.aolnews.com/2011/02/10/russian-scientists-say-asteroid-on-collision-course-with-earth/]

In 2004, NASA suggested the possibility that the asteroid called Apophis, bigger than two football fields, might collide with our planet in 2029. Further computations changed their minds about that prediction. And now, Russian figures give us a new date for a possible encounter with the giant rock from space. "Technically, they're correct -- there is a chance in 2036" that Apophis will hit Earth, Donald Yeomans, head of NASA's Near Earth Object Program, told the Life's Little Mysteries website. But Yeomans added that the odds of this happening are only 1 in 250,000. Last month, Leonid Sokolov of Russia's St. Petersburg State University announced that "Apophis will approach Earth at a distance of 37,000 to 38,000 kilometers on April 13, 2029. Its likely collision with Earth may occur on April 13, 2036." But Sokolov also conceded that a 2036 collision was unlikely because scientists should be able to figure out a way to prevent it. "Our task is to consider various alternatives and develop scenarios and plans of action, depending on the results of further observations of Apophis," Sokolov told RIA Novosti, a Russian news agency. The Russian researchers theorize that the nearly 1,000-foot-diameter Apophis might pass through an area in space called a gravitational keyhole in its 2029 pass of Earth. This keyhole might alter the asteroid's course and aim it for a more direct hit of our home planet. Yeomans explains that NASA isn't concerned about Apophis coming too close to us in 2029. "We've already ruled out the possibility of it hitting at that time," he said. "On the other hand, if it goes through what we call a keyhole during that close Earth encounter ... then it will indeed be perturbed just right so that it will come back and smack Earth on April 13, 2036." But he added that the chance of this happening is very small. Many works of science fiction and movies have imagined the staggering aftermath of an asteroid hitting the Earth, including "Meteor" (1979) and 1998's "Deep Impact" and "Armageddon." If it turns out that Apophis seems truly destined to beat the odds and collide with us, Yeomans said, NASA will come up with a plan and the necessary technology to alter the asteroid's path in 2036.

## **A2: Small Asteroids Bad**

### Even small asteroids only hit once in 10,000 years

Morrison et. al, 3

[ Morrison, D., NASA Astrobiology Institute, A. W. Harris, NASA Jet Propulsion Laboratory, G. Sommer, RAND Corporation, C. R. Chapman, Southwest Research Institute, and A. Carusi, Istituto di Astrofisica Spaziale, Roma, Dealing with the impact hazard. In Asteroids III, ed. W. Bottke, A. Cellino, P. Paolicchi, and R. P. Binzel, 739–54. 2003. University of Arizona Press. ]

While most of the data are approximately consistent with a power law, the lunar-derived NEO population curve of Werner et al. (2002) shows an obvious departure, usually interpreted as a shortage of small (diameter less than a few hundred meters) impactors, although it might also suggest an early excess of large asteroids or comets not currently represented in the NEA flux. Interpreted in the usual way, however, the lunar curve indicates that the frequency of Tunguska-size impactors is roughly one per 10,000 yr, more than an order of magnitude below the usually quoted frequency of such impacts, and a surprising result given that we experienced such an event within the last century. We don’t know where the problem lies, but we suggest that the NEA population derived by Werner et al. from the lunar cratering statistics warrants consideration of alternative interpretations of the data

### **No concern from small objects; largest craters are from substantially large NEO’s**

NATIONAL  ACADEMY  OF  SCIENCES 2009

(Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies ISBN 978-0-309-14968-6 Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies; National Research Council NATIONAL ACADEMY OF ENGINEERING INSTITUTE OF MEDICINE NATIONAL RESEARCH COUNCIL http://www.nap.edu/catalog.php?record\_id=12842)

2 Risk Analysis Impacts are one of the most fundamental processes shaping planetary surfaces throughout the solar system. Images of many solar system objects are dominated by craters formed throughout the past 4.5 billion years. Smaller airless bodies in particular retain a significant history of collisions. Earth’s Moon has been used to determine variation in the rate of impacts since the earliest days of the solar system. Imagery, coupled with the dating of lunar materials, has allowed scientists to demonstrate that the rate of impacts has gradually diminished since these early times. Although the frequency of impacts due to bodies of all sizes is considerably less than during the first 700 million years of solar system history, as the planetary orbits have stabilized and a significant proportion of the smaller objects has been accreted, the most significant risk remains from collisions with bodies on oval-shaped orbits (such as comets) and objects with orbits that pass near Earth’s orbit. The average amount of material accreted daily to Earth is estimated to be in the range of 50 to 150 tons of very small objects (Love and Brownlee, 1993). This material is mostly dust, although there are abundant small objects that burn up quickly in the atmosphere and are evidenced by meteor trails. More rarely, larger objects impact Earth. It is now widely believed that the impact of an approximately 10-kilometer-diameter object formed the Chicxulub Crater near the Yucatan Peninsula about 65 million years ago, very likely resulting in the extinction of the dinosaurs. Its mass is similar to that of the total amount of dust and other small objects accreted to Earth during the time since that impact. Substantial atmospheres around planetary bodies act as significant filters to incoming objects. Smaller objects, particularly those that are lower in density and more fragile, vaporize in the upper reaches of the atmosphere, while more intact, larger bodies may survive to impact the surface. Thus, small craters are much less common on bodies with dense atmospheres, such as Earth, Venus, and Titan, than they are on Mercury and the Moon, with Mars somewhere in between. Of course there are still substantial numbers of large impact craters even on Venus, with its dense carbon dioxide atmosphere; the lack of weathering and erosion, coupled with low rates of volcanic and tectonic activity over the past 0.5 billion years, has allowed the retention there of a significant number of craters, most largely unaltered since emplacement. By contrast, the movement of water on Earth and the action of plate tectonics have both resulted in the loss of much of the cratering record on this planet There are more than 170 established impact craters on Earth, including the approximately 1.2-kilometer Meteor Crater in Arizona (Figure 2.1). The largest known terrestrial crater is the 300-kilometer-diameter Vredefort Crater in South Africa, dated at around 2 billion years old..

## A2: Asteroid Mining

### Asteroid mining is prevented by international treaties

Lamb ’01

[David, Philosophy and Bioethics at the University of Birmingham, “The Search for Extraterrestrial Intelligence: A Philosophical Inquiry”]

Space travel, it has been argued, is now or never affair (Breuer, 1982), as we are using up the necessary material resources. There are proposals to mine asteroids. Space Dev is an American exploration company that wants to stake its claim to an asteroid, which is intended to be mined for its minerals when the technology becomes available (Kleiner, 1997: 18). This raises legal problems, as international treaties prevent nations from staking a claim to heavenly bodies. But the status of private companies is not that dear in this field. It h~1s been pointed out that in about 200 years there will not he the fossil and metallic raw material for spaceships and space stations (Breuer, 1982: 256). If work is not undertaken soon to extract material from the I'vloon, it will be too late to exploit the Moon or the asteroids, as there will not be the material left on Earth to create the rockets capable of lifting a minimum o[ 2,000 tonnes of implements and a nuclear }'eactor to the I'vloon. The distances vvithin the solar system are daunting, not only in terms o[ material resources, but in terms of the psychological problems encountered in long periods in space. <112>

## A2:Nuclear Mitigation Bad

### **NEO mitigation require nuclear propulsion – no other system can provide the necessary energy**

Remo 6

[John L. Remo, The New York Academy of Sciences, 12 Jan. 2006 Assessing NEO Hazard Mitigation in Terms of Astrodynamics and Propulsion Systems Requirements, Vol. 1017, <http://onlinelibrary.wiley.com/doi/10.1196/annals.1311.019/full>]

The inherent uncertainty in NEO orbits and physical properties places unique demands of a NEO reconnaissance/rendezvous/interception mission to be carried out in a timely manner. For example, the closer to impact the more energy must be expended in a shorter period of time for the equivalent deflection, which in turn increases the uncertainty in the material response and momentum coupling coefficients. NEO mitigation missions are distinct from typical space exploration missions that enjoy the luxury of years of planning based on accurate determinations of the exact position of the target in time. Conventional planetary exploration missions also generally include the advantages of gravitational boosts from other planetary bodies, but the demands of a NEO mitigation require that the mission be executed within an externally imposed time frame and without regard for gravitational boosts and related libration points. This is because the time and place of the mitigation interaction will be determined by what is thought to be the collision course of the NEO with Earth; a NEO mitigation mission will have to be carried out within a constrained time frame dictated by the time to impact Earth. Without necessarily being able to take advantage of a trajectory that is gravitationally boosted (accelerated) by planetary bodies, the NEO interception spacecraft (NIS) must totally rely upon its own power to reach its objective in a timely manner. Furthermore, interception should generally take place as far away from Earth as possible in order to increase the net displacement of an orbital velocity deflection and (ideally) provide a time/distance buffer against unforeseen consequences. These factors place a large burden on the mission and limit propulsion options. Clearly, the above missions require propulsion systems well beyond the limits of even the most efficient and powerful conventional chemical propulsion systems. Because of the unique mission demands, spacecraft used for interception must have a robust propulsion system capable of delivering a large payload at a long range and also be capable of changing its direction to compensate for unanticipated NEO orbital variations. This last requirement demands long specific impulse propulsion systems that can be started and stopped as the need arises to provide Δ*V*spacecraft to alter trajectories. Given current propulsion system technology, such a system can only be provided by nuclear reactor based technology that could initially propel the primary spacecraft with nuclear thermal power (NP) and then provide electricity to provide nuclear electric powered (NEP) submodules (secondary units) using electric (plasma) propulsion.

# A2: Solvency

## A2: U.S. Key

### **Any planetary defense system will require international cooperation**

Jones ‘8

[Thomas, fellow at the American Institute of Aeronautics and Astronautics, “Asteroid deflection: Planning for the inevitable,” *Aerospace America*, October, lexis]

Any efforts at NEO deflection must be international in scope. First, because of tracking uncertainties, a NEO’s predicted impact point will lie along a thin line spanning most of a hemisphere (the projection of its orbital plane on Earth’s surface). This risk corridor will span many nations until tracking accuracy improves, quite close to impact. Second, the process of deflecting a NEO will necessarily shift that impact point along the corridor, toward the Earth’s limb, lowering impact risk for one nation but temporarily raising it for another, until the threat is eliminated entirely. Only an international consensus on deflection decisions will succeed; without it, a serious impact threat will generate controversy, prolonged argument, and political inaction—in short, paralysis.

### Private enterprise investment in planetary defense requires international cooperation

**Urias et al 96**

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

Since private enterprises and not governments produce systems, it will be important to achieve the cooperation of the global community to ensure that the economic needs of these enterprises are fulfilled. In this regard, it may be beneficial to adopt the ESA policy of juste retour, despite its inherent drawbacks in efficiency and economies of scale, to promote global commitment and cooperation.31 Considering the general willingness of governments to participate in large space projects and with the ever-present uncertainty of the budget process, it is conceivable that a consortium-based PDS effort could become another International Space Station (ISS). In the latter case, the ISS project ended up with many ideas, studies, and proposals, but offered little to nothing in the way of actual development due to normal budget fluctuations, infighting, and the resulting inability of the participants to absorb the exorbitant developmental costs. Like ISS, a repeat of this approach might also cause the PDS project to be added to the list of failures.

### **Fear of weaponinzation will require international cooperation on planetary defense**

Urias et al 96

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

If one nation, such as the US, attempted to place weapons in space, the world would likely oppose such an attempt. Therefore, the US would not likely attempt to forge a PDS alone. Realistically, the US would require a coalition with other nations, such as the Europeans, Russians, Japanese, and other aerospace nations of the future, before placing weapons in space. While discussing the interaction of each of these nations is beyond the scope of this paper, the political and economic issues are worthy of comment since these factors will affect all participants. In this section, our Italian co-author, Ms Iole M. DeAngelis, offers insight into this area, especially, from a European point of view.29

## A2: U.S. Key – Europe

### A planetary defense system will require an international effort coordinated by europe

**Urias et al 96**

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

As discussed in this paper, the development, testing, and deployment costs of a planetary defense system likely will be staggering, especially if the three-tier PDS concept is adopted. However, we believe the catastrophic results of a large asteroid or comet impact, including the potential extinction of the human race, justify such an expenditure, especially if it can be incrementally funded. Obviously, since the planetary defense problem is global in nature, one should not expect that the PDS costs will be borne by one or even a few countries. Indeed, such an endeavor will certainly fail without the cooperation and commitment of the entire global community. In this sense, Europe must be a major player in the successful implementation of a PDS. When considering future European involvement in space-related issues, it is important to include the activities of the European Space Agency (ESA), with its international perspective and influence. Without a doubt, the ESA will be critical to the successful development and deployment of the PDS, especially with its close ties to France as one of ESA’s most influential members.

## A2: U.S. Key – UN

### The UNs global charter makes it the ideal organization to lead a planetary defense system

Urias et al 96

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

Because of its global charter, the United Nations is probably the best organization to assume the leadership role in pulling together the global community, educating it about the planetary defense problem, garnering support for the development of a global PDS strategy, and ultimately serving as the primary advocate for the evolution of a functional planetary defense system to protect the EMS against ECO impacts. Clearly, the international influence of the UN will serve as an important foundation for the global community to implement the PDS strategic plan.

## A2: Status Quo Detection Fails 1/2

### **Detection and complete inventory of NEO’s is difficult, making numerous errors possible**

NATIONAL ACADEMY OF SCIENCES 2009 (Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies ISBN 978-0-309-14968-6 Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies; National Research Council NATIONAL ACADEMY OF ENGINEERING INSTITUTE OF MEDICINE NATIONAL RESEARCH COUNCIL <http://www.nap.edu/catalog.php?record_id=12842>)

3 Survey and Detection of Near-Earth Objects Congress has established for NASA two mandates addressing near-Earth object (NEO) detection. The first mandate, now known as the Spaceguard Survey, directed the agency to detect 90 percent of near-Earth objects 1 kilometer in diameter or greater by 2008. By 2009, the agency was close to meeting that goal. Although the estimate of this population is continually revised, as astronomers gather additional data about all NEOs (and aster- oids and comets in general), these revisions are expected to remain. The 2009 discovery of asteroid 2009 HC82, a 2- to 3-kilometer-diameter NEO in a retrograde (“backwards”) orbit, is, however, a reminder that some NEOs 1 kilometer or greater in diameter remain undetected. The second mandate, the George E. Brown, Jr. Near-Earth Object Survey section of the NASA Authorization Act of 2005 (Public Law 109-155), directed that NASA detect 90 percent of near-Earth objects 140 meters in diameter or greater by 2020. However, what the surveys actually focus on is not all NEOs but the potentially hazardous NEOs. It is possible for an NEO to come close to Earth but never to intersect Earth’s orbit and therefore not be potentially hazardous. The surveys are primarily interested in the potentially hazardous NEOs, and that is the population that is the focus of this chapter. Significant new equipment (i.e., ground-based and/or space-based telescopes) will be required to achieve the latter mandate. The administration did not budget and Congress did not approve new funding for NASA to achieve this goal, and little progress on reaching it has been made during the past 5 years. The criteria for the assessment of the success of an NEO detection mandate rely heavily on estimates that could be in error, such as the size of the NEO population and the average reflectivity properties of an object’s surface. For many years, the average albedo (fraction of incident visible light reflected from an object’s surface) of NEOs was taken to be 0.11. More recent studies (Stuart and Binzel, 2004) determined that the average albedo was more than 25 percent higher, or 0.14, with significant variation in albedo present among the NEOs. The variation among albedos within the NEO population also contributes to the uncertainties in estimates of the expected hazardous NEO population. This difference implies that, on average, NEOs have diameters at least 10 percent smaller than previously thought, changing scientists’ understanding of the distribution of the NEO population by size. Ground-based telescopes have difficulty observing NEOs coming toward Earth from near the Sun’s direction because their close proximity to the Sun—as viewed from Earth—causes sunlight scattered by Earth’s atmosphere to be a problem and also poses risks to the telescopes when they point toward these directions. Objects remaining in those directions have orbits largely interior to Earth’s; the understanding of their number is as yet very uncertain. In addition, there are objects that remain too far from Earth to be detected almost all of the time. The latter include Earth-approaching comets (comets with orbits that approach the Sun at distances less than 1.3 astronomical units [AU] and have periods less than 200 years), of which 151 are currently known. These represent a class of objects probably doomed to be perpetually only partly known, as they are not likely to be detected in advance of a close Earth encounter. These objects, after the completion of exhaustive searches for NEOs, could dominate the impact threat to humanity. Thus, assessing the completeness of the NEO surveys is subject to uncertainties: Some groups of NEOs are particularly difficult to detect. Asteroids and comets are continually lost from the NEO population because they impact the Sun or a planet, or because they are ejected from the solar system. Some asteroids have collisions that change their sizes or orbits. New objects are introduced into the NEO population from more distant reservoirs over hundreds of thousands to millions of years. The undiscovered NEOs could include large objects like 2009 HC82 as well as objects that will be discovered only months or less before Earth impact (“imminent impactors”). Hence, even though 85 percent of NEOs larger than 1 kilometer in diameter might already have been discovered, and eventually more than 90 percent of NEOs larger than 140 meters in diameter will be discovered, NEO surveys should nevertheless continue, because objects not yet discovered pose a statistical risk: Humanity must be constantly vigilant. Finding: Despite progress toward or completion of any survey of near-Earth objects, it is impossible to identify all of these objects because objects’ orbits can change, for example due to collisions. Recommendation: Once a near-Earth object survey has reached its mandated goal, the search for NEOs should not stop. Searching should continue to identify as many of the remaining objects and objects newly injected into the NEO population as possible, especially imminent impactors.

A2: Status Quo Detection Fails 2/2

### Asteroids headed towards earth will be detected early

Smith 9

[Lewis, Science Reporter, “Astronomers track asteroid's collision with Earth,” The Times, March 26, 2009, http://www.timesonline.co.uk/tol/news/science/article5976704.ece]

Big asteroids, those that are more than half a mile long and would be likely to cause devastation if they hit the planet’s surface, are much easier for astronomers to see, and any headed for Earth would, researchers believe, be detected years or even decades before they arrived.

## A2: U.S. Leadership Now

### The US isn’t looking for space leadership – pursuing international cooperation

Fukushima 11

Yasuhito Fukushima. January 2011. An Asian perspective on the new US space policy: The emphasis on international cooperation and its relevance to Asia. Elsevier.

Obama’s NSP is, however, rooted in cooperation and incorporates the concept throughout, instead of just mentioning it in one section. The introduction states that “the United States hereby renews its pledge of cooperation,” whereas for the principles of space activities, the USA will adhere to its principles “in this spirit of cooperation” and proposes that other nations follow suit. Also, as one of the goals of its national space programs, emphasis is placed on the expansion of international cooperation. In the inter-sectoral guidelines there is a special section on international cooperation, which stipulates the need to strengthen US space leadership, identify areas for potential international cooperation, and develop transparency and conﬁdence-building measures (TCBMs). According to a senior administration ofﬁcial, who played a central role in shaping the document, enhancing international cooperation and collaboration in space is positioned as a “key cornerstone” in Obama’s NSP.

## A2: Space Based PDS Key

Space based systems aren’t necessary – more risks and costs

NASA 7

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, “Near-Earth Object Survey and Deflection Analysis of Alternatives Report to Congress”, March 2007, pg. 10 <http://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf>

Not only are space-based systems likely to be more expensive to develop than ground-based systems, space-based systems also have some additional risks. Getting a space-based system into place subjects it to possible launch and deployment failures and places it in an extreme environment that can result in a shorter lifetime (seven to ten years). This shorter lifetime is an important consideration if a NEO program is expected to continue to track objects for extended periods of time. In addition, they depend on spacecraft-to-ground data links and unique onboard software.

# Politics

## Politics Link – Plan Unpopular

### The plan is seen as a waste of money in a tough economic climate

Park et al. 1994

[Richard L. Park, President of the American Physical Society, PhD, Lori B. Garver of the National Space Society, and Terry Dawson of the US House of Representatives, “The Lesson of Grand Forks: Can a Defense against Asteroids be Sustained?” Hazards Due to Comets and Asteroids ed. Tom Gherels, pg. 1225-1228]

IV. INVOLVING CONGRESS Efforts to persuade governments lo invest significant resources in evaluation of the hazard of asteroid impacts must overcome what has been called "the giggle factor." Clearly, elected officials in Washington are not being inundated with mail from constituents complaining that a member of their family has just been killed or their property destroyed by a marauding asteroid. Indeed, the prevailing view among government officials who hear about this issue for the first time is that the epoch of large asteroid strikes on Earth ended millions or billions of years ago. Congressional involvement has been confined to the Committee on Science, Space and Technology of the U. S. House of Representatives, whose current chair, George Brown of California, has maintained an interest in the asteroid issue for several years. The Committee directed NASA to conduct two international workshops on the asteroid threat (House Committee on Science, Space and Technology 1990). The objective of the first was to determine the extent to which the threat is "real," and to define a program for significantly increasing the detection rate of large asteroids in Earth-crossing orbits. The second dealt with the feasibility of preventing large asteroids from striking Earth (see the Chapter by Canavan et al.). In March of 1993, the Space Subcommittee held a formal hearing to examine the results of the two workshops. Some members remain skeptical that the threat is real. But even among those who recognize that it is only a question of when a major impact will occur, there was no sense of urgency. Given the severe constraints imposed by the current budget situation, therefore, it seems unlikely that Congress would agree to devote more than a few million dollars per year to asteroid detection and research. If prudently spent, however, even that modest level of resources should significantly speed up the process of cataloging Earth-crossing asteroids. Perhaps the major impact of the workshops has been in NASA itself. The Agency now seems persuaded that near-Earth asteroids are deserving of scientific attention, and that efforts should be made to increase the rate at which such objects are identified.

## Politics Link Turns Case

### Public opinion is key to funding and research for the plan

**Urias et al 96**

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

Both education and communication will be crucial to the success of the PDS developmental process. The ECO threat must be presented in layman’s terms, not using complex scientific jargon, for the program to gain public support. For example, an 80- year-old grandmother must be able to understand why a part of her pension will be used to pay for this system. Public opinion will influence political decisions regarding funding and research and development commitments.

### **The program must avoid political infighting to be successful**

Borchers 2009

(Brent W., Major, USAF Should the USAF be Involved in Planetary Defense?AIR COMMAND AND STAFF COLLEGE AIR UNIVERSITY <http://www.dtic.mil/cgi> bin/GetTRDoc?AD=ADA539693&Location=U2&doc=GetTRDoc.pdf)

Another camp would see that the newly formed, post 9/11 Department of Homeland Security would have purview over such a project. After all, the main reason we are concerned about a NEO impact event is to take care of the civilians at home and prevent loss of innocent life. This department would certainly have a valid claim to stake in this case. However, the department of Homeland Security is among the newest of U.S. organizations they may not have the capability and experience within their ranks to develop and maintain such a large and complicated system. They also have virtually no experience in space or weapons systems when compared to the USAF, DOD and NASA. Whoever gets the final nod to go ahead with the project of planetary defense, chances are there would be a lot of debate in Congress as to who gets the funding for such a project and some of it probably won’t be altruistic in nature. Senators and Representatives could be swayed to vote for a certain agency to take the lead depending on the economic impact it would have in their districts. This problem is exacerbated because we’re talking about building a system before we need it. Most people still wouldn’t see a NEO as a serious threat and the elected representatives may only see this project as a “cash cow” to argue over on Capitol Hill and play politics within their districts. To this day there are still Congressional “food fights” that we see over who gets to build the next tanker aircraft for the USAF or the next search and rescue helicopter contract for the AF. These “food fights” in Congress don’t really take into account what the organization knows that it needs or what it wants for the mission. We’d have to be sure such a problem doesn’t derail a planetary defense project before it is even started.

## A2: Plan Popular

### No constituency supports the plan

**France ‘2k**

(Martin, Lt. Colonel, USAF, “Planetary Defense: Eliminating the Giggle Factor, [Air & Space Power Journal](http://www.airpower.maxwell.af.mil/airchronicles/apje.html),

<http://www.airpower.maxwell.af.mil/airchronicles/cc/france2.html>)

Perhaps the greatest intellectual challenge in dealing with this threat is the extraordinarily low annual likelihood of occurrence coupled with the incomparably dire consequences.12 The higher than expected likelihood of "death by asteroid" is attributed to the supposition that no event short of global nuclear war has the potential to kill tens or hundreds of millions of people—more than accounting for a large-scale impact’s low chance of occurrence. There is, however, no "relevant history" for an asteroid strike causing a global catastrophic event, so even if it is inevitable that such a strike will someday occur, few are able to internalize the risk or view a need for action. Political changes need constituencies and ‘people who will be harmed by an impact’ simply do no make up an identifiable constituency today13 —unlike the millions who fight for funding to further diminish those threats which are, statistically, far less likely to kill them (e.g., nuclear power accidents).

### **More evidence – no one cares**

**Urias et al 96**

[COL (Sel) John M. Urias Et. Al., Planetary Defense: Catastrophic Health Insurance for Planet Earth,” A Research Paper Presented To Air Force *2025,October 1996, http://csat.au.af.mil/2025/volume3/vol3ch16.pdf]*

Most of the world’s population does not know or care about the prospect of cosmic collisions, although this hazard from space is a subject of deadly concern to humanity. Unfortunately, there are fewer than a dozen people currently searching for ECOs worldwide, fewer people than “it takes to run a single McDonalds.”2