

**NASA ADVISORY COUNCIL (NAC)
Ad-Hoc Task Force on Planetary Defense**

CORRECTED MINUTES

Meeting Date: July 8 - 9, 2010

AGENDA:

- Ad-Hoc Task Force Timeline
- Fact Finding Report
- Next Generation Ground-Based Search
- Space-Based Search Options
- Proposed Space-Based Infrared Near Earth Object (NEO) Search System
- Short Term Warning Capability and Implications
- Emergency Management Issues: NASA's Interface
- Deflection Concept Development and Validation
- International Coordination on Planetary Defense
- Preliminary Discussion of Task Force Recommendations and Final Report

ATTENDING:

Ad-Hoc Task Force: Tom Jones (Co-Chair), Rusty Schweickart (Co-Chair), Richard Binzel, Clark Chapman, Lindley Johnson, Brian Wilcox, Donald Yeomans, Bette Siegel, Jane Parham

Presenters: Stephen Larson, Robert Arentz, Roger Linfield, Amy Mainzer, John Tonry, Dennis Mileti, Edward Lu

Public: Leonard David, Space.Com Reporter (newsspace@aol.com); Tad Friend, New Yorker Staff Writer (tad_friend@newyorker.com); James Rendleman, Secure World Foundation (jrendleman@swfound.org)

ACTIONS

Target August 1 for submission of draft Task Force report sections (Clark by August 6)

NAC.TF_100708_001: *Tom Jones.* Distribute David Morrison white paper on Planetary Defense component in precursor programs.

NAC.TF_100708_002: *Rick Binzel.* Analyze NRC report to see where characterization fits.

NAC.TF_100708_003: *Tom Jones.* Draft Task Force report section on synergy (science, exploration, and Planetary Defense).

NAC.TF_100708_004: *Lindley Johnson.* Pursue fact-finding meetings with DOD and DHS.

NAC.TF_100708_005: *Tom Jones.* Pursue fact-finding at NASA HQ.

DISCUSSION

Timeline for Ad-Hoc Task Force on Planetary Defense

A brief discussion reiterated the Task Force charge: to provide a set of recommendations to the NASA Advisory Council (NAC) regarding NASA's role in Planetary Defense, which recommendations will ultimately go to the NASA Administrator.

Task Force members agreed to meet on August 17 and August 20, via Webex, to draft the Task Force final report and recommendations.

Discussion Points:

- Recommendations for the White House or other agencies are outside the Task Force purview.
- Ken Ford, NAC Chair, has requested from the Task Force a coherent, organized report that creates priorities for the NASA Administrator should NASA be tasked in the area of Planetary Defense, with crisp and actionable recommendations.
- Overlap noted between Planetary Defense efforts and fundamental science. If an object that is a serious threat is discovered, we need to learn everything about it, both to explain why it is important to defend the planet against it and to understand the best method of defense based on the composition of the object.

Fact Finding Meetings Primarily with NASA Managers

During the past several months, Task Force members have interviewed various NASA managers on the topic of Planetary Defense. The following ideas and suggestions resulting from the fact-finding meetings were noted:

Discussion Points:

- The basic element in the Task Force report is: How should responsibility for NASA's role in Planetary Defense be structured within NASA. This topic has not been addressed in other reports, such as the National Research Council (NRC) report.
- Key would be an individual at NASA HQ who would have a budget.
- NASA should lead but other agencies would be involved as appropriate.
- NASA should have leadership role for U.S. in international activities related to Planetary Defense.
- A dedicated space mission that looks for NEO threats would be useful.
- Ground-based search capabilities may not achieve 140-meter limit by 2020.
- Target a new search for earth-like orbits, which would be of interest to the Exploration Program.
- If NASA Administrator gives priority to Planetary Defense, center directors can structure their organizations to meet objectives of coordinating the work. All Directorates should be involved, so that no Directorate ignores the topic.
- David Morrison, senior scientist at the NASA Astrobiology Institute, Ames Research Center, has written a white paper on Planetary Defense component in precursor programs. Tom Jones will distribute to Task Force. **(Action 001)**
- NASA Chief Technologist is not clear, at this point, that NASA has responsibility in the area of Planetary Defense.
- A new office for Planetary Defense is needed at NASA; functions would be crosscutting.
- Planetary Defense must be placed as a top-level NASA Strategic Goal or as other appropriate significant NASA structural element.
- To date all NASA funding for NEO research has come from the Science Mission Directorate.
- NASA Science Mission Directorate (SMD) has significant expertise related to the elements of Planetary Defense. SMD Associate Administrator encouraged ground-based options.
- Three dimensions of defense – Science, Exploration, and Planetary Defense. Each dimension contributes to the others.
- NASA Exploration Systems Mission Directorate's (ESMD) budget for asteroid robotic precursor missions is totally subscribed.

- ESMD is in the process of better defining NEO missions, so the Task Force has an opportunity now to have input into that.
- No discussions so far with Department of Defense or Department of Homeland Security, though they are considering the possibility of meeting with us. Task Force will pursue this.

Next Generation Ground-Based Search

Dr. Stephen M. Larson, University of Arizona Lunar and Planetary Laboratory, began his briefing by quoting U.S. Public Law 109-155, 42 USC 16691, enacted December 30, 2005: “The NASA Administrator shall plan, develop, and implement a NEO Survey program to *detect, track, catalogue, and characterize the physical characteristics* of near-Earth objects equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth. It shall be the goal of the Survey program to achieve 90 percent completion...*within 15 years* after the date of enactment of this Act.” [December 30, 2020] Dr. Larson noted that existing ground telescope systems are not capable of meeting the Congressional goal. He suggested a plan and presented proposed telescope instrumentation and survey strategies that could potentially meet this goal.

Discussion Points:

- Assuming there will be a space-based observing and tracking system, the value of an improved ground-based system is the capability of performing follow-up observations. Space-based system could not cover all the sky all the time.
- Proposed improved ground-based system would mitigate the error ellipse due to the larger aperture – you can follow objects longer as they fade away.
- Proposed improved ground-based system covers the entire sky twice a month, in average weather.

Space-Based Search Options

Mr. Robert Arentz and Mr. Roger Linfield, Ball Aerospace & Technologies Corp., presented a briefing entitled, “Why Exploration needs an IR telescope in a Venus-like orbit to find NEOs.” This briefing provided additional points supporting the assertion that current ground-based telescopes are not capable of meeting the Congressional goal discussed above. The briefing promoted the use of an infrared system operating in a Venus-like orbit as the only system able to meet the Congressional goal without the contribution of ground-based assets, noting that a similar conclusion was reached by the 2010 NRC study. Further, for Planetary Defense (catalog of all NEOs), an IR telescope in a Venus-like orbit would speed up the survey by decades.

Discussion Points:

- Since the Ad-Hoc Task Force is focused on Planetary Defense, not on the human exploration program, the primary value of the orbiting IR telescope is the greatly increased observation range and the decreased time it will take to discover NEOs 140 meters and larger.

Proposed Space-Based Infrared Near Earth Object (NEO) Search System

Dr. Amy Mainzer, Principal Investigator for the NEOWISE Project (NASA Jet Propulsion Lab), described the space born telescope, WISE (Wide Field Infrared Survey Explorer), launched in 2009, and noted its NEO discoveries to date. WISE will not meet Congressional mandate, but it’s a proof of concept for a larger NEO survey.

Dr. Mainzer explained her NEOWISE project as an enhancement to the WISE mission and a prototype of the powerful NEOCam (a 50 cm infrared telescope in Venus-like orbit), which is

expected to meet the Congressional goal and was recommended in the 2010 NRC report as the fastest way to find most potentially hazardous NEOs.

Discussion concerned technical details.

Short Term Warning Capability and Implications

Dr. John Tonry, Professor, University of Hawaii Institute for Astronomy, briefed the Task Force on the Asteroid Terrestrial-impact Last Alert System (ATLAS), including an overview of hardware, software, and performance.

Discussion Points:

- Advantage of distributing ATLAS system around planet is uncorrelated weather. Also, distributed longitude allows search for very small rocks.
- If ATLAS is funded initially, it could be replicated for distribution to universities and other organizations at no further cost to the government.
- It is the software that is expensive, rather than the hardware. In the proposed ATLAS system, cost of software is defrayed because some of the required software is already in hand. Cost for subsequent systems would be zero.
- ATLAS solves a segment of the big problem of Planetary Defense.

Emergency Management Issues: NASA's Interface

Dr. Dennis Mileti, Professor Emeritus and former Director of the Hazards Center at the University of Colorado at Boulder, presented a lecture without briefing charts. The lecture is summarized below.

Involved in disaster research for 40 years in many countries, Dr. Mileti, is an expert on the structure of warning systems and why they have failed: lack of integration of different system components. He noted the importance of understanding the behavior of organizations and agencies, and the social psychology of public response to warnings. Extensive research on warning systems and response, with findings well replicated, is available at the Hazards Center Library, University of California at Boulder.

An effective warning system structure integrates players across disparate parts of society. Scientists who monitor the environment detect a risk and provide judgment about the nature of the risk. Then the information goes to the emergency management agency, which could involve a local agency, a nation, or a multitude of nations, and a collective decision must be made. Then the information goes to a third universe – the public. All of this requires advanced preparation and cooperation.

In the case of detection of a NEO threat, you have 15 years advance warning. If you make a mistake in communicating this risk to the public, there is time to correct it. If the window of time is short, a matter of weeks or less, the emergency management system must be well oiled and practiced. The bottom line is designing that system in light of all that has been learned from decades of study of failures. And the more rarely the system is used, the greater the importance of emergency preparedness among the mix of scientists, emergency responders, states, nations, and the public. A current example of a good warning system and emergency planning, required by the federal government, is U.S. nuclear power plants. Another is the newly completed (July 2) U.S. tsunami program.

The first step in weaving together an interdisciplinary warning system including scientists, emergency managers, and the public, is a 5x5 matrix. On the left side are different kinds of events and different thresholds that could be detected – five categories of risk. On the other

side are five kinds of actions the public must take. In between are the actions the emergency management community would take. If the scope is larger, it is doomed to fail. Implementation is icing on the cake. The EPA is changing to this matrix approach and is pleased with their dry runs.

Important bottom line: Emergency planning works; not planning does not work.

Culture and level of development matter, because culture limits the number of options available. However, regarding the structural elements of a warning system, culture plays no role. It is implementation that is impacted by culture and available resources.

Social psychology, individual human beings and how they perceive and think, has been the topic of more research than any other element regarding warnings to the public. How the public interprets information is important. You cannot communicate based on what you want to say. The essence of communication is that when you open your mouth, you need to speak in terms of how it is going to land on the ears of whom you are talking to – what you want to leave them with. Don't talk to others as you would talk to yourself. Words matter – and how they are communicated.

You must use words the general public will understand. And it is important for the information to be consistent across the organizations communicating to the public. You must monitor the media to see what is being said to see differences from what the emergency management agencies have said.

There are templates for what warning messages should look like, which Dr. Mileti will share with any federal agency. Wording of the message is of paramount importance, especially in terms of what the public should do. Warning messages need to be thought through and drafted ahead of time, then given to emergency managers and the practitioners of the different disciplines involved, such as psychologists, sociologists, space physicists, or whatever they may be.

When a disaster is pending is not the time to deliver a science lecture to the public. Detection of a threat is only part of the message. You must convey that there is a possible risk and what people need to do about it. This is more important than describing the specific event. Have a well-designed message ahead of time, and you can tweak it to fit any particular details regarding the nature of the threat.

The next topic is public education, meaning giving people information they don't already have. One thing they may not know is that the United States may have a warning system for NEOs. People should also be familiarized with who would be giving them information about what they should do. They need to know that a warning system exists and what it might look like. Planetary Defense is very captivating and would be popular.

Public education is part of what emergency managers do, from the national level to small villages. However, leadership is needed from science agencies. That information does not sell well if it is written by a scientist and handed out. It needs to be done through interaction. An iconic public education document from California, Putting Down Roots in Earthquake Country, was formulated by seismologists and emergency managers. You don't have to learn this by doing it. Many ideas and tools are readily available.

Discussion Points:

- Advice to NASA: Bring NASA decision-makers together with experts from local emergency managers to reveal the importance of Planetary Defense. Instill in NASA managers that they need to provide leadership to reach out to the emergency management community.
- NASA outreach on Planetary Defense begins with the Department of Homeland Security (DHS). However, realistically NASA will be involved with everyone. If you issue a warning to Topeka, Topeka will want to communicate with NASA.
- NASA should begin conversations with other agencies even before it is clear where responsibilities lie. The leadership always falls on the detecting agency, which has to stretch. As examples, the USGS has taken the lead for earthquake preparedness, NOAA leads hurricane preparedness.
- Currently, there is dramatic increased interest in public warning systems at DHS, and they require FEMA to adopt that interest. FEMA has not issued technical guidance in many years, and they are interested in upgrading the quality of warnings in America because of warnings of impending terrorist activities.
- If a major NEO impact was detected to occur in the near future, warning should be issued whenever you discover this. Release the information as soon as you have it. NASA, as well as its emergency manager partners, should be aware of how to handle response. Only local communities can recommend evacuation, because they have to manage and fund it.
- As a hypothetical, if there were a 1 in 10,000 chance that in three years Topeka would be obliterated, no matter how you communicate it people would ignore it because the probability is too low. The emergency management community needs to develop thresholds.

Deflection Concept Development and Validation

Dr. Edward Lu, physicist and former NASA astronaut, presented data on asteroid deflection. The briefing addressed how often deflection capability may be needed, probability of close approach of asteroids, dilemmas of decision makers, deflection campaigns and demonstrations.

Discussion Points:

- Briefing page 4, second bullet: should read PHO (Potentially Hazardous Object), rather than NEO.
- The real decision is what to do given the available information: either get more data or take action now to deal with potential hazard.
- To the extent possible, science missions should consider a Planetary Defense component. Funding has to be added to incentivize Principal Investigator to add that component.
- Mr. Lu advocates a demonstration mission in advance of a real case need to launch an asteroid deflection campaign.
- A priority has to be placed on precision in pinning down the orbit of the asteroid at the start of the process of deflection. Mr. Lu noted that priorities should be (1) Detection, (2) Demonstration deflection, and (3) orbit measurement.
- All three capabilities should be integrated in deflection campaign: Science, Exploration, and Planetary Defense. This could be a responsibility of Task-Force recommended Planetary Defense lead at NASA.
- Craft an effective rationale from the standpoint of decision makers.
- A good analogy for the decision-maker standpoint: If you stand with your eyes closed while people are throwing rocks at your head and you take no action, you either live or die. If you squint, you realize that something is going by your head. If you open your eyes, you can duck long before you are certain you will be hit. However you will duck

more often than you really must. In Planetary Defense, do we “duck” Potentially Hazardous Objects when we don’t have to? We need to work out this ratio.

- Decision makers don’t do a cost analysis, they respond to the emergency situation.
- Another purpose for a demonstration mission is basically physics. These objects are not simple, and how they would respond to deflection is not understood. We need to get clear on what we need to learn about the objects.
- More than one demonstration is needed to discover answers.
- Another purpose of a demonstration is to uncover things we did not think of.
- Special characterization missions will be very costly. However, it would be a fraction of the cost of an entire mission if simply added on.

International Coordination on Planetary Defense

Discussion Points:

- Cooperation is crucial among nations with capability to launch deflection campaigns in response to NEO threats. Regardless of the deflection technology used, while deflection is in operation some countries will be placed under temporary increased risk. Every country has a risk corridor over it.
- The Association of Space Explorers (ASE) has held four international workshops over two years to address the question of how the world can prepare to make a timely and coordinated decision regarding a NEO threat.
- ASE has defined functional international responsibilities for Planetary Defense:
 - Mission Authorization and Oversight Group
 - Information, Analysis and Warning Network
 - Mission Planning and Operations Group
- This report was given to the United Nations in 2008. The functions are in ongoing discussions at the UN, in which Lindley Johnson and Tom Jones are participating. There is forward motion toward 2013 as the target for release of this information.
- Workshop in October 2010 will concern the Mission Planning and Operations Group (MPOG) coordination with space faring countries that have expertise in asteroid operations. Tom and Lindley would like to include a discussion of a deflection demonstration mission or at least a reference mission. Goal is to raise this to a level of interest that the international space agencies regard as actionable.
- A champion is needed to move things forward. It is reasonable that leadership in MPOG should be NASA. The NASA Administrator is aware of this UN / ASE activity.
- Although Planetary Defense and involvement in the UN is not in NASA’s mission statement, it is in NASA’s charter to support the State Department. NASA’s leadership role in the international Planetary Defense arena is in the U.S.’s interest.
- Public education as to why this is an international issue is a major challenge, since there is not much information that has addressed it. You can’t prepare or communicate to the public on the fly.
- The kind of discussions NASA could lead are relatively inexpensive – hosting meetings with invited participants. It would be a good investment to advance this cooperation.

The Task Force reviewed the very important paper by Steve Chesley, Potential Impact Detection for Near Earth Asteroids – 2005 – Apophis case.

Discussion Points:

- Up to this point, observation systems have been designed to discover the maximum number of objects. Now we are interested in getting precise orbit.

- Disaster manager's decision on when to take action is so difficult because there is always doubt whether the NEO will strike and do damage. There is currently zero consensus what the threshold is for this. Further, it is a geopolitical decision in an international forum, with each nation having its input.
- Our responsibility as scientists is to provide the best information. If we decrease by a factor of 10 the times any agency has to discuss a NEO disaster decision, we have done a public service. That is our goal.
- Reality is that there are risk corridors over the whole Earth when a threat is discovered. International coordination decisions should be made prior to a specific risk emerging, so that the leadership does not default to a specific country at risk.

Task Force Recommendations to NASA Advisory Council - Preliminary Discussion

- Task Force is not working in a vacuum. The recently released National Research Council (NRC) report reflected high participation and in-depth thinking. Some recommendations were made. There are also numerous Planetary Defense conferences occurring around the world.
- The NRC is a primary advisory structure for NASA. The more effectively we go from NRC recommendations into Task Force recommendations, the more effective the outcome with NASA.
- Capability will be leveraged across NASA to address Planetary Defense. NASA needs a point person for putting a plan together and implementing it – a Planetary Defense Coordination Office, reporting to the NASA Administrator. This office would have funding for specific utilization or to seed implementation of Planetary Defense capabilities through NASA Directorates.
- Task Force should have no more than five major recommendations, organized for effective Planetary Defense action.
- Recommendations will accomplish the George E. Brown Congressional goal. [*... detect, track, catalogue, and characterize the physical characteristics of near-Earth asteroids and comets at least 140 meters in diameter in order to assess the threat of such near-Earth objects striking the Earth.*]
- Recommend NASA Planetary Defense office top-level responsibilities and actions.
- Recommend NASA provide leadership in public international forums.
- In each recommendation, priorities might be labeled according to the three program stages: (1) Research, (2) Development, and (3) Implementation.
- An over-arching priority would be that Planetary Defense is an integrative activity – science, exploration, Planetary Defense. Possibly in a preamble to the report.
- NAC Chair, Ken Ford, requests Task Force to provide foundation briefings for our recommendations.

Task Force Report Section Assignments

- Search and Warning: Don Yeomans
 - Title change to: Acquire Adequate Search, Tracking, and Warning Capabilities
 - Reduce false warnings – major responsibility
 - Warnings must be timely and accurate
- Characterization: Rick Binzel
 - This is not a separate category. Rick will handle characterization topics in the other sections.
 - Rick will analyze NRC report to see where characterization fits. **(Action 002)**.
 - Understanding nature of threat might be a better title for this topic.

- Analysis of effects, rather than analysis of NEO, will be of interest to emergency managers. However, it may be beneficial to broaden thinking of characterization to include effect of threat AND makeup of object.
- Mitigation: Brian Wilcox
 - NASA responsibility to initiate discussion with DHS.
 - OSTP should designate a lead for Planetary Defense.
 - Nuclear mitigation should be included but worded carefully. It should be emphasized that there is only an extremely low probability to ever use nuclear. Make it clear what nuclear can and cannot do.
 - Look for opportunities supported by Planetary Defense funding for cost-effective mitigation capability demonstrations.
- Synergy of Science, Exploration, and Planetary Defense: Tom Jones
 - Identify new ways NASA could economize but still make breakthroughs.
 - Synergy may not require a lot of text, but if it is placed at the top level, it helps facilitate coordinator.
 - Tom will draft a synergy section. (**Action 003**).
- Preparing for Impact Threat Response – title for Research and Development.
 - Emergency management community will expect R&D information.
 - Possibly call it Space Situational Awareness – asteroids are included under this term in Europe.
- Social, Legal, Political – change title to “Provide Leadership”:
 - Information leadership
 - Parallel: NOAA and weather-related threats.
 - Opening: Everyone will look to NASA Administrator for guidance and information, even if OSTP does not give NASA lead role for Planetary Defense.
 - All of the analytic and factual information will become NASA’s responsibility.
 - NASA must recognize its role as the warning agency.

Comments from the Public

- The new space policy, in terms of cooperation, may make a good point for the Planetary Defense effort.
- Obama’s positive press on international cooperation and the Global Exploration Strategy (still under discussion) provide an entrée for Planetary Defense.
- Carl Sagan’s comment – “Anyone who can move an impact off the planet can put an object on the planet” – is why you want to be public and transparent with Planetary Defense.
- Regarding structures for international cooperation, the U.S. could be the driver and bring others along to the ISS. If you are considering models for execution, there are many solutions.
- Look at NASA Planetary Protection Office as a model for Planetary Defense Office. John Rummel, of that office, had a lot of interaction with other agencies.