



October 2, 2002

ply to Attn of: AC5-02-29

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FROM: AC5/Associate Director (Technical)

SUBJECT: The MOON Will Save Us

Ref a: William E. Burrows, "Planetary Defense," *Space News International*,
 September 23, 2002.

Ref b: Robert G. Watts, "Mature Strategies for CO₂ Stabilization," *Cambridge
 University Press*.

A World-Wide Requirement: In reference a, William Burrows recommends a large scale return to the Moon for the "sole purpose of protecting the planet against incipient or sudden catastrophe." The NASA Vision Mission is "to understand and protect our home planet." We understand our home planet too well, but protecting it against incipient or sudden catastrophe is currently a dream. We can, however, develop the technologies that will help protect the people on this planet. This is real science by the people, for the people.

New Knowledge: This past year, Helium-3 buckballs in the Permian extinction event, and an Iridium layer in the Triassic/Jurassic extinction support other impact evidence. The new knowledge is clear. The last 4 major extinctions on this planet were caused by impacts. It was recently reported that the chances are 1 in 5,000 that in the next hundred years Earth will receive a civilization-killer asteroid impact. According to Dave Morrison's *Near Earth Orbit News*, this is based on the visual discovery that the asteroid belt contains 700,000 asteroids larger than 1 km in diameter. More recently the EOS Transactions, American Geophysical Union papers reported that an infrared survey of the asteroid belt has found that there are between 1.1 and 1.9 million asteroids larger than 1 km in diameter in the asteroid belt. If this new discovery is valid, our chances of an asteroid civilization-killing asteroid hit will increase by how much? Can our statistics folks figure? Impacts are only one way Planet Earth evolves. Volcanoes are another. Super volcanoes, according to the geologic record, occur twice per 100,000 years. The last one was Toba in Sumatra. Seventy-six thousand years ago, it put

2800 cu km of rhyolite ash into the upper atmosphere. According to a Discovery TV program several months ago, the Toba eruption is why all humans have pretty much the same DNA. The nuclear winter that 2800 cu km of ash produced necked the human population down to "several thousand" of us. The likelihood of a civilization-killer impact from an asteroid hit is 1 in 5,000 per hundred years or a super volcano occurrence is 1 in 500 per hundred years. According to my statistics buddy these independent events have a mean of 1 in 455 per 100 years. This is one high-risk statistic. The bottom line is that SINGLE PLANET SPECIES DO NOT LAST.

Progress Needed: Purely by accident, the technologies that we must develop to live and work on the Moon and Mars are the same environmental control technologies that will preserve the human race. Of course, we have no clues right now as to when the next impact will occur or when the next super volcano will erupt. Space Guard is discovering earth-crossing 1 km diameter and greater asteroids at an ever-increasing rate, but who knows how many remain to be found? Yellowstone erupted 640,000 years ago and put 2-1/2 meters of ash in Nebraska, 1200 km away. According to the geologists, Yellowstone should erupt about every 600,000 years. It could produce a nuclear winter and wipe out the breadbasket of the USA.

New Technologies: To live and work on the Moon we must have:

1. **Reliable Uninterruptible Power.** Department of Energy representatives reported that they can put 300 kw in a container somewhat larger than a garbage can. The uranium fuel rods would not be inserted until power was required. Therefore there would be no chance of a launch accident. The United States also needs reliable uninterruptible electrical power. Paul Spudis said that one South Pole Crater rim 2 x 5 km sees sunlight all but 70 hours/year. That is where we should build the Solar arrays in the proto-electric plant to deliver via microwave 100% reliable uninterruptible electrical power to rectennas on Earth. This beamed power will pass through clouds and/or ash. The reference supports a Lunar-based Solar Power System to deliver 100% reliable electric power for the Earth people. David Criswell also has worked for years on the methods and locations to build Lunar Solar Power Stations to support 10 billion humans on Earth by 2050 – essentially pollution free.
2. **Terraforming With 100% Recycling.** At JSC, folks in the Advanced Projects Office have evaluated systems that allow closed loop recycling of food, water, and waste including fluids like sweat and urine. Engineers and Scientists have been growing crops such as wheat, tomatoes and lettuce in that closed loop system. Since many states in the USA are running out of water, a cheap way to recycle water to make it drinkable will be essential. At JSC we should continue with the Bioplex and the Integrity idea to develop this technology as soon as possible.
3. **Inflatable Structures.** Many acres of large inflatables, suitably compartmented, will be needed to support living and working on vacuum surfaces. The Transhab at JSC was a good first cut. Self-sealing and properly shielded regions in the inflatables will be needed to protect against small impacts, solar flares, and cosmic rays.

4. **Surface Exploration Pressure Suits.** The goal of this suit should be mobility, reliability, and comfort. Mobility would be needed for surface geologic exploration, shoveling, and drilling, etc. I was in a suit at ILC in June which provided the mobility, but the shoulder bearings and other places bit your body badly on the shoulders, etc. This suit is a good first cut. But, as is usual for new bearing-fitted pressure suits, more attention must be made to comfort. When the suit cuts or bruises your body, useful work quickly stops. The suit weight, with the backpack, would be 100 lbs. more or less. Our current 25-year old pressure suit weighs 300 lbs.
5. **Pressurized Mission Control Center Explorations.** Exploration on the Moon and Mars should be very mobile and very safe. This can be done by using boxcar or larger inflatable Rovers on wheels. With a Mission Control Center-like Interior, the Mission Control team would operate 10 to 50 Microrovers to explore on the surface. When items of interest were discovered, the geologists would then suit-up in the Rover Airlock and explore outside. Inefficient time spent in a pure vacuum is not healthy over the long haul. The Mission Control Center could be powered by an advanced wheeled uranium power source and, if reliability was a worry (and it will be) drag along the return Ascent Stage.
6. **In-Situ-Resource Processing.** Use of resources on the Moon and/or Mars will be necessary. Many ways of producing minerals and useful products, such as solar cells for electrical production, have already been suggested. Trying these pilot electrical plants out on the Moon will be the best way. Dust, of course, will be a continuing problem. It is one time-related reason that we must go to the Moon first because it is only 2-1/2 days away. When critical rotating machinery fails, and it will because of some dust path that we haven't anticipated, the 2-1/2 day Moon is the best place – not the 90 to 200 days-away Mars.
7. **Operationally User-Friendly Systems.** The right combinations of analog-critical switches and software will be needed for autonomous/operations on the surfaces. ISS has gone overboard for software. Critical systems need fast and reliable 3-pole switches just as the Shuttle has. The best user-friendly cabin/cockpit/control center designs need to be implemented.
8. **Heavy Lift.** Initially, before we get In-situ Resource processing established, a very large rocket will be needed to put hardware on the Moon. The uprated Saturn V would put 55 regular tons on a translunar trajectory. The Synthesis Group heavy-lift rocket would put a 120 metric tons in a translunar trajectory.
9. **Fast Heavy Lift.** Franklin Chang-Diaz's Variable Stability Impulse Magneto Plasma Rocket (VASIMR) with the right amount of nuclear power can put humans in Mars orbit in 90 days. Large chemical rockets take 180 to 200 plus days. The VASIMR or clusters of VASIMR's could be docked to rubble-pile asteroids and move them out of the way if they were targeted at Earth.

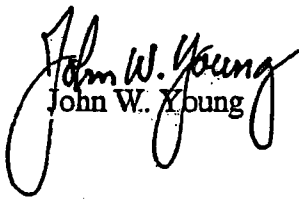
Conclusions: It is concluded that -

1. In order to save the human race we must develop the technologies that will allow us to live and work on other places in the Solar System.
2. This past year, new knowledge has shown us that the human race is at significant risk from normal Solar System and Earth evolving events.
3. The Moon is the very best place to establish the first human bases for living, working, and supporting Earth people in this century.

Recommendations:

It is urgently recommended that

1. NASA redo the risk statistics for civilization extinction events and get the word out on what we must do to save the human race over the short or long haul.
2. We commence development of the 9 advanced technologies that we will need to live and work on other places in the Solar System because SINGLE PLANET SPECIES DO NOT LAST and we have no idea how much time we have.


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