# ADV Asteroids

## 1AC Asteroids

**Long-Period Comets are they’re likely, evade current defenses, and risk extinction**

**IAA 9** (International Academy of Astronautics, “Dealing With The Threat To Earth From Asteroids And Comets”, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg35/sg35finalreport.pdf)

Detection of Long-Period Comets Long-period comets (LPCs) tend to be ignored in NEO studies at this time because the probability of an impact by a long-period comet is believed to be very much smaller than by an asteroid. However, virtually all NEOs larger than a few kilometers are comets rather than asteroids, and such large NEOs are the most destructive, and potentially the “civilization killers”. Additionally, the Earth regularly passes through the debris field of short-period comets giving us the annual meteoroid showers such as the Leonids and Taurids. These are very predictable but thankfully benign impact events. If the Earth were to encounter sizable objects within the debris field of a long-period comet, we would likely have very little warning time and would potentially be confronted with many impactors over a brief period of time. Although this type of event is currently speculative, this is a conceivable scenario which humanity could face. While the risk of a cometary impact is believed to be small, the destruction potential from a single large, high velocity LPC is much greater than from a NEA. Therefore, it is important to address their detection and potential methods for deflecting, disrupting, or mitigating the effects before one impacts the Earth.

### You must take the chance on Orion – it would save billions of lives from asteroids and spur massive economic growth

Dinkin 05 (Sam, January 24 2005, regular columnist at The Space Review, “Revisiting Project Orion”, http://www.thespacereview.com/article/309/1, SS)

Here are a few of many reasons why to embrace the risk:

Orion can lead to anti-asteroid operational capability decades ahead of anything else. That results in a flux of 200 fewer dead a year from the chance of the Earth population being destroyed by asteroids. Richard Posner says we should count extra because we would be saving the species. There are people willing to pay a lot of money to take a trip on Orion or use it to found a colony. Those people won’t pay for it (and any pollution- or flu-reducing taxes associated with using it) unless they get something in exchange. An analogy is that if you set the fines for speeding in a sports car high enough, you can use the money collected to make the roads safer and reduce the overall death rate from highway accidents, versus electronic switches that prevent each car from exceeding the speed limit.

A trip on Orion will generate economic growth, scientific advancement, and wonder that will extend and enrich many lives in the future. Like a firing squad where there is a chance that everyone has a blank, it is possible that no one will die due to the Orion launch. How would the diffuse benefit of hundreds—or billions—of lives saved or improved due to success of Orion stack up to a diffuse risk?

### Developing EPPP will enable safe fast asteroid deflection

Ragheb 10 (12/16/2010, Magdi Ragheb, Associate Professor of nuclear, plasma, and radiological engineering, Ph.D. Nuclear Engineering, “NUCLEAR DEFENSE AGAINST STELLAR OBJETS,” <https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Nuclear%20Defense%20Against%20Stellar%20Objects.pdf>, ngoetz)

A single or multiple pulse detonations of nuclear fission, fission/fusion or fusion devices can be used to easily alter the trajectory of the planetesimal from its collision course with Earth. Two stages occur in the process. First, the illumination of its surface by the prompt x-rays and gamma rays traveling at the speed of light from the pulse would cause ablation of the surface and generate thrust that is parallel to the object’s projected area. This would be followed by a second wave consisting of the plasma of fission products producing a second impulse in the same direction. The process can be carried out remotely without astronauts being dispatched to carry out the process. It is also suggested that the thrust would be parallel to the object’s projected area, independent of its mass distribution or angular momentum if it was rotating in space. The amount of impulse could be adjusted by the frequency of pulses, detonation standoff distance, and yield and type of the pulse unit.

If an External Pulse Plasma Propulsion (EPPP) system is used, it would double as the propulsion means as well the nudging means. This approach does not require any unrealistic asteroid capture or attachment of a propulsion unit to an unreachable surface that could be rotating, with insignificant gravity.

### EPPP is crucial to prevent an extinction size asteroid collision – fast interception and safe deflection system

Bonometti et al 2k ( 19 January 2000, J. A. Bonometti, P. J. Morton and G. R. Schmidt, Space Technology and Applications International Forum-2000, Volume 504, pp. 1236-1241, “External Pulsed Plasma Propulsion.” <http://www.angelfire.com/stars2/projectorion/EPPP.html>, ngoetz)

Application #2: Comet/Asteroid Deflection. The other and perhaps most compelling application for EPPP is its use in asteroid or comet defense. Collisions between the Earth and small planetary objects occur frequently, with the typical result being that the objects burn up in the atmosphere. However, there is a low, but not negligible, probability of a collision with objects of sufficient size to cause catastrophic damage or an extinction-scale event. Good risk management would dictate that some effort be placed on devising countermeasures, if possible. Past studies identified a number of possibilities, almost all of which entailed ground and space-based infra

structure more extensive than that envisioned for ballistic missile defense. Because of the limitations of current propulsion technology, these systems would require permanent deployment of interceptors in deep space in order to allow engagement at a sufficient distance from Earth. In addition, the low-impulse methods of altering the object’s trajectory, such as sails or electric thrusters, would probably not provide enough time for adequate trajectory alteration between detection and impact - especially in the case of a comet.

EPPP could be applied to the development of a much less expensive, purely ground-based deterrence system. If a likely catastrophic collision were identified, an EPPP-propelled interceptor could be launched into space using a conventional chemical launcher. It would have the power density necessary to rapidly travel to the target in time to force the threatening object from its collision course. The object’s course change might be performed using sails or electric thrusters. However, these schemes are very risky since their effectiveness depends on the body’s size, shape, speed, trajectory and many other properties. There is little room for error once the target is engaged, and the propulsion systems must operate reliably for very long durations to effect the change. Alternatively, the same EPPP system that propelled the interceptor could be used to move the target. Single or successive pulse detonations at a predetermined distance from the asteroid’s surface could be used to easily “nudge” the planetesimal and alter its course. The first wave of X-rays from the pulse would illuminate the planetesimal’s surface causing ablation and thrust parallel to the object’s projected area. The second wave of pulse fission products would produce another impulse in the same direction. This approach has important advantages. It does not require asteroid capture or attachment of a propulsion unit to a highly variable surface. Since the “thrust” is parallel to the object’s projected area, this approach is independent of the object’s relatively indeterminate mass distribution and angular momentum. Also, the amount of impulse delivered can be easily tailored to any asteroid by the number of pulses, detonation standoff distance, and type of pulse unit.

**It’s try-or-die – comet or asteroid impact is inevitable**

**Verschuur 96** (Gerrit, Adjunct Professor of Physics – University of Memphis, Impact: The Threat of Comets and Asteroids, p. 158)

In the past few years, the comet impact scenario has taken on a life of its own and the danger of asteroids has been added to the comet count. In the context of heightened interest in the threat, reassuring predictions have been offered about the likelihood of a civilization-destroying impact in the years to come. Without exception, the scientists who have recently offered odds have been careful in making any statement. They have acted in a "responsible" manner and left us with a feeling that the threat is not worth worrying about. This is not to criticize their earnest efforts, only to point out that estimates have been attempted for centuries. The way I look at the business of offering odds is that it hardly matters whether the chance of being wiped out next century is 1 in 10,000, for example, or that the likelihood of a civilization-destroying impact is once in a million years. That's like betting on a horse race. The only thing that is certain is that a horse will win. What matters is the larger picture that begins to force itself into our imagination; comet or asteroid impacts are inevitable. The next one may not wipe us out in the coming century, or even in the century after that, but sooner or later it will happen. It could happen next year. I think that what matters is how we react to this knowledge. That, in the long run, is what will make a difference to our planet and its inhabitants. It is not the impact itself that may be immediately relevant; it is how we react to the idea of an impact that may change the course of human history. I am afraid that we will deal with this potentially mind-expanding discovery in the way we deal with most issues that relate to matters of great consequence; we will ignore it until the crisis is upon us. The problem may be that the consequences of a comet catastrophe are so horrendous that it is easiest to confront it through denial. In the end, though, it may be this limitation of human nature that will determine our fate.

**The impact is extinction – *high magnitude* and *aperiodic strikes* shatter traditional considerations of “timeframe” and mean we should treat NEO threats as imminent**

**Brownfield 4** (Roger, Gaishiled Project, “A Million Miles a Day”, Presentation at the Planetary Defense Conference: Protecting Earth From Asteroids, 2-26, http://www.aiaa.org/content.cfm?pageid=406&gTable= Paper&g ID=17092)

Once upon a time there was a Big Bang... Cause/Effect - Cause/Effect -Cause/Effect and fifteen billion years later we have this chunk of cosmos weighing in at a couple trillion tons, screaming around our solar system, somewhere, hair on fire at a million miles a day, on course to the subjective center of the universe. Left to its own fate -- on impact -- this Rock would release the kinetic energy equivalent of one Hiroshima bomb for every man, woman and child on the planet. Game Over... No Joy... Restart Darwin's clock… again. No happy ever after. There is simply no empirical logic or rational argument that this could not be the next asteroid to strike Earth or that the next impact event could not happen *tomorrow*. And as things stand we can only imagine a handful of dubious undeveloped and untested possibilities to defend ourselves with. There is nothing we have actually prepared to do in response to this event. From an empirical analysis of the dynamics and geometry of our solar system we have come to understand that the prospect of an Earth/asteroid collision is a primal and ongoing process: a solar systemic status quo that is unlikely to change in the lifetime of our species. And that the distribution of these impact events is completely aperiodic and random both their occasion and magnitude. From abstracted averaged relative frequency estimates we can project that over the course of the next 500 million years in the life of Earth we will be struck by approximately 100,000 asteroids that will warrant our consideration. Most will be relatively small, 100 to 1,000 meters in diameter, millions of tons: only major city to nation killers. 1,000 or so will be over 1,000 meters, billions of tons and large enough to do catastrophic and potentially irrecoverable damage to the entire planet: call them global civilization killers. Of those, 10 will be over 10,000 meters, trillions of tons and on impact massive enough to bring our species to extinction. All these asteroids are out there, orbiting the sun... now. Nothing more needs to happen for them to go on to eventually strike Earth. As individual and discrete impact events they are all, already, events in progress. By any definition this is an existential threat. Fortunately, our current technological potential has evolved to a point that if we choose to do so we can deflect all these impact events. Given a correspondingly evolved political will, we can effectively manage this threat to the survival of our species. But since these events are aperiodic and random we can not simply trust that any enlightened political consensus will someday develop spontaneously before we are faced with responding to this reality. If we would expect to deflect the next impact event a deliberate, rational punctuated equilibrium of our sociopolitical will is required now. The averaged relative frequency analysis described above or any derived random-chance statistical probabilistic assessment, in itself, would be strategically meaningless and irrelevant (just how many extinction level events can we afford?). However, they can be indirectly constructive in illuminating the existential and perpetual nature of the threat. Given that the most critically relevant strategic increment can be narrowly defined as the next “evergreen” 100 years, it would follow that the strategic expression of the existent risk of asteroid impact in its most likely rational postulate would be for one and only one large asteroid to be on course to strike Earth in the next 100 years... If we do eventually choose to respond to this threat, clearly there is no way we can address the dynamics or geometry of the Solar System so there is no systemic objective we can respond to here. We can not address 'The Threat of Asteroid Impact' as such. We can only respond to this threat as these objects present themselves as discrete impending impactors: one Rock at a time. This leaves us the only aspect of this threat we *can* respond to - a rationally manifest first-order and evergreen tactical definition of this threat Which unfortunately, as a product of random-chance, includes the prospect for our extinction. Asteroid impact is a randomly occurring existential condition. Therefore the next large asteroid impact event is inevitable and expectable, and that inevitable expectability begins... now. The Probability is Low: As a risk assessment: “The probability for large asteroid impact in the next century is low”... is irrelevant. Say the daily random-chance probability for large asteroid impact is one in a billion. And because in any given increment of time the chance that an impact will not happen is far greater than it will, the chance that it will happen can be characterized as low. However, if we look out the window and see a large asteroid 10 seconds away from impact the daily random-chance probability for large asteroid impact will still be one in a billion... and we must therefore still characterize the chance of impact as low... When the characterization of the probability can be seen to be tested to be in contradiction with the manifest empirical fact of the assessed event it then must also then be seen to be empirically false. Worse: true only in the abstract and as such, misleading. If we are going to *respond* to these events, when it counts the most, this method of assessment will not be relevant. If information can be seen to be irrelevant ex post it must also be seen to be irrelevant ex ante. This assessment is meaningless. Consider the current threat of the asteroid Apophis. With its discovery we abandon the average relative frequency derived annual random-chance probability for a rational conditional-empiric probabilistic threat assessment derived from observing its speed, vector and position relative to Earth. The collective result is expressed in probabilistic terms due only to our inability to meter these characteristics accurately enough to be precise to the point of potential impact. As Apophis approaches this point the observations and resulting metrics become increasingly accurate and the conditional-empiric probability will process to resolve into a certainty of either zero or one. Whereas the random-chance probability is unaffected by whether Apophis strikes Earth or not. These two probabilistic perceptions are inherently incompatible and unique, discrete and nonconstructive to each other. The only thing these two methodologies have in common is a nomenclature: probability/likelihood/chance, which has unfortunately served only to obfuscate their semantic value making one seem rational and relevant when it can never be so. However, merely because they are non rational does not make averaged relative frequency derived random-chance probabilities worthless. They do have some psychological merit and enable some intuitive 'old lady' wisdom. When we consider the occasion of some unpredictable event that may cause us harm and there is nothing tangible we can do to deflect or forestall or stop it from happening, we still want to know just how much we should worry about it. We need to quantify chance not only in in case we can prepare or safeguard or insure against potentially recoverable consequences after the fact, but to also meter how much hope we should invest against the occasion of such events. Hope mitigates fear. And when there is nothing else we can do about it only then is it wise to mitigate fear... “The probability for large asteroid impact in the next century is low” does serve that purpose. It is a metric for hope. Fifty years ago, before we began to master space and tangibly responding this threat of asteroid impact became a real course of action, hope was all we could do. Today we can do much more. Today we can hold our hope for when the time comes to successfully deflect. And then, after we have done everything we can possibly do to deflect it, there will still be of room for hope... and good luck. Until then, when anyone says that the probability for large asteroid impact or Extinction by NEO is low they are offering nothing more than a metric for hope -- not rational information constructive to metering a response or making a decision to do so or not. Here, the probability is in service to illusion... slight-of-mind... and is nothing more than comfort-food-for-thought. We still need such probabilistic comfort-food-for-thought for things like Rogue Black Holes and Gamma Bursts where we are still imaginably defenseless. But if we expect to punctuate the political equilibrium and develop the capability to effectively respond to the existential threat of asteroid impact, we must allow a rational and warranted fear of extinction by asteroid impact to drive a rational and warranted response to this threat forward. Forward into the hands and minds of those who have the aptitude and training and experience in *using* fear to handle fearful things. Fear focuses the mind... Fear reminds us that there are dire negative consequences if we fail. If we are going to concern ourselves with mounting a response and deflecting these objects and no longer tolerate and suffer this threat, would it not be far more relevant to know in which century the probability for large asteroid impact was *high* and far more effective to orient our thinking from when it *will not* to when it *will* occur? But this probabilistic perspective can not even pretend to approach providing us with that kind of information. As such, it can never be strategically relevant: contribute to the conduct of implementing a response. The same can be said when such abstract reasoning is used to forward the notion that the next asteroid to strike Earth will likely be small... This leads us to little more than a hope based Planetary Defense. If we are ever to respond to this threat well then we must begin thinking about this threat better. Large Asteroid Impacts Are Random Events. Expect the next one to occur at any time. Strategically speaking, this means being at DefCon 3: lock-cocked and ready to rock, prepared to defend the planet and mankind from the worst case scenario, 24/7/52... forever. Doing anything less by design, would be like planning to bring a knife to a gunfight. If we expect our technological abilities to develop and continue to shape our nascent and still politically tacit will to respond to this threat: if we are to build an effective Planetary Defense, we must abandon the debilitating sophistry of “The probability for large asteroid impact in the next century is low” in favor of rational random inevitable expectation... and its attendant fear.

## EXT Solves asteroids

### Fission would solve for asteroid caused extinction

Smith 2003 (Warne,, March 12 2003, writer for Nuclearspace.com, “The Case for Orion”, http://www.spacedaily.com/news/nuclearspace-03h.html, SS)

Perhaps one of the best arguments for allowing nuclear power to increase our foothold in space is provided by Daniel Durda, a senior research scientist at the Southwest Research Institute in Boulder, Colorado."The worst scenario I can think of is a multi-kilometer-diameter, long-period comet discovered several months out on an impact trajectory as it is entering the inner solar system," he said. "There is absolutely nothing we could do about it at this point in time. Nothing."You have only to look at the pockmarked moon to realise we can and do occasionally get hit by large bodies. Survival should be a strong motivator for us even if our exploratory urge has diminished.

# ADV Exploration

## 1AC Exploration

### EPPP allows us to colonize Mars – shorter trip times, broader return window, and better payload

Bonometti et al 2k ( 19 January 2000, J. A. Bonometti, P. J. Morton and G. R. Schmidt, Space Technology and Applications International Forum-2000, Volume 504, pp. 1236-1241, “External Pulsed Plasma Propulsion.” <http://www.angelfire.com/stars2/projectorion/EPPP.html>, ngoetz)

Application #1: Human Interplanetary Exploration. There are two reasons for seriously considering EPPP as an option for future development. The first is its potential for human exploration. Since the early years of the space program, most human exploration studies have concentrated on either the Moon or Mars. Although it is recognized in NASA’s Strategic Vision that the ultimate goal is to extend human presence throughout the solar system and eventually the stars, only a negligible amount of effort has been devoted to these type of missions. EPPP provides a technology that would allow us to seriously consider missions to the outer planets. It would also enable dramatically shorter trip times to Mars and other nearer-term destinations. The propulsion concepts that have been traditionally considered for Mars missions are chemical propulsion based on 02/H2 combustion and solid-core nuclear thermal propulsion. Although the Isp of nuclear thermal (-900 set) is approximately twice that of chemical (-450 set), both systems suffer from the same limitations with regards to trip time and mission planning. The main advantage of nuclear thermal is its potential to reduce vehicle mass in low-earth orbit, thus reducing the number of heavy-lift vehicle launches. The performance that characterizes these two concepts favors Hohmann-type transfers into very slow heliocentric orbital trajectories. This narrows the available trajectories for return and necessitates long stays on the Mars surface while awaiting favorable return windows. This leaves the crew and equipment exposed to an extremely hostile environment for long periods of time - nominally 560 days surface stays with 170 to 200 day transit times (Kos, 199 . Cost is also significant, since earth launches are about half the mission budget in most conventional scenarios. Longer missions translate to larger payloads and more expendables, both of which increase launch requirements. EPPP can solve this problem with its much higher Isp (5,000 to 10,000 seconds), while still providing the high-thrust needed for fast orbit transfers. The result is higher energy transfer orbits, which could greatly reduce not only transit time, but permits broader return windows. This provides much more flexibility in mission planning and would not constrain the crew to long stay times on the Martian surface. It would also reduce the crew’s exposure to the highly radioactive space environment and long periods of weightlessness.

### EPPP is inexpensive, safe, quick and allows us to colonize the entire solar system

Ragheb 11(5/5/2011, Magdi Ragheb, Associate Professor of nuclear, plasma, and radiological engineering, Ph.D. Nuclear Engineering, “Nuclear And Plasma Space Propulsion,” https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Nuclear%20and%20Plasma%20Space%20Propulsion.pdf, ngoetz)

As initially considered in the Orion project, the vehicle would be launched from the Earth’s surface. The release of radioactivity in the atmosphere was an unacceptable alternative at the time, and still remains so. However, if the components can be launched with a transport vehicle to low Earth orbit and assembled there, these objections disappear. The space environment is already extremely harsh in terms of radiation. It has more background radiation in the form of gamma rays than the small pulse units would produce. In a matter of 24 Earth hours, the resulting ionized mass would dissipate in the background space plasma density. The exhaust particles velocities would exceed the Earth’s escape velocity and even the solar escape velocity, resulting in no residue or permanent contamination above the level caused by the natural radiation from the sun.

This technology is immediately available for space missions. There is no guarantee that other technologies such as fusion propulsion, matter/antimatter and beamed-energy sails that are under study will be available during the first half of the twenty-first century. Fusion must await the demonstration of a system possessing sufficient energy gains for commercial and space applications. Matter/antimatter has low propulsion efficiency and a prohibitive cost of the possible production and storage methods. Beamed energy would require tremendous investments in ground and space based infrastructure.

The need for high power densities for space missions favors nuclear energy sources. Solid core nuclear thermal, gas core, and electrical nuclear propulsion systems have problems with the constraint of the need of containment of a heated gas, which restricts its specific impulse values. External pulse systems possess higher temperature limits and lower inert masses and circumvent that limitation.

Several methods of external momentum coupling have been investigated other than the standard pusher plate. These include a combined magnetic field and pusher plate, a rotating cable pusher, and a large lightweight sail.

Because the reaction is external to the material walls of the vehicle, the system’s operation is independent of the reaction rate, pressure temperature and the fuel characteristics. The physics of fission in a vacuum are simple where a shell of ionized gas with extremely large radial velocities is produced. It is also recognized that common materials can withstand an intense nuclear damage environment over short intervals of time in the nanoseconds range. The acceleration of the ship is only limited by human and equipment tolerances. Imparting high thrust for short periods of time results in fast and efficient trajectories. Research emphasizes low ablation pusher plate designs, low energy pulse unit yields, and dedicated space operation out of the Earth’s atmosphere.

The overall advantage is that this approach can yield space vehicle for a Mars mission of duration of just 1-3 months. This should be compared to the mission time of about 25 months with chemical or other propulsion technologies. The latter technologies favor Hohmann type transfers into very slow heliocentric orbital trajectories; which narrows the available trajectories for return and necessitates long stays on the Mars surface waiting for the occurrence of favorable return windows. This stay would be in an extremely hostile environment with 560 days surface stays and 170-200 days transit times. It would also provide more flexible return windows and eliminate the need for long stay times in the vicinity of Mars, where the astronauts’ bodies would be ravaged by the effects of a long period of weightlessness and high space radiation, in addition to the lurking deadly danger of unforecast solar flares.

Short duration missions on Mars provide by External Plasma Pulse Propulsion would also be associated with lower overall mission costs. Longer missions translate into a need for larger payloads and expandables that need to be launched into space at high cost. The specific impulse of nuclear thermal systems is in the range of 900 sec, which is about twice those of chemical propulsion systems in the range of 450 sec. The main advantage here is the reduction of the vehicle mass in low Earth orbit, thus reducing the number of heavy lift vehicle launches.

External Pulse Plasma Propulsion is distinguished by specific impulses in the range of 5,000-10,000 secs. Even higher specific impulses of 100,000 secs can be achieved with larger vehicles, and more energetic detonations using fission/fusion and fusion sources. These can open up the whole solar system for human exploration and colonization.

### Reducing the travel time is key to exploration of Mars

Drake 10 (October-November, 2010, Bret G. Drake, Ph.D., Journal of Cosmology, Vol 12,“Human Exploration of Mars: Challenges and Design Reference Architecture 5.0,” <http://journalofcosmology.com/Mars105.html>, ngoetz)

4.5. Advanced Propulsion Although human expeditions to Mars could be conducted using cryogenic propulsion and aerocapture, nuclear propulsion presents a compelling prospect for reducing the mass or travel time required. Advanced propulsion concepts, including space storable propellants (oxygen, methane, and hydrogen), nuclear thermal propulsion, and the ability to store and manage cryogenic fluids for long durations, would be required. Development and demonstration of advanced, long-duration transportation concepts to understand their performance and reliability would be a key element in future human exploration missions.

### The moon is the key stepping stone to future colonization of Mars and beyond

Mitchell et al 10 (October-November, 2010, Edgar D. Mitchell, Sc.D., Apollo 14 Lunar module pilot, Sixth person to walk on the Moon, Robert Staretz, M.S., Journal of Cosmology, Vol 12, “Our Destiny – A Space Faring Civilization?” <http://journalofcosmology.com/Mars104.html>, ngoetz)

Establishing a fully self sufficient colony on the moon as a stepping stone to the planets will not come cheaply and may prove not to be feasible at all. However, the moon will be a great laboratory and learning environment for the kinds of obstacles, living conditions, and hazards that will also have to be faced on Mars or more distant venues. In some cases the hazards on the moon are even more severe than the Martian environment. For example solar radiation, solar wind, micrometeorites, and 500 degree temperature gradients are far more indicative of what our space explorers will experience during the trip to Mars than the extremes that will be encountered on the Martian surface. The knowledge gained and the technologies developed to support permanent bases on the moon will greatly benefit both for our first voyages to Mars as well as the first Martian colonies and even worlds beyond.

### Exploration of the solar system helps us find other civilizations – solves all modern problems

Mitchell et al 10 (October-November, 2010, Edgar D. Mitchell, Sc.D., Apollo 14 Lunar module pilot, Sixth person to walk on the Moon, Robert Staretz, M.S., Journal of Cosmology, Vol 12, “Our Destiny – A Space Faring Civilization?” <http://journalofcosmology.com/Mars104.html>, ngoetz)

Interplanetary exploration aside, there is no certainty that we will survive the gathering storm on Earth of the man made challenges to our survival. If we do endure, it is likely that we will eventually meet other intelligent technological civilizations in this increasingly apparent life friendly universe that we live in if we haven’t already done so. Hopefully these civilizations will have solved once and for all many of the dilemmas currently facing humanity. Clearly any civilization that mastered the technological challenges of interstellar travel will most likely be much older and far more advanced than us in many ways that we cannot even conceive. They will also likely be much wiser in how they utilize their technologies. When we begin a dialogue with them, perhaps our first order of business should be to find out how they managed to get beyond the civilization threatening technological adolescent stage in which we on Earth are now engaged.

### Colonization solves extinction – unexpected calamities

Ragheb 11 (5/5/2011, Magdi Ragheb, Associate Professor of nuclear, plasma, and radiological engineering, Ph.D. Nuclear Engineering, “Nuclear And Plasma Space Propulsion,” https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Nuclear%20and%20Plasma%20Space%20Propulsion.pdf, ngoetz)

In their role as stewards of life on Earth and perhaps in the whole known universe, humans have a duty to preserve and spread life. With their acquired intelligence, science and technology, it is their sacred destiny to preserve life with the equivalent of Noah’s Arks on both the moon and Mars.

Life can be subject to extinction on Earth either from within through volcanic eruptions or viral epidemics or from astral assailants as asteroid or comets impacts from space, as we know has happened in the past. It is urgent to keep backup copies of life, like we keep for files on computers, on the moon and Mars protected from the possible unexpected calamities that could extinguish life on Earth.

### An Orion type space ship would start a new age of space exploration – key to avoid extinction by asteroids or inevitable internal problems

Smith 3 (Mar 12, 2003, Wayne Smith, founder of NuclearSpace a Pro-Nuclear Space Movement, "The Case For Orion,” <http://www.spacedaily.com/news/nuclearspace-03h.html>, ngoetz)

Unparalleled access to space means we can lift the industrial infrastructure necessary to start using natural space resources for the first time. We could then mine asteroids and build fleets of Orions off Earth where environmental impact studies would be of no concern.

The last frontier is after all an endless ocean of positive particulate radiation. Like the Starship Enterprise we would never in all likelyhood try to land Orions on Earth. They would act as interplanetary ferries. We would still need to develop a reusable launch vehicle but it would only need enough fuel to reach orbit. Our newly aquired mining, construction and fuel processing industries in space would ensure that abundant fuel stops in the form of space stations would exist for return journeys. One Orion launch might be all thats necessary to kick off a new age of space exploration.

Perhaps one of the best arguments for allowing nuclear power to increase our foothold in space is provided by Daniel Durda, a senior research scientist at the Southwest Research Institute in Boulder, Colorado.

"The worst scenario I can think of is a multi-kilometer-diameter, long-period comet discovered several months out on an impact trajectory as it is entering the inner solar system," he said. "There is absolutely nothing we could do about it at this point in time. Nothing."

You have only to look at the pockmarked moon to realise we can and do occasionally get hit by large bodies. Survival should be a strong motivator for us even if our exploratory urge has diminished.

There was a time once when we were all about exploration, conquest and colonization. We can now be defined as a civilization that focuses on internal problems that will or can never be completely solved.

## EXT Plan Solves

### Fusion lets us go to Mars quickly and bring enough people to build a colony

Winterberg, 89 (October 1989, Posted online August 7, 2009, Friedwardt Winterberg, Research Professor at the University of Nevada, Reno, PhD in physics, winner of the 1979 Hermann Oberth Gold Medal of the Wernher von Braun International Space Flight Foundation, “Colonizing Space With Fusion Propulsion,” Colonizing Space With Fusion Propulsion, ngoetz)

The great challenge that future spaceflight poses is the development of rocket-propulsion systems that can carry large payloads at extremely high speeds, thereby making possible manned spaceflight to distant planets. The Apollo program demonstrated that we are able to land man on another planet in the solar system, but not with a very large payload. The Moon is relatively near to the Earth. If we were to attempt to go to Mars with chemical propulsion, it would take years, and the astronauts would have to travel in a spacecraft not much bigger than the interior of a bus. Making sure that nothing would go wrong in such a small vehicle traveling for years would be very difficult. Such an environment is clearly not practical for long-term space travel.

Chemical propulsion is adequate only for unmanned space probes. However, unmanned probes for scientific reasons alone are neither desirable, nor can they lead to the goals that we must accomplish. What will we find on Mars or elsewhere in the solar system? Only man, with his versatility of mind, is able to respond to totally unexpected experiences. Pre-programmed robots cannot do that.

It is only with fusion propulsion— fission is also inadequate—that manned spaceflight to distant planets will become practical. And man not only will be able to explore the solar system; he will be able to colonize and industrialize it. This is one reason why everyone working with fusion is so excited.

The crucial problem in rocket propulsion is to achieve a very large exhaust velocity. The key performance parameter is specific impulse or the impulse per unit weight of the rocket propellant, measured in seconds:

ma(At/mg) = Δν/g.

The hotter the gas, the greater the motion of the gas molecules and hence the exhaust velocity of the gas. Therefore, the extremely high-temperature and high-velocity products of a fusion reaction—106 meters per second—give fusion propulsion systems a very large potential specific impulse of 100,000 seconds. Chemical rockets have maximum specific impulses of less than 450 seconds, and fission systems less than 1,000 seconds.

When a chemical fuel is burned, the gas molecules and hence the exhaust reach a velocity on the order of a few kilometers per second, at best 3 kilometers or about 2 miles per second. Such a fuel, composed of hydrogen mixed with oxygen, is the most powerful rocket fuel we know and was used in the upper stage of the Saturn rocket.

As we know from rocket theory, rocket velocity can be increased to as much as three times more than exhaust velocity using a three-stage rocket system. In fact, to escape the Earth's gravitational pull, it is necessary to attain a rocket velocity of about 12 kilometers per second, which can be accomplished only with a multistage rocket. Each stage can attain a velocity of about 3 kilometers per second; and when three stages are put on top of each other, the spaceship can escape the Earth's gravitational field and head for the Moon. However, the maximum velocity that can be attained with chemical propulsion is 10 to 20 kilometers per second.

Chemical propulsion, adequate for escaping the Earth's gravity, thus does not permit us to travel to Mars in a time less than years. The trick of getting to Mars in a short time, possibly only weeks, is to use a higher exhaust velocity. This requires a propulsion fuel that has a much larger energy density and thus higher combustion temperature.

The answer is thermonuclear propulsion. In a thermonuclear reaction, the temperatures are not a few thousand degrees, as in chemical combustion; they are typically a hundred million degrees. Using fusion propulsion, we can get an exhaust velocity on the order of not just a few kilometers per second, but a few thousand kilometers per second.

The idea is to launch a fusion space rocket that would be assembled in orbit, where there is no gravity and it is therefore possible to build much larger structures. All of the different parts and materials for the space rocket would be carried up into orbit by chemically propelled space shuttles (to go from a planetary surface to an orbit, chemical propulsion is always the most convenient means). The rocket constructed in this fashion could carry a payload of thousands or even millions of tons, which it would take from an Earth orbit into an orbit around Mars. Then man would descend onto the surface of Mars, using chemical rockets.

EPPP is capable of going to mars – high Isp

Bonometti et al 8 (2008, A. Bonometti, and P. Jeff Morton, Propulsion Research Engineers, MSFC Propulsion Research, Joseph “External Pulsed Plasma Propulsion (Eppp) Analysis Maturation,” <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20000097368_2000138015.pdf>, ngoetz)

EPPP is well suited as a propulsion system for interplanetary missions. Manned interplanetary missions become increasingly feasible with propulsion systems that provide high Isp and thrust levels. EPPP is able to provide both these in abundance. The first manned interplanetary mission will likely be a Mars exploration mission. In this section, a Mars mission will be described at a cursory level, for a manned landing and return based upon an EPPP system employing today's technology.

### Space nuclear power is key to go to mars an colonize the moon

James 5 (April 2005, James R. Downey, professor of Science and Technology at the Army War College, Lieutenant Colonel, USAFR Anthony M. Forestier, graduate degrees in defense studies, management, and aerosystems, Wing Commander, RAAF David E. Miller, graduate degrees in systems management and airpower studies, Lieutenant Colonel, USAF, 37, “Flying Reactors The Political Feasibility of Nuclear Power in Space,” ngoetz)

Manned Lunar Base and Man-on-Mars. Pursuit of the manned lunar base and subsequent trip to Mars announced by President Bush in 2004 will necessitate the use of SNP in some form for technical reasons. Man will not be able to get to Mars without the advantages of power density and longevity offered by SNP over any foreseeable alternative power source. Of note, no government agency has mentioned the nuclear power aspect of the proposal, probably due to the public sensitivity of the issue.

# ADV Mining

## 1AC Mining

### Fusion rockets are key to bring enough supplies to colonize and mine the moon

Winterberg, 89 (October 1989, Posted online August 7, 2009, Friedwardt Winterberg, Research Professor at the University of Nevada, Reno, PhD in physics, winner of the 1979 Hermann Oberth Gold Medal of the Wernher von Braun International Space Flight Foundation, “Colonizing Space With Fusion Propulsion,” Colonizing Space With Fusion Propulsion, ngoetz)

Nevertheless, for the last 15 years, there has been a much more exciting possibility—that of reviving the project using inertial-confinement fusion—mini H-bombs— which is a much more effective method.

Recall that the hydrogen or fusion bomb is always ignited using an atomic or fission bomb as a trigger, which then sets off the much larger thermonuclear explosion. Earth orbit, carrying the materials needed to construct a Until the mid-1960s, this was the only known method of fusion-propelled superrocket. Such a spaceship will be able to carry a large crew as well as heavy equipment such as earth-moving machines. This spaceship could travel to Mars. It could also be used as a tugboat to travel to and colonize the Moon. To date, we have only landed on the Moon and inspected a few acres. But with our fusion-propelled superrocket, we would be able to go into lunar orbit, descend to the surface of the Moon with chemical rockets, unload necessary materials, and build a lunar colony. (See Figure 3.)

What would be the point of establishing a lunar colony? Although the Moon has no water, it has a core where very valuable metals are concentrated, metals that may eventually run out on Earth. Retrieving these metals is essential fusion research, believes that this application of fusion for the future of civilization.

### Fusion is key to exploration and mining

Palaszewski 6 (October 2006, Bryan Palaszewski, Master of Science Degree in Mechanical Engineering, "Atmospheric Mining in the Outer Solar System,” <http://mdcampbell.com/TM-2006-214122AtmosphericMining.pdf>, ngoetz)

Mining in the outer solar system is an important option for exploration and exploitation (refs. 5 to 10). Launching and transporting all of the materials for exploration from Earth is expensive and may make the idea of exploration untenable. The large reserves of atmospheric gases in the outer planets are an excellent resource for fuels and other life sustaining or colony building gases (ref. 10). The moons of the planets can be a great resource for oxygen, ceramic precursors, and metals. Outer planet moons, such as Europa, Ganymede, and Callisto, may have reserves of liquid and frozen water. Specialized factories created in the outer solar system can leverage all of these resources and allow for extended stays in that cold, dark environment.

In-Situ Resources Utilization

Many decades of research have been focused on using the natural resources of the solar system to allow sustainable human exploration and exploitation of the environments of the planets and the Sun (refs. 4 to 23). Everything from preliminary experiments in propellant production to creation of human colonies in space has been proposed (refs. 11 to 23). Studies such as those of reference 10 have shown that the outer planets can provide the rich resources for interstellar exploration and the eventual human colonization of the galaxy.

As human exploration is initiated in the outer solar system, the travel time and other natural hazards (planetary radiation belts, solar coronal mass ejections, etc.) will create new challenges for the explorers. In-situ resources will likely be a great asset in this exploration. Shielding from radiation can be created with rock from the moons or with hydrogen and other liquefied gases from the planetary atmospheres. High speed travel will be augmented by nuclear fission (ref. 24) and advanced future fusion propulsion (ref. 25), fueled by the atmospheric gases.

**Lunar mining will spur the development of fusion reactors that do not produce radioactive waste**

**Schmitt 4** (October 2004, Harrison H., Popular Mechanics, Apollo 17 astronaut, “Mining the Moon,” vol. 181, no. 10, Academic Search Premier)

Initially, scientists believed they could achieve fusion using deuterium, an isotope of hydrogen found in seawater. They soon discovered that sustaining the temperatures and pressures needed to maintain the so-called deuterium-deuterium fusion reaction for days on end exceeded the limits of the magnetic containment technology. Substituting helium-3 for tritium allows the use of electrostatic confinement, rather than needing magnets, and greatly reduces the complexity of fusion reactors as well as eliminates the production of high-level radioactive waste. These differences will make fusion a practical energy option for the first time.

It is not a lack of engineering skill that prevents us from using helium-3 to meet our energy needs, but a lack of the isotope itself.Vast quantities of helium originate in the sun, a small part of which is helium-3, rather than the more common helium-4. Both types of helium are transformed as they travel toward Earth as part of the solar wind. The precious isotope never arrives because Earth's magnetic field pushes it away. Fortunately, the conditions that make helium-3 rare on Earth are absent on the moon, where it has accumulated on the surface and been mixed with the debris layer of dust and rock, or regolith, by constant meteor strikes. And there it waits for the taking.

An aggressive program to mine helium-3 from the surface of the moon would not only represent an economically practical justification for permanent human settlements; it could yield enormous benefits back on Earth.

LUNAR MINING

Samples collected in 1969 by Neil Armstrong during the first lunar landing showed that helium-3 concentrations in lunar soil are at least 13 parts per billion (ppb) by weight. Levels may range from 20 to 30 ppb in undisturbed soils. Quantities as small as 20 ppb may seem too trivial to consider. But at a projected value of $40,000 per ounce, 220 pounds of helium-3 would be worth about $141 million.

Because the concentration of helium-3 is extremely low, it would be necessary to process large amounts of rock and soil to isolate the material. Digging a patch of lunar surface roughly three-quarters of a square mile to a depth of about 9 ft. should yield about 220 pounds of helium-3 — enough to power a city the size of Dallas or Detroit for a year.

Although considerable lunar soil would have to be processed, the mining costs would not be high by terrestrial standards. Automated machines, perhaps like those shown in the illustrations on pages 56 and 57, might perform the work. Extracting the isotope would not be particularly difficult. Heating and agitation release gases trapped in the soil. As the vapors are cooled to absolute zero, the various gases present sequentially separate out of the mix. In the final step, special membranes would separate helium-3 from ordinary helium.

The total estimated cost for fusion development, rocket development and starting lunar operations would be about $15 billion. The International Thermonuclear Reactor Project, with a current estimated cost of $10 billion for a proof-of-concept reactor, is just a small part of the necessary development of tritium-based fusion and does not include the problems of commercialization and waste disposal.

The second-generation approach to controlled fusion power involves combining deuterium and helium-3. This reaction produces a high-energy proton (positively charged hydrogen ion) and a helium-4 ion (alpha particle). The most important potential advantage of this fusion reaction for power production as well as other applications lies in its compatibility with the use of electrostatic fields to control fuel ions and the fusion protons. Protons, as positively charged particles, can be converted directly into electricity, through use of solid-state conversion materials as well as other techniques. Potential conversion efficiencies of 70 percent may be possible, as there is no need to convert proton energy to heat in order to drive turbine-powered generators. Fusion power plants operating on deuterium and helium-3 would offer lower capital and operating costs than their competitors due to less technical complexity, higher conversion efficiency, smaller size, the absence of radioactive fuel, no air or water pollution, and only low-level radioactive waste disposal requirements. Recent estimates suggest that about $6 billion in investment capital will be required to develop and construct the first helium-3 fusion power plant. Financial breakeven at today's wholesale electricity prices (5 cents per kilowatt-hour) would occur after five 1000-megawatt plants were on line, replacing old conventional plants or meeting new demand.

**This spurs a transition to a nuclear fusion economy --- solves safety and proliferation risks, public fears and prevents economic and environmental collapse**

**Kulcinski & Schmitt 2000** (July 2000, G.L. Kulcinski and H.H. Schmitt, with the Fusion Technology Institute in the Department of Engineering Physics at the University of Wisconsin-Madison, Fusion Technology Institute, “Nuclear Power Without Radioactive Waste – The Promise of Lunar Helium-3,” Presented at the Second Annual Lunar Development Conference, “Return to the Moon II”, 20–21 July 2000, Las Vegas NV, <http://fti.neep.wisc.edu/FTI/pdf/fdm1131.pdf>)

Observations on the Development of Fusion Energy in the 21st Century

If one accepts the need to develop nuclear energy to satisfy the needs of Earth’s inhabitants in the 21st century and beyond, then it is reasonable to ask “How can one transition from the current fission nuclear economy to a future fusion economy and what would be the benefits of such a transition?” A detailed discussion of this important question is beyond the scope of this paper but the general outline of an answer is summarized in Figure 6. For example, the level of concern over proliferation, nuclear waste, safety, and radiation damage to reactor components is very high in the case of fission reactors. This is not to say that the fission industry has not or cannot solve those problems, but it is clear that the public has concerns in those areas. If one moves to the first-generation fusion fuels, the issues of proliferation, nuclear waste, and safety are somewhat alleviated. However, the radiation damage issue is as difficult (or some would say even more difficult) to solve. One additional area of concern that is faced by first-generation fuels is the safe handling of large amounts of radioactive tritium.

Basically, the use of second-generation fuels (D3He) eliminates the proliferation issue and the safety issues are greatly reduced. However, these advantages are purchased at the price of more difficult physics requirements. Finally, the move to the third-generation fuel (3He3He) completely removes the concerns over proliferation, radiation damage, nuclear waste, safety, and tritium. However, these benefits have to be balanced against the much more difficult physics requirements of this fuel cycle.

Conclusions

It is appropriate, as society enters a new millennium, to question how future generations will be able to sustain life on Earth while expanding into the solar system. One of the essential questions to answer is how will future generations find enough energy to avoid the economic and environmental collapse that could occur if fossil fuels become prohibitively expensive in the next 50-100 years. Presently, nuclear energy appears to be the only solution capable of sustaining society as we know it. There is a growing resistance, whether justified or not, to expansion of fission energy. Fusion energy represents an improvement over fission, if it can be shown to be economic, but the first-generation fuels (DT, DD) are very capital intensive because they generate large amounts of radioactive waste and must contain large amount of radioactive materials in a hostile environment. The second-generation fuels (D3He) represent a tremendous improvement over the DT and DD cycles but face somewhat more difficult plasma physics requirements. Ultimately, the thirdgeneration fusion fuels (3He3He) could remove the concern of the public over radioactive waste and releases of radioactivity during reactor malfunctions. This optimism must be balanced against much more challenging physics regimes compared to those for the first- and second-generation fusion fuels.

If one takes the long-range viewpoint, it is clear that some effort should be expended early in the 21st century to developing the third-generation fusion fuels. The ultimate payoff from such research could be the “pot of gold at the end of the rainbow”, the production of clean, safe, economical, and long lasting nuclear energy without nuclear waste in the 21st century.

### Access to the moon is key to human survival

Cheetham & Pastuf 8 (Brad and Dan, Research Associate at the Goddard Space Flight Center NASA Academy students in Department of Mechanical and Aerospace Engineering at the University of Buffalo, “Lunar Resources and Development: A brief overview of the possibilities for lunar resource extraction and development,” <http://www.eng.buffalo.edu/~cheetham/index_files/Moon%20Paper%20441.pdf>)

The Moon has helped define existence on Earth since life began. It is one of the most visible and important celestial bodies which humans and other animals ever see. The Earth and Moon are tied to each other and the destiny of the human race is critically dependent on the Moon. As the population of Earth grows and the available resources on earth dwindle, serious problems will begin to develop (Lewis 11). Future generations of the Earth require that the Moon be utilized just as today we require oil and previous generations required the discovery of the “New World” by Columbus to prosper.

The Moon is approximately 240,000 miles from Earth. Its mass results in a force of gravity 1/6th of that felt on Earth. The Moon lacks an atmosphere, and as a result the surface has never been weathered and only experiences changes due to asteroid and meteor impacts. These impacts potentially leave rocks and evidence of early Earth that have been preserved for billions of years (Aeronautics). Furthermore, there exists, on the lunar surface, numerous valuable raw materials. As a result of these attributes the Moon presents endless value to humans both now and in the future. This paper will examine the various reasons for returning to the Moon permanently and begin to discuss the technical developments and solutions that will allow the beginning of the next phase of human expansion to begin.

## Add-on Colonization Impact

### Colonization checks resource conflict and prevents extinction

Garan, 10 (Ron, Astronaut, 3/30/10, Speech published in an article by Nancy Atkinson, “The Importance of Returning to the Moon,” <http://www.universetoday.com/61256/astronaut-explains-why-we-should-return-to-the-moon/>)

Resources and Other Benefits: Since we live in a world of finite resources and the global population continues to grow, at some point the human race must utilize resources from space in order to survive. We are already constrained by our limited resources, and the decisions we make today will have a profound affect on the future of humanity.

Using resources and energy from space will enable continued growth and the spread of prosperity to the developing world without destroying our planet. Our minimal investment in space exploration (less than 1 percent of the U.S. budget) reaps tremendous intangible benefits in almost every aspect of society, from technology development to high-tech jobs. When we reach the point of sustainable space operations we will be able to transform the world from a place where nations quarrel over scarce resources to one where the basic needs of all people are met and we unite in the common adventure of exploration. The first step is a sustainable permanent human lunar settlement.

## Add-on Heg

### A new space race has started to get helium-3 from the moon

Williams, 7 (8/23/07, Mark, Technology Review, “Mining the Moon; Lab experiments suggest that future fusion reactors could use helium-3 gathered from the moon,” <http://www.technologyreview.com/Energy/19296/>)

At the 21st century's start, few would have predicted that by 2007, a second race for the moon would be under way. Yet the signs are that this is now the case. Furthermore, in today's moon race, unlike the one that took place between the United States and the U.S.S.R. in the 1960s, a full roster of 21st-century global powers, including China and India, are competing.

Even more surprising is that one reason for much of the interest appears to be plans to mine helium-3--purportedly an ideal fuel for fusion reactors but almost unavailable on Earth--from the moon's surface. NASA's Vision for Space Exploration has U.S. astronauts scheduled to be back on the moon in 2020 and permanently staffing a base there by 2024. While the U.S. space agency has neither announced nor denied any desire to mine helium-3, it has nevertheless placed advocates of mining He3 in influential positions. For its part, Russia claims that the aim of any lunar program of its own--for what it's worth, the rocket corporation Energia recently started blustering, Soviet-style, that it will build a permanent moon base by 2015-2020--will be extracting He3.

The Chinese, too, apparently believe that helium-3 from the moon can enable fusion plants on Earth. This fall, the People's Republic expects to orbit a satellite around the moon and then land an unmanned vehicle there in 2011.

Nor does India intend to be left out. (See "India's Space Ambitions Soar.") This past spring, its president, A.P.J. Kalam, and its prime minister, Manmohan Singh, made major speeches asserting that, besides constructing giant solar collectors in orbit and on the moon, the world's largest democracy likewise intends to mine He3 from the lunar surface. India's probe, Chandrayaan-1, will take off next year, and ISRO, the Indian Space Research Organization, is talking about sending Chandrayaan-2, a surface rover, in 2010 or 2011. Simultaneously, Japan and Germany are also making noises about launching their own moon missions at around that time, and talking up the possibility of mining He3 and bringing it back to fuel fusion-based nuclear reactors on Earth.

## Add-on Asteroids Mining

### Exploration capabilities from a Orion-type space ship allows mining asteroids

Smith 3 (Mar 12, 2003, Wayne Smith, founder of NuclearSpace a Pro-Nuclear Space Movement, "The Case For Orion,” <http://www.spacedaily.com/news/nuclearspace-03h.html>, ngoetz)

Unparalleled access to space means we can lift the industrial infrastructure necessary to start using natural space resources for the first time. We could then mine asteroids and build fleets of Orions off Earth where environmental impact studies would be of no concern.

The last frontier is after all an endless ocean of positive particulate radiation. Like the Starship Enterprise we would never in all likelyhood try to land Orions on Earth. They would act as interplanetary ferries. We would still need to develop a reusable launch vehicle but it would only need enough fuel to reach orbit. Our newly aquired mining, construction and fuel processing industries in space would ensure that abundant fuel stops in the form of space stations would exist for return journeys. One Orion launch might be all thats necessary to kick off a new age of space exploration.

# ADV Leadership

## 1AC Leadership

### Chinese space program rising now – development of nuclear plasma propulsion key to maintain US dominance

Garibaldi 4 (Gabriele Garibaldi, holds an MIA from the University of Pisa. As a freelance analyst, he introduced the Italian public to the issue of "space weaponization" by publishing a book and several articles in all the most influential Italian reviews of international relations, July 20, 2004 “Chinese Threat to American Leadership in Space” Security Dialogue. < http://www.taiwansecurity.org/IS/2004/IS-Garibaldi-0704.htm> apanday)

The Chinese lunar plans and American anxieties

This information has led the USA to seriously examine the Chinese space challenge, and despite the American advantage, they remain nervous about China's next goal on the agenda: the Moon.

According to Robert Walker, former president of the Commission on the future of the American aerospace industry, China is engaged in an aggressive space program focused on a Moon landing, followed by establishing a permanent base within a decade. According to Japanese experts, China will be able to reach the Moon within three to four years and eventually aiming for Mars in the future. It will be sufficient for it to spend 1% of its GDP over the next few years in order to provide the financing for a significantly competitive space program.

The U.S., on the other hand, at least according to Walker, is no longer able to repeat the Moon mission of thirty-five years ago. This inability to compete in a new Moon race is more than an issue of national pride: it also raises serious strategical questions over China's rising potential as a lunar power. China, if it succeeded in its goal, would acquire enormous international prestige. However, most significantly, by establishing permanent bases on the Moon, China would gain the ability to exploit lunar resources and therefore gain important technological advantages over other nations (including nuclear fusion, using the helium 3 isotope), with concrete consequences on Earth's activities.

Walker's conclusion is that the Chinese space program has yet to be taken seriously by American politicians. Nevertheless**, it represents a serious challenge to the US leadership in Space. The US must answer such a challenge by developing new technologies (for instance, the nuclear plasma propulsion system) in order to reach the Moon and Mars faster than currently possible, and to travel more frequently and thriftily into Earth's low orbit.**

### Plan is key to preserve scientific space exploration – failure collapses science and tech leadership.

George Abbey andNeal Lane 05(George Abbey is Baker Botts Senior Fellow in Space Policy at the James A. Baker III Institute for Public Policy at Rice University. From 1995 until 2001, he was Director of the Johnson Space Center in Houston, Texas. He holds the NASA Distinguished Service and the Outstanding Leadership and Exceptional Service Medals. Neal Lane is the Malcolm Gillis University Professor at Rice University. He also holds appointments as Senior Fellow of the James A. Baker III Institute for Public Policy, where he is engaged in matters of science and technology policy, and in the Department of Physics and Astronomy. Prior to returning to Rice University, he served in the federal government as Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy, from August 1998 to January 2001, and as Director of the National Science Foundation (NSF), American Academy of Arts and Sciences, “ United States Space Policy Challenges and Opportunities”, <http://www.amacad.org/publications/spacePolicy.pdf>//sb)

Understanding of the universe, the solar system, and the Earth, and in providing the knowledge and technology that enable human exploration of space. Unless NASA asserts that science is one of its highest priorities, it will be relegated, in Washington parlance, to the “to be protected” category, rather than remaining in the “to be enhanced” column. Any rational and truly visionary plan for NASA’s future should specify science, including robotic exploration of space, as one of NASA’s principal goals. Otherwise, the unique contributions that NASA can make to astronomy and to planetary, earth, and space science will be lost, and America will no longer occupy its leadership role in these frontier areas of science.

### Space technology is key to U.S. leadership

Rocco Martino, 2007, Ph.D. in astrophysics from the Institute of Aerospace Studies, Senior Fellow at the Foreign Policy Research Institute, former Professor of Mathematics at NYU, former Professor of Systems Engineering at the University of Waterloo, Spring, “A Strategy for Success: Innovation Will Renew American Leadership”, Orbis, Vol. 51, No. 2, KK

Much of the foreign policy discussion in the United States today is focused upon the dilemma posed by the Iraq War and the threat posed by Islamist terrorism. These problems are, of course, both immediate and important. However, America also faces other challenges to its physical security and economic prosperity, and these are more long-term and probably more profound. There is, ﬁrst, the threat posed by our declining competitiveness in the global economy, a threat most obviously represented by such rising economic powers as China and India. There is, second, the threat posed by our increasing dependence on oil imports from the Middle East. Moreover, these two threats are increasingly connected, as China and India themselves are greatly increasing their demand for Middle East oil. The United States of course faced great challenges to its security and economy in the past, most obviously from Germany and Japan in the ﬁrst half of the twentieth century and from the Soviet Union in the second half. Crucial to America’s ability to prevail over these past challenges was our technological and industrial leadership, and especially our ability to continuously recreate it. Indeed, the United States has been unique among great powers in its ability to keep on creating and recreating new technologies and new industries, generation after generation. Perpetual innovation and technological leadership might even be said to be the American way of maintaining primacy in world affairs. They are almost certainly what America will have to pursue in order to prevail over the contemporary challenges involving economic competitiveness and energy dependence

### It’s the vital internal link.

Johnson-Freese 11 (Dr. Joan Johnson-Freese, Professor of National Security Affairs at the Naval War College. Previously, she was on the faculty at the Asia Pacific Center for Security Studies; the Air War College in Montgomery, AL; and Director of the Center for Space Policy & Law at the University of Central Florida. “China in Space: Not Time for Bright, Shiny Objects”, 7/1/11, defense.aol.com/2011/07/01/chinas-in-space-not-time-for-bright-shiny-objects/) AK

Railing against that reality while planning to deploy a global fleet of new SM-3, Block II missiles is feckless and will fall on deaf geostrategic ears. Finally, cutting edge space technology has been the hinge of American military power for the past two decades but is its greatest uncertainty moving forward. The successful raid on Osama Bin Laden's compound in Abbotabad, Pakistan was in some ways analogous to General Norman Schwartzkopf's "Hail Mary" maneuver, marching his troops across the Iraqi desert in 1990 - a risky move possible because of our high tech advantage over a low tech enemy that carried a big payoff. Just as Schwartzkopf's troops could "see" their way across the desert with GPS and communicate with each other via satellites, the intelligence community and Seal Team Six used communication satellites, GPS, signals intelligence and satellite imagery to find and take out America's Most Wanted Fugitive. Space assets have been critical in providing the United States with an edge when it needed it, and that edge must be protected. In the forthcoming article "Space, China's Strategic Frontier," in the Journal of Strategic Studies, Eric Hagt and Matt Durnin present a convincing case that China is crossing a threshold, moving from being able to use space for limited strategic purposes to having the capabilities to use space in tactical operations as they happen. That threat to America's edge must be a priority. Too much time and resources have been spent worrying about whether China was clandestinely developing a Death Star powered by dilithium crystals as a shashoujian, or "assassin's mace," that had to be countered by orbiting Rods from God as part of US space control. And now there is a move afoot to resurrect Reagan-era space-based missile defense interceptors as part of a technical calculation where X + Y = deterrence, though deterrence is as much or more a psychological calculation as it is a technical one. Further, the Chinese (and others) are not as worried about the US technical capabilities associated with space control and missile defense as they are about a political climate in the United States that is obsessed with missile defense and our own bright shiny objects. Meanwhile, that obsession has given China the time it needed for the careful development of space systems to give it operational military space capabilities akin to our own. Satellites are a globalized industry, within which China plays a growing and maturing role, and space - like it or not - is not exclusive US territory, so we cannot prevent China from developing or launching the same kinds of spacecraft that have proved so valuable to the US military. China has also learned from the US experience that too much dependency on these valuable high-tech assets creates a risk in itself and, determined not to get into that situation, have factored redundancy and back-up capabilities into future plans. So what can the United States do? It can stay ahead, as it has done in the past. This is not a case of US decline - a drum beat loudly and consistently of late - but of other countries developing. Certainly, given the undesirable effects shown in countries that have not developed, a developing China is a better alternative than an imploding China. But it requires the United States to focus more on its space assets in terms of both upgrading the technology where needed, providing redundancy for the capabilities they provide, and robust research and development far more and better than our track record to date. The New York Times called the 2005 cancellation of the projected $5 billion-plus Future Imagery Architecture (FIA) program, intended to provide the next generation of optical and radar spy satellites - described as technologically "audacious" in complexity -- "perhaps the most spectacular and expensive failure in the 50-year history of spy satellite projects." Since then, political and bureaucratic debates over whether to again stretch for new technology, use satellites of a proven design, or rely more on commercial satellites have largely prevailed over purposeful action. Mismanagement and underinvestment in replacement satellites for the Global Positioning System (GPS) have threatened that system as well. This is simply unacceptable. A May 2011 GAO study on Space Acquisition states that while efforts to address two decades of problems in nearly every military space acquisition program have been "good" there is still a substantial amount to do. And given the increasing capabilities of the Chinese, it is imperative that we not just be "good," but "the best." Space systems supporting force enhancement must be kept cutting edge, well-coordinated and able to get information to the warfighters better and faster than anyone else. The administration, Congress and the Pentagon must focus their efforts in a bi-partisan, non-sensationalist manner toward maintaining the military space edge that has repeatedly proven invaluable in operations. The time to be distracted by bright, shiny objects has passed.

### Hegemony prevents extinction

Khalizad 11 (Zalmay, United States ambassador to Afghanistan, Iraq, and the United Nations, The National Review, “The Economy and National Security” 2-8, http://www.nationalreview.com/articles/259024/economy-and-national-security-zalmay-khalilzad?page=1

If U.S. policymakers fail to act and other powers continue to grow, it is not a question of whether but when a new international order will emerge. The closing of the gap between the United States and its rivals could intensify geopolitical competition among major powers, increase incentives for local powers to play major powers against one another, and undercut our will to preclude or respond to international crises because of the higher risk of escalation. The stakes are high. In modern history, the longest period of peace among the great powers has been the era of U.S. leadership. By contrast, multi-polar systems have been unstable, with their competitive dynamics resulting in frequent crises and major wars among the great powers. Failures of multi-polar international systems produced both world wars. American retrenchment could have devastating consequences. Without an American security blanket, regional powers could rearm in an attempt to balance against emerging threats. Under this scenario, there would be a heightened possibility of arms races, miscalculation, or other crises spiraling into all-out conflict. Alternatively, in seeking to accommodate the stronger powers, weaker powers may shift their geopolitical posture away from the United States. Either way, hostile states would be emboldened to make aggressive moves in their regions.

### China war causes extinction

Johnson, Journalist, 5-14-2K1 (Chalmers, “Time to Bring the Troops Home,” The Nation, Volume 272, Number 19)

China is another matter. No sane figure in the Pentagon wants a war with China, and all serious US militarists know that China's minuscule nuclear capacity is not offensive but a deterrent against the overwhelming US power arrayed against it (twenty archaic Chinese warheads versus more than 7,000 US warheads). Taiwan, whose status constitutes the still incomplete last act of the Chinese civil war, remains the most dangerous place on earth. Much as the 1914 assassination of the Austrian crown prince in Sarajevo led to a war that no one wanted, a misstep in Taiwan by any side could bring the United States and China into a conflict that neither wants. Such a war would bankrupt the United States, deeply divide Japan and probably end in a Chinese victory, given that China is the world's most populous country and would be defending itself against a foreign aggressor. More seriously, it could easily escalate into a nuclear holocaust. However, given the nationalistic challenge to China's sovereignty of any Taiwanese attempt to declare its independence formally, forward-deployed US forces on China's borders have virtually no deterrent effect.

## EXT China Uniqueness

### China rising now with nuclear response – US perceived as a threat

**Zhang 11** (Baohui Zhang, “The Security Dilemma in the U.S.-China Military Space Relationship” Asian Survey, Vol. 51, No. 2 [March/April 2011], pp. 311-332, Published by: University of California Press <http://www.jstor.org/stable/10.1525/AS.2011.51.2.311> ap)

Chinese military strategists believe U.S. missile defense poses a real threat to China’s nuclear deterrent. Until recently, the Chinese military tended to believe that U.S. missile defense could not effectively deter a major nuclear power like China or Russia. It was thought that a range of countermeasures, such as deploying decoys and multiple warheads, could be employed to de- ceive and overwhelm U.S. missile defense. Now, however, with the maturing of a multilayered missile defense system by the U.S. and its allies, Chinese nuclear experts are losing confidence in China’s offensive capabilities. This pessimism was illustrated in a 2008 interview of Wang Wenchao in a Chi- nese military magazine. Wang, credited with being the chief designer of China’s sea-based strategic missiles, expressed grave pessimism about China’s offensive nuclear capability against U.S. missile defense. He said, “I have done research: Facing a multi-tiered missile defense system, if any single layer can achieve a success rate of 70%, then 100 single warhead missiles could all be intercepted even if they are mounting a simultaneous attack.”30

This is why Wu Tianfu—arguably the most important deterrence strate- gist of the Second Artillery of the PLA, which runs China’s strategic nuclear forces—charges that the U.S. has “forced China to engage in a space arms race.”31 More specifically, U.S. missile defense has forced China to integrate space war with its strategic nuclear deterrence. China must possess the ability to weaken American space-based assets such as early-warning satellites, to ensure the credibility of its own offensive nuclear forces. Thus, space war and nuclear war are now intertwined in Chinese strategic thinking. Indeed, Chi- na’s official media have credited Wu with establishing the PLA’s first space war research institute.32 Shen Dingli, a prominent Chinese nuclear expert, also states that the January 2007 ASAT test was crucial for China’s nuclear deterrence: “When an America with both superior nuclear and conventional arsenals aspires to build missile defense, China’s response is first to oppose it verbally, then counter it with action if the U.S. refuses to stop. China cannot afford to lose the effectiveness of its still-limited nuclear deterrent.”33

The result is China pursuing an emerging integrated space-nuclear strategy. As argued by Hou Xiaohe and Zhang Hui, strategists at the PLA National Defense University, space warfare will aim at the eyes and ears of missile de- fense, which are early-warning satellites and other sensors deployed in space. China’s ability to cripple these U.S. space assets will significantly weaken the effectiveness of American missile defense, allowing less time and providing less accurate information to guide ground-based interceptors toward the incoming missiles. The strategists also point out that this strategy is more cost-effective than merely expanding China’s nuclear missiles: “Using limited resources to develop anti-satellite weapons to attack enemy space assets that are costly and easily damaged will become an important choice for weaker countries.”34 Lieutenant General Ge Dongsheng gives the most systematic elaboration of the new integrated space-nuclear strategy: “Developing space capability and creating a new type of integrated space-nuclear strategic force is the guarantee of effective deterrence and counter-strike.” According to General Ge, this strategy is now a necessity with the emerging link between space war and nuclear deterrence:

**With the development and integration of space and information technologies, we must recognize that early warning, surveillance, tracking, communication and guidance, which are all critical for nuclear war, are increasingly dependent on space systems. Thus, improving nuclear capability through space capability is now an unavoidable trend.** **We therefore must accelerate the development of space capability to create a new type of integrated space-nuclear strategic force.**

### China is making strategic, long-term, moves towards space modernism - The U.S. must act or be left behind.

**Adams**, Jonathan. "China is on path to 'militarization of space'." *Christian Science Monitor* 28 Oct. **2010**: N.PAG. *Academic Search Premier*. EBSCO. Web.

China looks set to pull ahead in the Asian space race to the moon, putting a spacecraft into lunar orbit Oct. 6 in a preparatory mission for an unmanned moon landing in two or three years. Chinese engineers will maneuver the craft into an extremely low orbit, 9.5 miles above the moon's surface, so it can take high-resolution photos of a possible landing site. Basically, China is looking for a good "parking space" for a moon lander, in a less-known area of the moon known as the Bay of Rainbows. The mission, called Chang'e 2 after a heroine from Chinese folklore who goes to the moon with a rabbit, highlights China's rapidly growing technological prowess, as well as its keen desire for prestige on the world stage. If successful, it will put China a nose ahead of its Asian rivals with similar lunar ambitions – India and Japan – and signal a challenge to the American post-cold-war domination in space. The Asian space race Compared with the American and Soviet mad dashes into space in the late 1950s and '60s, Asia is taking its time – running a marathon, not a sprint. "All of these countries witnessed the cold war, and what led to the destruction of the USSR," says Ajey Lele, an expert on Asian space programs at the Institute for Defense Studies and Analysis in New Delhi, referring to the military and space spending that helped hasten the decline of the Soviet regime. "They understand the value of money and investment, and they are going as per the pace which they can go." But he acknowledged China's edge over India. "They started earlier, and they're ahead of us at this time," he says. India put the Chandrayaan 1 spacecraft into lunar orbit in 2008, a mission with a NASA payload that helped confirm the presence of water on the moon. It plans a moon landing in a few years' time, and a manned mission as early as 2020 – roughly the same timetable as China. Japan is also mulling a moonshot, and has branched out into other space exploration, such as the recent Hayabusa mission to an asteroid. Its last lunar orbiter shared the moon with China's first in 2007. Both Japan's and India's recent missions have been plagued by glitches and technical problems, however, while China's have gone relatively smoothly. Mr. Lele said the most significant aspect of the Chang'e 2 mission was the attempt at a 9.5-mile-high orbit, a difficult feat. India's own lunar orbiter descended to about 60 miles in 2008, he said, but was forced to return to a more stable, 125-mile-high orbit. A low orbit will allow for better scouting of future landing sites, said Lele. "They [the Chinese] will require huge amounts of data on landing grounds," said Lele. "A moon landing hasn't been attempted since the cold war." During the famed 1969 Apollo 11 manned mission to the moon, astronaut Neil Armstrong had to take control of the lander in the last moments of descent to avoid large moon boulders strewn around the landing site. China hopes to avoid any such last-minute surprises with better reconnaissance photos, which would allow them to see moon features such as rocks as small as one-meter across, according to Chinese media. Is China's space exploration a military strategy? Meanwhile, some have pointed out that China's moonshot, like all space programs, has valuable potential military offshoots. China's space program is controlled by the People's Liberation Army (PLA), which is steadily gaining experience in remote communication and measurement, missile technology, and antisatellite warfare through missions like Chang'e 2. The security implications of China's space program are not lost on India, Japan, or the United States. The Pentagon notes that China, through its space program, is exploring ways to exploit the US military's dependence on space in a conflict scenario – for example, knocking out US satellites in the opening hours of a crisis over Taiwan. "China is developing the ability to attack an adversary's space assets, accelerating the militarization of space," the Pentagon said in its latest annual report to Congress on China's military power. "PLA writings emphasize the necessity of 'destroying, damaging, and interfering with the enemy's reconnaissance … and communications satellites.' " More broadly, some in the US see China's moon program as evidence that it has a long-range strategic view that's lacking in Washington. The US has a reconnaissance satellite in lunar orbit now, but President Obama appears to have put off the notion of a manned return to the moon. With China slowly but surely laying the groundwork for a long-term lunar presence, some fear the US may one day find itself lapped –"like the tale of the tortoise and the hare," says Dean Cheng, an expert on China's space program at the Heritage Foundation in Washington. "I have to wonder whether the United States, concerned with far more terrestrial issues, and with its budget constraints, is going to decide to make similarly persistent investments to sustain its lead in space."

## EXT Heg Uniqueness

### US still leader in space – they are reprioritizing – assumes NASA cuts

**Pop Sci 10** (Popular Science, a leading source of science, technology and gadget news since 1872. 2/2/2010, “NASA Budget: Constellation Officially Canned, But The Deep-Space Future Is Bright” < http://www.popsci.com.au/2010/02/nasa-budget-constellation-officially-canned-but-the-deep-space-future-is-bright/> apanday)

In a teleconference today, NASA Administrator Charles Bolden outlined the budget’s goals, emphasizing that while Constellation is getting the axe, NASA’s deep space exploration ambitions have not been curtailed, nor are they being fiscally undercut. Rather, NASA is reprioritizing, seeking more or less a five-year period of intense study on possible means toward future manned missions to deep space before embarking on a mission to the moon or beyond. Between now and fiscal 2015, the agency plans to fully utilize the R&D capabilities of the ISS, demonstrate better deep space flight technologies and fly some unmanned missions around the near solar system to scout out the most scientifically interesting targets for future manned exploration.

### NASA focusing on deep space exploration – leadership not gone

**Highfield 7/12** (Roger Highfield, editor of 'New Scientist', 7/12/11, “Space exploration and the shuttle: our eyes are still on the final frontier” The Telegraph. < http://www.telegraph.co.uk/science/roger-highfield/8631602/Space-exploration-and-the-shuttle-our-eyes-are-still-on-the-final-frontier.html> apanday)

Nasa's administrator, Charles Bolden, insists that his agency has a future and has promised to maintain American leadership in space travel for the next half-century. He wants to leave low-Earth-orbit missions to the private sector, so that Nasa can focus on deep space exploration.

## EXT China I/L

### China’s space development will decrease US hegemony

**Quigley, Rogers, & Tichenor 9** (Erik N. Quigley, Maj, USAF & Advanced Space Research Elective advisors: Lt Col Richard Rogers, Lt Col Brian Tichenor, Maxwell Air Force Base, Alabama, April 2009 “GEO-POLITICAL CONSIDERATIONS TO CHINA‘S RISE IN SPACE POWER” <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA539644> apanday)

Chinas military space threat to the US hegemon status is real and growing. Evidence of Chinas recent rise in space military capability is evident through their recent anti-satellite (ASAT) demonstrations, robust R&D programs, and national motives to become a regional power. China understands the geo-political importance of using military space as an avenue for regional and worldwide recognition and is posturing itself with a historically-proven military &#8215;active defense culture within their military space programs. The US response to Chinas emerging threat is slow and under-prioritized. This lack of a response is apparent with a current unbalanced national strategy for China and sub-standard funding levels for significant national and DoD military space acquisition programs. Competing national security priorities such as the GWOT are crippling the ability for the US to provide the best response to overmatch Chinas rise in military space power.

## EXT Space Leadership Key to Heg

### Space leadership is critical to overall hegemony

**Stevens 10** (J.P, Vice President, Space Systems, Aerospace Industries Association, “Maintain U.S. global leadership in space”, <http://www.aia-aerospace.org/issues_policies/space/maintain/>/sb)

**U.S. space efforts** — civil, commercialand national security **— drive our nation’s competitiveness**, economic growth and innovation. To maintain U.S. preeminence in this sector and to allow space to act as a technological driver for current and future industries, **our leadership must recognize space as a national priority and robustly fund its programs.** Space technologies and applications are essential in our everyday lives. Banking trarnsactions, business and personal communications as well as emergency responders, airliners and automobiles depend on communications and GPS satellites. Weather and remote sensing satellites provide lifesaving warnings and recurring global measurements of our changing Earth. National security and military operations are deeply dependent upon space assets. **The key to continuing U.S. preeminence is a cohesive coordination body and a national space strategy**. Absent this, the myriad government agencies overseeing these critical systems may make decisions based upon narrow agency requirements. The U.S. space industrial base consists of unique workforce skills and production techniques. The ability of industry to meet the needs of U.S. space programs depends on a healthy industrial base. U.S. leadership in space cannot be taken for granted. Other nations are learning the value of space systems; the arena is increasingly contested, congested and competitive. Strong government leadership at the highest level is critical to maintaining our lead in space and must be supported by a healthy and innovative industrial sector.

### Key to the industrial base.

**Institute for Defense Analyses 08** ( Leadership, Management, and Organization for National Security Space, Report to Congress of the Independent Assessment Panel on the Organization and Management of National Security Space, http://www.armyspace.army.mil/ASJ/Images/National\_Security\_Space\_Study\_Final\_Sept\_16.pdf//sb)

Space capabilities underpin U.S. economic, scientific, and military leadership. The space enterprise is embedded in the fabric of our nation’s economy, providing technological leadership and sustainment of the industrial base. To cite but one example, the Global Positioning System (GPS) is the world standard for precision navigation and timing. Global awareness provided from space provides the ability to effectively plan for and respond to such critical national security requirements as intelligence on the military capabilities of potential adversaries, intelligence on Weapons of Mass Destruction (WMD) program proliferation, homeland security, and missile warning and defense. Military strategy, operations, and tactics are predicated upon the availability of space capabilities. The military use of space-based capabilities is becoming increasingly sophisticated, and their use in Operation Enduring Freedom and Operation Iraqi Freedom is pervasive.

# Solvency

## Plan

### Plan: The United States federal government should develop an Orion type fusion launch vehicle.

## 1AC Solvency

### An Orion type fusion vehicle is the only way to go to the moon mars and beyond

Winterberg 8 (March 2008, Friedwardt Winterberg, Research Professor at the University of Nevada, Reno, PhD in physics, winner of the 1979 Hermann Oberth Gold Medal of the Wernher von Braun International Space Flight Foundation, , “Pure Nuclear Fusion Bomb Propulsion,” arxiv.org/pdf/0803.3636, ngoetz)

With chemical propulsion manned space flight to the moon is barely possible and only with massive multistage rockets. For manned space flight beyond the moon, nuclear propulsion is indispensible. Nuclear thermal propulsion is really not much better than advanced chemical propulsion. Ion propulsion, using a nuclear reactor driving an electric generator, has a much higher specific impulse, but not enough thrust for short interplanetary transit times, needed for manned missions. This leaves nuclear bomb propulsion as the only credible option. Both its thrust and specific impulse are huge in comparison.

For a history of nuclear bomb propulsion, reference is made to a long article by A.R.Martin and A.Bond [1]. Under the name project Orion, it was studied in great detail under the leadership of Theodore Taylor and Freeman Dyson. Its history has been published by George Dyson [2], the son of Freeman Dyson. The project was brought to a sudden halt by the nuclear test ban treaty, motivated by the undesirable release of nuclear fission products into the atmosphere. For pure fusion explosions the situation is much more favorable, because neutron activation of the air is much less serious. In nature it happens all the time by cosmic rays.

A first step in this direction is the non-fission ignition of thermonuclear micro-explosions, expected to be realized in the near future. By staging and propagating thermonuclear burn, it should lead to the non-fission ignition of large thermonuclear explosive devices. During project Orion detailed engineering studies about bomb propulsion were made. Apart from some basic considerations, the result of this work shall not be repeated here. I rather will focus on three crucially important topics:

1) The architecture of the space craft incorporating the non-fission ignition driver.

2) The fusion explosive.

3)The delivery of the ignition pulse to the fusion explosive.

The launch from the surface of the earth remains the most difficult task. For it a different approach is proposed. The idea to use intense relativistic electron or ion-beam induced nuclear micro-explosions for rocket propulsion was proposed by the author [3,4], and the use of fission-triggered large fusion bomb propulsion for interstellar space flight by Dyson [5]. An electron-beam induced pure nuclear fusion micro-explosion propulsion system (project Daedalus) was extensively studied by the British Interplanetary Society [6].

### The plan is cost effective, safe, technologically feasible today and the only way to get to mars today

Ragheb 11 (5/5/2011, Magdi Ragheb, Associate Professor of nuclear, plasma, and radiological engineering, Ph.D. Nuclear Engineering, “Nuclear And Plasma Space Propulsion,” https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Nuclear%20and%20Plasma%20Space%20Propulsion.pdf, ngoetz)

This is a nuclear propulsion concept generating its thrust with plasma waves generated from a series of miniature supercritical fission or fusion pulses. The intense plasma wave energy transfers its momentum into vehicle acceleration that can be withstood by the structure of the vehicle and its crew. Very high specific impulses and thrust to weight ratios can be obtained by this approach, which other technologies cannot obtain. Their appeal also stems from their low costs and reusability. They offer fast interplanetary transit times, safety and reliability, and do not require major technological breakthroughs. This could be the only realistic approach available with present day technology for a Mars mission in the twenty first century.

## AT Accidents

### Nuclear ships are safe – military transports nukes frequently

Bonometti et al 8 (2008, A. Bonometti, and P. Jeff Morton, Propulsion Research Engineers, MSFC Propulsion Research, Joseph “External Pulsed Plasma Propulsion (Eppp) Analysis Maturation,” <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20000097368_2000138015.pdf>, ngoetz)

Safety and security are neither major issues nor an overwhelming expense to such a mission. Manned shuttle launches are extremely secure, even from terrorists desiring to "make headlines". The military routinely transports, stores and services thousands of nuclear weapons around the world without incident. These are far more powerful and dangerous than what would be used as pulse units and several steps could be taken to ensure pre-detonation is impossible other than in space behind the vehicle (even handling is safer than for LOX/LH2). Finally, in most other realistic Mars missions, substantial nuclear power in some form must be used and these same risks, costs and political objections must be overcome as well.

## AT Can’t Refuel

### It can mine hydrides for the return trip

Ragheb 11 (5/5/2011, Magdi Ragheb, Associate Professor of nuclear, plasma, and radiological engineering, Ph.D. Nuclear Engineering, “Nuclear And Plasma Space Propulsion,” https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Nuclear%20and%20Plasma%20Space%20Propulsion.pdf, ngoetz)

Hydrides can also be used. Water is one of them, but it dissociates into hydrogen and oxygen at high temperature exceeding 2,500 Kelvin. In addition it is highly corrosive as high temperature steam. Other hydrocarbons can be used giving a dissociated molecular weight around 8 at high temperature and pressure. The nitrogen hydrides ammonia and hydrazine give dissociated molecular weights of about 10, but present a health hazard.

For a trip to Mars, water stored under its surface as permafrost could be mined for the return trip in a nuclear rocket, and its use needs careful investigation.

### The rocket can re-fuel on mars

Winterberg, 89 (August 7, 2009, Friedwardt Winterberg, Research Professor at the University of Nevada, Reno, PhD in physics, winner of the 1979 Hermann Oberth Gold Medal of the Wernher von Braun International Space Flight Foundation, “Colonizing Space With Fusion Propulsion,” Colonizing Space With Fusion Propulsion, ngoetz)

Mars is a much more likely candidate for a large scientific and industrial colony than the Moon because it has water, which contains hydrogen, including the fusion fuel deuterium. But on Mars, water doesn't exist in the form of lakes or rivers, so we must come up with some other means of tapping it.

Nuclear energy is the solution to this problem, too. We can sink a shaft, place some fusion explosives in it, and ignite a very clean explosion with a particle beam, leaving no fission products. In this way, we can release the underground steam in a geyser to the surface, providing a water source for the colony.

## AT Too Much Force

### Pusher plates solve extreme acceleration

Krystek 3 (2003, Lee Krystek, graduate of Rutgers University and has a Master of Science Degree from the New Jersey Institute of Technology, “The Spaceship that Almost Was,” ngoetz)

Ulam and Everett, thinking about this in the mid-50's, realized that the extreme acceleration of such a blast would easily crush any members of the crew to a pulp and even destroy an electronic guidance system. To solve this problem, they decided that the ship should be powered by a series of small A-bombs, perhaps ejected out the back of the vessel in one second (later to be shorted to 1/4 second) intervals. This mitigated the shocks somewhat, but still created too much acceleration to be tolerated by a human crew. Another scientist, Ted Taylor, who found himself intrigued by the idea of a nuclear bomb driven spaceship, came up with the idea of adding a shock absorber to the bottom of the ship. A large heavy round plate (later to become known as the "pusher plate") would take the initial blast and transmit the acceleration to the rest of the ship through a set of column-like shock absorbers.

### Shock absorbers and electromagnetic track would protect the people on the ship

Dinkin 05 (Sam, January 24 2005, regular columnist at The Space Review, “Revisiting Project Orion”, http://www.thespacereview.com/article/309/1, SS)

Shock absorbers have also come a long way since the 1950s. To protect the people from the huge kick of a blast, Orion envisioned huge shock absorbers designed to absorb the impulse of the 1000-ton pusher plate with the entire rest of the ship. Other versions looked at further absorption just in the crew area. My recommendation would be to put the crew on a long electromagnetic track. They could potentially be the only part of the ship that is isolated from the high-g shocks. By having a very small mass isolated from the pusher shocks, the mass of the shock absorbers could be reduced from 900 tons to something more manageable. Additional mass would need to be used to strengthen the components that would not have been exposed to high-g shocks in the old design, but I think a substantial improvement in the mass fraction devoted to shock absorption should be able to be achieved.

## AT Chemical Rockets Solve

### Only nuclear can carry the required payload

Krystek 3 (2003, Lee Krystek, graduate of Rutgers University and has a Master of Science Degree from the New Jersey Institute of Technology, “The Spaceship that Almost Was,” ngoetz)

The scientists tackled the project with unbounded enthusiasm. What was so exciting about the concept of Project Orion was the scale of the spaceship. While most chemical rockets must use most of their mass for fuel, Orion would use only a small part of its total mass for this purpose because nuclear reactions are so much more powerful than chemical reactions. This meant most of the ship's mass could used for food, space for passengers and scientific equipment. With the Apollo missions that flew to the moon, for every 600 pounds that was sent into space, only one pound returned to Earth. The rest was used up as fuel or expended as lower stages of the rocket. It was estimated that an Orion ship, using nuclear pulse propulsion, would be able to send ships to Mars with 1.5 pounds of launch weight for every pound returned. A mission to Saturn would require 5 pounds of launch weight for every pound returned.

### Nuclear propulsion is better than chemical propulsion – laundry list

Bromley, 2K (Blair P., doctor at AECL-Chalk River Laboratories, member of CAIAB of the Nuclear, Plasma, and Radiological Engineering. “Nuclear Propulsion: Getting More Miles per Gallon,” Space Exploration, Astrodigital, 2001, <http://www.astrodigital.org/space/nuclear.html> apanday)

So how do nuclear propulsion systems stack up against chemical systems for a particular space mission? Table 2 shows the results for a Mars mission comparing a high-performance chemical system (H2/O2) with a solid core NTR operating with hydrogen propellant. The payload mass is 100 tonnes and the round-trip travel time is 1 year (6 months to Mars, 6 months return to Earth). The structural mass fraction  is assumed to be 0.05 for the chemical system, and 0.1 for NTR system, to account for the extra mass associated with the reactor and shielding1. The final results are striking. The chemical system has a payload fraction of about 17%, while the NTR system is 40%. More than three times as much propellant is needed for the chemical system. This will translate directly into higher mission costs since all the propellant must be launched into orbit. If we assume that it costs about $5000 per kg to put hardware and propellant into orbit, the chemical system will cost at least 3 billion dollars, while the NTR system would cost about 1.3 billion dollars. So, on the basis of launch costs, one could have two nuclear missions for the price of one chemical mission. Indeed, nuclear propulsion gets "more miles per gallon".

## AT Not Technically Feasible

### We have had the necessary tech since the 60s

Krystek 3(2003, Lee Krystek, graduate of Rutgers University and has a Master of Science Degree from the New Jersey Institute of Technology, “The Spaceship that Almost Was,” ngoetz)

By 1958 the team was planning test vehicles including an orbital model eighty feet in diameter, 120 feet high and weighing 880 tons. It was estimated to need 800 bombs ranging from .03 to 3 kilotons in power to put the ship into orbit. The launch would be from Jackass Flats at the Nevada Test Site near the locations used to test nuclear weapons. Later versions of the ship might be launched from a barge in the Pacific Ocean. A single nuclear explosion is quite an incredible sight and eight-hundred of them detonating at quarter second intervals would be almost unimaginable. Team member Ted Taylor was quoted in George Dyson's Project Orion as saying about the launch, "The first flight of that thing [Orion] doing its full mission would be the most spectacular thing that humans had ever seen."

The scientists estimated that a trip to Mars would be possible as soon as 1965. The unofficial motto for Orion Project soon became "Saturn by 1970." The enthusiastic engineers at General Atomic, **some of the brightest people on the planet**, were completely serious about this goal.

### Large, efficient ship are possible. The explosions won’t damage the ship

Reynolds 2(September 11, 2002, Glenn Harlan Reynolds, Beauchamp Brogan Distinguished Professor of Law, he teaches Space law among other forms of law @ University of Tennessee, “The Road Not Taken (Yet),” http://www.ideasinactiontv.com/tcs\_daily/2002/09/the-road-not-taken-yet.html, ngoetz)

Orion was a nuclear-propelled spaceship. And by "propelled," I mean propelled. The idea - which sounds strange but turned out to look pretty practical - was to propel a spaceship by means of nuclear explosions. Bombs, of a sort, though specially constructed and low in yield, from less than a kiloton to a couple of kilotons. The bombs would be ejected and explode a few dozen meters behind a large pusher plate. The plate would absorb much of the blast, convert it to momentum, and transfer that momentum to the rest of the ship via a system of shock absorbers.

It's not terribly surprising, of course, that if you set off a nuclear explosion next to a large object, the object in question will move. The surprising discovery was that you could do that without destroying it at the same time. But experiments demonstrated that properly treated substances could survive intact within a few meters of an atomic explosion, protected from vaporization by a thin layer of stagnating plasma. (In addition, the 1957 Pascal-B underground nuclear test accidentally launched a manhole cover at speeds that may have exceeded escape velocity, though it isn't clear whether Orion researchers knew about this. The story of this test, often misnamed "Operation Thunderwell," which was actually the name of another nuclear-spacecraft project, has sparked many Internet legends.) The original idea had been Stanislaw Ulam's in 1948, but beginning in 1958 physicists Ted Taylor and Freeman Dyson (author George Dyson's father) worked with numerous other scientists and engineers to design a 4,000-ton spacecraft that would take advantage of this fact to extract motive force from atomic explosions. And, yes, I really did write 4,000 tons: Orion was big, clunky, and mechanical - featuring springs, hydraulic shock absorbers, and other 19th-century-style accoutrements. To handle the shock, it needed to be big. It probably would have had rivets.

In fact, one of the greatest appeals of Orion was that the bigger you made it, the better it worked. While chemical rockets scale badly - with big ones much harder to build than small ones - Orion was just the opposite. That meant that large spacecraft, capable of long missions, were not merely possible, but actually easier, for a variety of reasons, than small ones. Bigger spaceships meant more mass for absorbing radiation and shock, more room to store fuel, and so on. As Freeman Dyson wrote in an early design study from 1959:

The general conclusion of the analysis is that ships able to take off from the ground and escape from the Earth's gravitational field are feasible with total masses ranging from a few hundred to a few million tons. The payloads also range from zero to a few million tons.

# AT DAs

## AT DA Spending

### Assembly in LEO lowers the cost

Bonometti et al 8 (2008, A. Bonometti, and P. Jeff Morton, Propulsion Research Engineers, MSFC Propulsion Research, Joseph “External Pulsed Plasma Propulsion (Eppp) Analysis Maturation,” <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20000097368_2000138015.pdf>, ngoetz)

The way to propel a large diameter EPPP vehicle to Low Earth Orbit (LEO) without nuclear energy is to carry a chemical explosive equal to oxygen and hydrogen combustion onboard or supply the propellant external to the ship. The latter is generally termed as beamed propellant (an alternate to the beamed energy terminology used for external supplied laser or microwave propelled vehicle concepts). More than likely a combination of advanced chemical explosive and beamed propellant technologies would be employed. A possible Mars mission scenario is presented in the next section that is based on explosive technology slightly less efficient than LOX/LH2, but better than conventional solid rocket motors. Its baseline pusher plate diameter is 16 meters and achieves 5,000 seconds lsp, with nuclear pulse units for interplanetary operation.

Launch costs of such a large vehicle into LEO is somewhat relative. Essentially, it is a one-time event and only must be comparable to the total cost involved in a Mars or similar interplanetary mission. The mass savings on a fast Mars trip (7 to 12 months) is enormous when compared to that required for the typical 3-year mission scenario using conventional propulsion. Therefore, even if the system is inefficient for ETO, the gross mission launch weight (all launch vehicle stages, propellant and mission payloads) could be half that of a 3-year mission. And since mission cost is proportional to gross mission mass in order-of-magnitude, it would be a considerable savings.

## AT DA Test Ban Treaty

### 1. No link – Fusion avoids violating the treaty – that’s winterburg

### 2. No impact – no major singnatures and normal means of the plan is withdraw from the treaty

Reynolds 2(September 11, 2002, Glenn Harlan Reynolds, Beauchamp Brogan Distinguished Professor of Law, he teaches Space law among other forms of law @ University of Tennessee, “The Road Not Taken (Yet),” http://www.ideasinactiontv.com/tcs\_daily/2002/09/the-road-not-taken-yet.html, ngoetz)

So what about now? Could Orion ever come back? The answer is yes. The Test Ban Treaty is a real obstacle to any future deployment of Orion. However, it binds only a few nations, and many nations (like India and China) that are both nuclear-capable and interested in outer space have never signed it. For an up-and-coming country looking to seize the high ground in space in a hurry, Orion could have considerable appeal. And, of course, even the United States could withdraw from the Treaty, on three months' notice, under the Treaty's own terms.

## AT DA Outer Space Treaty

### Orion is no more a violation of the Outer Space Treaty than any other rocket

Reynolds 2(September 11, 2002, Glenn Harlan Reynolds, Beauchamp Brogan Distinguished Professor of Law, he teaches Space law among other forms of law @ University of Tennessee, “The Road Not Taken (Yet),” http://www.ideasinactiontv.com/tcs\_daily/2002/09/the-road-not-taken-yet.html, ngoetz)

Some have suggested that the 1967 Outer Space Treaty, which forbids placing "nuclear weapons or any other kinds of weapons of mass destruction" in outer space, would also be a barrier to Orion, but I don't think so. A nuclear "bomb" used for space travel, arguably, isn't a "weapon." It's a tool - just as the Atlas rockets that launched the Mercury astronauts were, because of their use, different from the otherwise identical Atlas missiles aimed at the Soviet Union. (When asked about the difference, Kennedy responded: "attitude.")

## AT DA Radiation

### In the worst case scenario, only ten people will die from global fallout

Dinkin 05 (Sam, January 24 2005, regular columnist at The Space Review, “Revisiting Project Orion”, http://www.thespacereview.com/article/309/1, SS)

Orion’s fantastic engineering is not good enough if the rocket kills people. Freeman Dyson, one of the great contributors to Orion, feels that he was decisive in getting the Orion project nixed in the 1963 Partial Test Ban Treaty. He was making the decision based on the fallout. He calculated that there would be enough fallout to kill one to ten people globally with each launch.

### No unique impact to radiation arguments, Coal kills 100k every year

Dinkin 05 (Sam, January 24 2005, regular columnist at The Space Review, “Revisiting Project Orion”, http://www.thespacereview.com/article/309/1, SS)

The morality of this is too simplistic: It kills people so let’s not do it. That would rule out just about every human transportation type.If something is worth a lot, then it is worth doing even if it kills people. We agree to a steady flux of deaths from the particulates and radiation released by coal-fired power plants because we want our homes heated and our refrigerators to run. One rough estimate is 100,000 deaths a year from coal-fired power plants.Suppose we simultaneously enact a policy to cut the coal contribution to global radiation by more than we added radiation to the atmosphere with the Orion launches (for example, by taxing Orion launches and using the money to buy coal emission permits)? Well, we would be saving lives on balance. The absolute moralist nevertheless would say, “No! Just save the lives and forget the Orion launch.”

### Worst fallout from fission would quickly disappear, mild fallout would be avoided by launcher plate and pulsar units

Smith 2003 (Warne,, March 12 2003, writer for Nuclearspace.com, “The Case for Orion”, http://www.spacedaily.com/news/nuclearspace-03h.html, SS)

Fallout is a serious objection to building and launching Orions. It's caused by debris from the ground being sucked into the fireball of an atomic blast, irradiated and then spewed out of the top. This radioactive plume coalesces in the atmosphere before eventually falling back to earth. It's a mix of isotopes with varying half lives. The most vicious of them are shortlived and are gone in just a few hours.The milder ones can hang around for millennia. This is called a groundburst. With groundbursts the blast and heat throws debris outwards. The debris sucked into the fireball and turned into fallout comes from the crater scoured in the ground by the energy of the blast.One answer to avoiding fallout for an Orion launch is ludicrously simple. Use a thick metal launchpad. Its as straightforward as that. The Orion team discovered that a thick metal plate can withstand close proximity nuclear blasts very well.Evidence of this obtained from nuclear tests was the foundation for further research into the feasibility of a pusher plate. It was discovered that ablation (erosion) of the surface of a pusher plate could also be reduced by coating it with graphite. Coating the launch pad in similar fashion would minimise ablation of the surface and therefore create very little fallout indeed. Airbursts are relatively clean from a fallout point of view. They do generate some fallout from atmospheric dust and water vapor but not as much as legend holds. Further reduction of fallout can be achieved by using more state of the art pulse units than those proposed back in the 60's. Over 80% of the atmosphere lies within the first 16km from the ground. Its almost completely gone at around 50km. Lessening the concern of bomb schrapnel as a source of residual fallout would make airbursts cleaner still. Casings could be composed of something less amenable to absorbing blast radiation for a start.

### Orion Fallout impacts are miniscule compared to previous impacts

Smith 2003 (Warne,, March 12 2003, writer for Nuclearspace.com, “The Case for Orion”, http://www.spacedaily.com/news/nuclearspace-03h.html,SS)

But isn't any level of fallout totally unacceptable? Thats the commonly held myth. Hundreds of atomic devices were detonated back in the 50's and 60's which would make Orion pulses look like xmas crackers by comparison. They were used without any attempt to minimise fallout whatsoever. Many thousands of tons of fallout would therefore have been created by any one of them. I hardly need to point out that the World was not destroyed as a consequence. We seem more than prepared to use big dirty nuclear weapons such as 'bunker busters' for war so why not small and relatively cleaner ones for peace? A study by the Center for Disease Control and Prevention in Atlanta which became public last March is the first to consider the health effects of nuclear detonations. It includes tests by all countries between 1951 and 1962 when open-air testing was finally banned. Public exposure to iodine-131, which can cause thyroid cancer, was included in light of new information obtained after the Chernobyl nuclear accident in Russia.According to the results obtained, of the 3.8 million Americans born in 1951 who would have been exposed to the highest fallout levels in their most vulnerable early years, atomic tests account for an estimated 1000 additional cancer deaths. Smoking, by comparison, is expected to account for about 250,000 cancer deaths within the same group. Considering the number and magnitude of tests conducted back in the 50's and 60's the figure of 11,000 total deaths seems small but even that is grossly exagerrated.

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### No impact to fallout - computer simulations and technical improvements solve

Smith et al 03

[Wayne. Wayne Smith is the founder of NuclearSpace (the Pro-Nuclear Space Movement. Letter to President Bush.]

My name is Wayne Smith and I founded the Pro-Nuclear Space Movement back in 1998 to promote nuclear powered energy and propulsion systems in space. We have had some measure of success over the years. The nuclear space initiative was cause for celebration as you can quite imagine. Over the years I've written articles and helped journalists seeking information. I even went head to head with Bruce Gagnon at SpaceDaily.com . Sometimes I worked to the point of utter exhaustion trying to help popularise nuclear space science and dispel it's myths. The turnaround in public opinion since I first started has been nothing short of staggering. The best option for affordable manned missions to Mars and beyond is the controversial Orion concept. www.projectorion.com The feasibility of this technology was established nearly half a century ago. It promises both high exhaust velocity and thrust. I am hoping you are open minded enough to hear me out. I realise that the word fallout conjures panic but I believe the residual radiation from a ground launch can be minimised to an acceptable level. In the past, any amount of radiation was considered lethal but recently this assumption has been proven false. The linear non threshold method of estimating the threat from fallout has come under fire in light of research into hormesis and cellular repair. Back in the 1960's it was estimated that an Orion launch might kill 10 people around the world from cancer. More recent calculations have revised this figure down to maybe 1 and even that calculation is questionable. This is for a launch straight off the desert floor of Nevada without any attempt to prevent contamination. It would have sucked many tons of dirt through the fireballs to become irradiated. I and other members of NuclearSpace have discussed this scenario for years and come up with many ways to reduce such fallout. The most obvious is to use a thick metal pad 1km or more in diameter coated with a graphite based oil. Oil has special opaquing properties and steel is sufficiently resilient to suffer only millimetres of ablation. Even without an extra graphite oil coating. No dirt means no fallout. Another option is a sea launch. This idea was suggested to me by Jerry Pournelle. Airbursts do create some fallout from atmospheric dust and water vapour but not as much as legend holds. I believe that preventing the groundburst alone would eliminate 99.99999% or more of the fallout generated. The remaining traces would gradually dissipate into the background radiation. We both know that the number one challenge for reaching Mars is getting payload off earth. Orion can reach space with almost the same mass it had on the pad. Not only is a Mars mission feasible but practical. The brilliant men who worked on this project are getting older and not everything they learned can be found in text form. Eventually they will pass on to the next world and take this invaluable knowledge with them forever. It should be pointed out that over 1 million people died last year in automobile related incidents. Over 10,000 from coal burning. Both Thorium and Uranium exist in coal beds and this material gets burned up with the coal before being pumped into our atmosphere. By comparison an Orion launch with sensible precautions would have negligible impact. Other ways of reducing fallout further include specially designed pulse units with radiation resistant casings. We could experiment with short lived radioisotopes too. Some only last a few hours. They would have to be placed in a pulse unit very quickly and used soon but we only need these expensive versions for the atmospheric stage. Launching vertically without an orbital trajectory would mean only a few minutes in the atmosphere. We would only need one launch. Building big means we can carry everything necessary for decades of spaceflight. Ten thousand tons is not unreasonable. Even one hundred thousand tons is possible. In fact, the bigger you construct it, the more efficient an Orion is. Orion's can't easily land but shuttles could be taken along. The industrial infrastructure to utilise space resources too. This opens up the possibility of building more ships in space. Perhaps with asteroid materials. Larger Orions are simpler to build, can carry more payload and make it easier to shield the crew against radiation. A small bunker could be built into the infrastructure with 60cm walls. Building big also means we can use larger pulse units. Hydrogen devices are a thousand times more powerful and cleaner than fission. Yet another way fallout can be reduced. There are other ways and I'm certain a research panel could think up more. An environmental impact study would demonstrate that a launch can be made perfectly safe. To both ensure zero risk to the surrounding area and prevent protestors from GNAWNPIS invading the launch area I would recommend launching from Antarctica. It has less atmospheric dust/water vapour to irradiate and no life exists there. If you check the figures by computer simulation you will find the fallout produced is insignificant. I believe the public can be convinced that such a mission is worthwhile. Back in the 60's shortly after Orion was declassified some of the Orioneers were on a plane and with a captive audience they explained their objectives. The response was overwhelmingly in favour of the idea. People are individuals with the ability to make good decisions when informed enough to weigh things up rationally.

## AT DA Space Weponazation

### 1. Link should have been triggered –

### A) NASA already had a program for nuclear power in space

EETimes 02

[Article by Loring Wirbel. “NASA makes nuclear propulsion a priority”. <http://www.eetimes.com/electronics-news/4043265/NASA-makes-nuclear-propulsion-a-priority>. 4/11/02.]

Nuclear propulsion for spacecraft will become NASA's highest priority as the agency seeks close to $1 billion in fiscal 2003 for research programs, with technology enablers taking priority over planetary missions, NASA administrator Sean O'Keefe told the National Space Symposium Thursday (April 11). O'Keefe, who came to NASA from the White House Office of Management and Budget earlier this year with a reputation as a bean counter, said the reorientation sought for NASA was due not to budgetary constraints but rather to a recognition that outer-planet missions are reaching a point of diminishing returns. A probe mission initiated today would not reach the outer three planets of the solar system until 2017, at which point the scientific research agenda may be quite different, he said. "The 18,000 mile-per-hour speeds have not changed since John Glenn's Friendship 7 mission," O'Keefe said. "This is not good enough for space exploration." NASA's past use of plutonium-based thermal generators in planetary missions sparked launch-site protests for such missions as the Cassini deep space probe, with environmental groups worried over widespread radiation dispersion if an accident befell the probe's Titan-4 launcher. O'Keefe said that he wants to make nuclear propulsion safer, but also wants to research alternatives such as ion propulsion. O'Keefe went further than his NASA predecessor, Daniel Goldin, in suggesting that the time is not right for manned missions to outer planets. He said that much more money needs to be spent studying radiation effects on the human body in deep space, since the Mars Odyssey orbiter has shown radiation exposure at least three times as great as what's experienced on the International Space Station. In fact, biological experiments looking at the effects of deep-space radiation should take a high priority in the space station's pared-down experiment portfolio, he said. The future of the International Space Station was one of the most contentious issues at the Space Symposium. Because of huge cost overruns, NASA has turned to a "Core Complete" program in which only three crew members would be on the ISS at a time and would devote only 20 hours a week to experiments, versus the 120 hours originally promised in ISS plans. The change led NASA to cancel several materials-science and physics experiments aboard ISS without a peer-review process. The space station's problems began in 1999 when NASA started to cut its overall science budget down to almost nothing over a three-year period, said Lawrence DeLucas, director of the Center for Biophysical Sciences and Engineering at the University of Alabama-Birmingham, at a Wednesday panel session. Without putting basic science back in the loop, DeLucas said, NASA will not realize its goals for the space station, whether the crew numbers three, six, or seven astronauts. Matthew Koss, assistant professor of physics at the College of Holy Cross, said the elimination of experiments on the space station constituted a "breach of faith with the scientific community." Jeffrey Sutton, the director of the National Space Biomedical Research Institute, said his multi-school institute has witnessed less of an effect of budget cutbacks than the materials science realm, but warned that "even if the budget for some experiments get restored, people carry wounds, and many may be wary of working with NASA for years to come." O'Keefe made no promises Thursday to restore elements to the NASA science budget in general or to space-station experiments specifically. However, he said he is keeping an open mind on bringing China into space-station collaboration, which could infuse new funds into the program. The first and most important goal of the space station is the sheer management of the program and the engineering functions involved in building a low-earth structure larger than a football field, he said. But O'Keefe said he would seek to restore experiments that truly play a role in NASA's mission of space exploration. "What we do scientifically is less a function of the crew size, and more a function of the requirement," he said. "We have to ask ourselves what we really seek to achieve in space experiments, and prioritize our programs accordingly."

### B) Obama administration is funding it

Grossman 10

[Harold. Quotes SpaceNews. Space Alert is published by Global Network Against Weapons and Nuclear Power in Space, Newsletter #22, Summer 2010. http://www.space4peace.org/newsletter/Space\_Alert\_22.pdf]

The Obama administration is seeking to renew the use of nuclear power in space. It is calling for revived production by the U.S. of plutonium-238 for use in space devices—despite solar energy having become a substitute for plutonium power in space. And the Obama administration appears to also want to revive the decadesold and long-discredited scheme of nuclear-powered rockets—despite strides made in new ways of propelling spacecraft. Last month, Japan launched what it called its “space yacht” which is now heading to Venus propelled by solar sails utilizing ionized particles emitted by the Sun. “Because of the frictionless environment, such a craft should be able to speed up until it is traveling many times faster than a conventional rocket-powered craft,” wrote Agence France-Presse about this spacecraft launched May 21. But the Obama administration would return to using nuclear power in space— despite its enormous dangers. A cheerleader for this is the space industry publication Space News. “Going Nuclear” was the headline of its editorial on March 1 praising the administration for its space nuclear thrust. Space News declared that “for the second year in a row, the Obama administration is asking Congress for at least $30 million to begin a multiyear effort to restart domestic production of plutonium-238, the essential ingredient in long-lasting spacecraft batteries.” The Space News editorial also noted “President Obama’s NASA budget [for 2011] also includes support for nuclear thermal propulsion and nuclear electric propulsion research under a $650 million Exploration Technology and Demonstration funding line projected to triple by 2013.” Space News declared: “Nuclear propulsion research experienced a brief revival seven years ago when then-NASA administrator Sean O’Keefe established Project Prometheus to design reactorpowered spacecraft. Mr. O’Keefe’s successor, Mike Griffin, wasted little time pulling the plug on NASA’s nuclear ambitions.” Being referred to by Space News, as “spacecraft batteries” are what are called radioisotope thermoelectric generators or RTGs, power systems using plutonium-238 to provide on board electricity on various space devices including, originally, on satellites. But this came to an end when in 1964 a U.S. Navy navigational satellite with a SNAP-9A (SNAP for Systems Nuclear Auxiliary Power) RTG on-board failed to achieve orbit and fell to the Earth, disintegrating upon hitting the atmosphere. The 2.1 pounds of plutonium fuel dispersed widely. A study by a group of European health and radiation protection agencies subsequently reported that “a worldwide soil sampling program carried out in 1970 showed SNAP-9A debris present at all continents and at all latitudes.” Long linking the SNAP-9A accident to an increase of lung cancer in people on Earth was Dr. John Gofman, professor of medical physics at the University of California at Berkeley, who was involved in isolating plutonium for the Manhattan Project.

### 2. Internal Link is terminally non-unique – U.S. is already weaponizing

Deblois-Kemp-Marwell-Garwin 04

[Bruce, R. Scott, Jeremy, Richard. International Security, Volume 29, Number 2, Fall 2004, pp. 50-84. Accessed by Project Muse. “Space Weapons Crossing the U.S. Rubicon”.]

In the next Missile decade, planned U.S. military activities in outer space will cross several important thresholds. By 2008, the U.S. Defense Agency intends to deploy a test bed of space-based kinetic-energy kill vehicles (KKVs) to destroy high-speed collision test targets that mimic nuclear-armed reentry vehicles in the midcourse of their arc through space. In early 2006 a Missile Defense Agency satellite experiment, NFIRE, is planned to attempt to intercept a rocket in or near boost phase. Beyond missile defense, these U.S. space-deployed weapons will have broad implications for the entire space sector. Because a KKV designed to intercept missiles could also function as an antisatellite weapon (ASAT) and as a means to deny other countries’ access to space, U.S. adversaries might feel compelled to develop means to counter these and other U.S. space weapons with their own systems based in space or on the ground.

### 3. No impact and shields the link – cooperation over nuclear propulsion with China and Russia in the status quo – ensures plan wouldn’t be misperceived

Helium.com 4/8

[Written by Bryce Tyson. 4/8/11. “Russia and US plan talks on new nuclear spacecraft” http://www.helium.com/items/2133329-russia-and-us-plan-talks-on-new-nuclear-spacecraft.

Space travel requires an enormous amount of energy to sustain spacecraft during increasingly lengthy journeys that will eventually take them to the outermost regions of the universe. In search of a way to power future space journey the United States and Russia are meeting to discuss the use of nuclear power. Hoping to work together on the project engineers from both countries will share their ideas to see if safe and practical nuclear power can be used in spacecraft. Although military use of nuclear power has proven safe and reliable, the technology has never been used in space and therefore raises obvious concerns. For example, if a nuclear –powered space craft should malfunction on liftoff, the impact on the world could prove to be disastrous. Similarly, there are questions to be addressed when it comes to nuclear fallout in space which could prove disastrous to humans and equipment. The Register says that all nations with well-developed manufacturing sectors are sought as partners in the endeavor, meaning Japan, Britain, France, China and Russia. For its part, Russia has already said that it wants to roll out its design for a nuclear space engine by the end of 2012. The engine would be used for power and propulsion simultaneously, creating new challenges. The register story says that nuclear power appears to be the only option to traditional rockets for lift-off, although nuclear ion or plasma-based solutions are expected to work better for propulsion after spacecraft are in orbit. Although some space-based nuclear projects have already been deployed, they have been relatively small. The Register says that radioisotope power is currently used in an array of satellites and will be used in future space rovers. NASA experience has shown that solar powered machines such as the Mars rovers cannot move very far with only solar power. In spite of the emerging plans Russia has for nuclear propulsion in space, it may be redundant, seeing that NASA reportedly has completed plans of its own. Regarding the joint initiative, the Register appears to be skeptical, making the inference that Russia’s inability to finance such a project on its own is the factor that drives its desire for an international partnership in the endeavor. Perhaps one of the greatest lessons of the Russian – US collaboration in nuclear power is that solar power does not have the potential to create enough energy to power the developed world. Just as space projects appear poised to abandon solar power; developed western nations that have pinned al future hopes on solar and wind energy may ultimately discover that the only way to fuel the future is with safe implementations of nuclear energy.

# AT CPs

## AT CP Fission

### Counterplan links to spending

Winterberg 8 (March 2008, Friedwardt Winterberg, Research Professor at the University of Nevada, Reno, PhD in physics, winner of the 1979 Hermann Oberth Gold Medal of the Wernher von Braun International Space Flight Foundation, , “Pure Nuclear Fusion Bomb Propulsion,” arxiv.org/pdf/0803.3636, ngoetz)

One can summarize these estimates by concluding that a very large number of nuclear explosions is needed , which for fission explosions, but also for deuterium-tritium explosions, would become very expensive. This strongly favors deuterium, more difficult to ignite in comparison to a mixture of deuterium with tritium. Here I will try to show how bomb propulsion 5 with deuterium, at worst with a small amount of tritium, might be possible.

## AT CP Free Market

### The government has to lead because to overcome technological hurdles of exploration beyond LEO

Elbon, Boing VP, 11 (7/15/11, John Elbon, vice president and program manager for commercial crew program at Boeing Space Exploration, Interviewed by Alan Boyle, Cosmic Log @ MSNBC.com, “Boeing runs hard in new space race,” <http://cosmiclog.msnbc.msn.com/_news/2011/07/15/7092706-boeing-runs-hard-in-new-space-race>, ngoetz)

A: The technologies that it takes to go beyond low Earth orbit are much more involved and less existent than the capabilities to go to low Earth orbit. We understand that mission, we've got the technology to do that. It's more about running the business than developing the technology. But going to Mars, for example, is a big deal. It's a long mission, so the vehicles have to be more reliable. You can't come home on a moment's notice. Logistics are a huge consideration. There are issues around radiation in deep space. Mars has an atmosphere, so entering and landing on Mars is different from landing on the moon or making a rendezvous with an asteroid. You have a communications delay, so the crew has to be able to operate independently from the ground.

All that needs to be worked out. Those issues are not well understood. So it's important that those missions are developed and executed through government-led programs. That's such a grand adventure that it will probably require an international approach.

### Knowing that the government will be an anchor tenant is the only way build the aerospace industry – investor confidence

Elbon, Boing VP, 11 (7/15/11, John Elbon, vice president and program manager for commercial crew program at Boeing Space Exploration, Interviewed by Alan Boyle, Cosmic Log @ MSNBC.com, “Boeing runs hard in new space race,” <http://cosmiclog.msnbc.msn.com/_news/2011/07/15/7092706-boeing-runs-hard-in-new-space-race>, ellipses in original, ngoetz)

Those markets are there, but to define how deep those markets are and put a business case together that warrants the investment it takes to develop a transportation capability ... from our perspective, that business case doesn't close. So because this is a new market, it's important that there is government funding to assist developers in producing this capability, and then that there is a government use of this system to be the foundation of the market. In fact, we can close our business case around that NASA business, and then look at the commercial market beyond that as a significant potential upside.

# WORK IN PROGRESS – Fission Specific

## ADV Disarment

### Dangerous radioactive fissile material from nuclear caches would be used as fuel for an EPPP rocket

Johnson’s Russia List 01

[Written by Martin Sieff. “Orion will rise!” 11/16/01. http://www.cdi.org/russia/johnson/5550-12.cfm.]

The sweeping cuts in Russian and U.S. nuclear arsenals agreed in Washington this week by presidents Vladimir Putin and George W. Bush raise major questions of environmental and security safety. But these could be answered in three words: "Build the Orion!" "Orion" in this case refers not to the hunter of classical mythology or to the vast constellation that dominates the night sky in the Northern Hemisphere. It means the manned spaceship powered by nuclear weapons designed more than 40 years ago by the great British-American physicist Freeman Dyson. Dyson was no crackpot. He was one of the greatest scientists of the 20th century. It was he who played a key role in explaining and popularizing the late Richard Feynman's Nobel-prize-winning, revolutionary methodology of calculating quantum electrodynamics theory to the world. In 1958, Dyson, and other young idealistic scientists gathered with small nuclear weapons designer Theodore "Ted" Taylor at the General Atomic division of the General Dynamics Corporation in San Diego, Calif., to work on Project Orion, the idea of a spaceship powered by atomic bombs. And they designed it. Dyson and his colleagues knew that the Soviet Union and the United States would build more rather than less nuclear warheads to keep up with one another. They knew it was only a matter of time before other nations joined the nuclear club. They also knew that even if the United States and the Soviet Union should ever reach strategic arms reduction agreements to mutually slash the size of their huge nuclear arsenals, the radioactive, fissile material taken from those warheads posed almost-eternal security risks of its own. It would have to be guarded with 100 percent perfect security indefinitely to prevent it falling into the hands of terrorists, criminals or political extremist fanatics. Nor could the fissile material once manufactured ever be rendered down into more harmless compounds or other elements. And even if it was protected safely, the environmental and contamination dangers from it would also last at the very least thousands, perhaps even hundreds of thousands of years, given the slow half-life, radioactive decay rates of the lethal elements involved. Dyson and Taylor proposed a radical solution to these problems. The atomic weapons could only be used up and totally rendered useless if they were actually exploded and they proposed to do this with lots of them. This would happen not on the earth or in the main atmosphere, but -- mainly -- in the far reaches of outer space, where the addition of the nuclear radiation to all the background radiation already there would be literally negligible and where the blast effects would be harmless. Dyson and Taylor proposed to explode atomic bombs at regular intervals at very short distances behind a specially designed space ship in order to propel it to the Moon and other planets in the Solar System far more quickly and cheaply than chemical-fuel rockets could ever do. Unlike President Ronald Reagan's 1980s vision of "Star Wars" or the Strategic Defense Initiative, the Taylor-Dyson "Orion" vision was far cheaper and more practical. It did not require the development of any new technologies whatsoever. It did not require the development of electronic sensors of simultaneous enormous sensitivity, robustness and reliability, which President Bush's current Anti-Ballistic Missile defense program will require. These are essential for the Bush ABM program to ensure that ground-based interceptor missiles can reliably intercept incoming intercontinental ballistic missiles at combined speeds of up to 36,000 miles per hour, or 18 times the speed of a fired bullet. Dyson even envisaged inter-planetary regular travel as a practical reality by 1970. "We sketched a 12-year flight program ending with large manned expeditions to Mars, in 1968 and to the satellites of Jupiter and Saturn in 1970," he wrote in his 1979 autobiography "Disturbing the Universe." "The costs of our program added up to about $100 million a year (in 1958 dollars)." Dyson, Taylor and their colleagues were simultaneously scientific visionaries and political idealists. They wanted to boost the space age out into the Solar System as quickly as possible to inspire the world. And they also wanted a safe, practical and even politically popular way to destroy the vast stockpiles of nuclear weapons then accelerating during the most tense years of the Cold War at a fearsome rate. Their answer to both these projects was the Orion project. In July 1958, Dyson spelled out these aims in a paper he called "A Space Traveler's Manifesto." He concluded, "We have for the first time imagined a way to sue the huge stockpiles of our bombs for better purpose than for murdering people. Our purpose, and our belief, is that the bombs which killed and maimed at Hiroshima and Nagasaki shall one day open the skies to man." Writing 20 years later, Dyson recalled, "We intended to build a spaceship which would be simple, rugged and capable of carrying large payloads cheaply all over the solar system. Our motto for the project was 'Saturn by 1970.'" In terms of research and development and progress in engineering concepts, the one-year project was an astonishing success. Major progress was made in the areas of theoretical physics, experiments with high velocity gas jets, the engineering design of full-scale spaceships and even the flight testing of scale models. "We built model shops which propelled themselves with chemical high-explosive charges instead of with nuclear weapons," Dyson later wrote. Today, the idea of propelling a space ship through the Solar System by exploding atomic bombs behind instinctively sounds as alien and impossible to the public and even many experts alike. But steam powered ocean navigation appeared equally bizarre and impossible at the start of the 19th century, or heavier than air flight at the start of the 20th. In Part Two, it will be seen that the political and environmental challenges of building and flying an Orion, like the technical and financial ones, may prove surprisingly attainable. At the beginning of the popular young children's TV animated show "Bob the Builder", the introductory song asks the question "Can We Build It?" and Bob replies cheerfully "Yes We Can!" Many U.S. and Russian space engineers frustrated by decades of shrinking budgets, incompetent bureaucratic shackles and -- worst of all -- shriveling vision would answer with just those words. Can they build it? Yes. They can.

### Orion is a peaceful use for nuclear weapons

Krystek 3 (2003, Lee Krystek, graduate of Rutgers University and has a Master of Science Degree from the New Jersey Institute of Technology, “The Spaceship that Almost Was,” ngoetz)

How would history have changed if the government had given the Orion Project the type of support it gave NASA during the early 60's? Could Americans have been exploring Saturn by 1970? Certainly there was an element of naiveté in the General Atomic scientist's plans about how easy space travel will be. A whole host of issues explored by NASA, including the medical affects of long duration spaceflight on the human body, were not being considered. Perhaps the scientists, so long involved in the building of nuclear weapons for the purpose of mass destruction, had finally found a positive, uplifting goal for their skills and they went at it wholeheartedly, not taking some of the difficulties of spaceflight into consideration.

## Solvency

### Fission would work for NPP

Smith 2003 (Warne,, March 12 2003, writer for Nuclearspace.com, “The Case for Orion”, http://www.spacedaily.com/news/nuclearspace-03h.html, SS)

Steady controlled fusion has been a dream since before the atomic age began but seems as far away today as it was in the time of Professor Ulam. To tap into the enormous energy yields of atomic power he had to consider alternative methods. Realising that nuclear blasts could not be easily contained and therefore presented an engineering nightmare he dispensed with the conventional rocket entirely.Instead of a chamber he put forward the notion of using a "pusher plate" instead. This was the concept pursued by the Orion team from 1958 until after the signing of the nuclear test ban treaty in 1963. To design Stanislaw Ulam's revolutionary new vehicle with its unheard of thrust and Isp. Even today the idea seems insane but the craziest thing of all is that they actually succeeded.The ship would have carried many small fission bombs, which would then have been ejected one by one behind the ship and detonated. A reaction mass would have been either incorporated into the bomblets or dropped separately. The explosion vapourising it into a plasma which would then bounce off the pusher plate. Springs and cushioning would support the plate and absorb the impact of the explosion to drive the ship forward.