

**ⁱRebuttal To
Yousaf M. Butt's
"The EMP Threat: Fact, Fiction, and Response"
by
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Dr. Butt's Allegations

Yousaf M. Butt in "The EMP Threat: Fact, Fiction, and Response" (*The Space Review*, Part 1, 25 January 2010 and Part 2, 1 February 2010) casts aspersions on the competence and honesty of the congressionally mandated Commission To Assess The Threat To The United States From Electromagnetic Pulse (EMP) Attack. Dr. Butt alleges that the EMP Commission's finding that terrorists or rogue states could make a potentially catastrophic nuclear EMP attack on the United States is "overblown." It is noted that the terminology in this discussion paper will use EMP (a general term) and (high-altitude electromagnetic pulse) HEMP interchangeably. It is noted that the terms E1 HEMP and E3 HEMP are only defined in this manner.

Although Dr. Butt holds a Ph.D. in physics, served in NASA, belongs to the Union of Concerned Scientists, and obviously did a quick study of EMP for his article, Dr. Butt is professionally unqualified to offer competent opinions about EMP, nuclear weapon designs, and the other specialized national security issues in his article. Unlike the EMP Commissioners, Dr. Butt never worked professionally in the Department of Defense or the Intelligence Community on the subject matter addressed in his article, nor has he had access to classified information indispensable to forming competent judgments about the EMP threat. Because Harvard University's prestigious *The Space Review* published Dr. Butt's article, we are concerned that the article will misinform the public and scientific community on a vitally important issue of national security policy, and so seek to correct the record with this rebuttal. The rebuttal offered here is ours and is not an official response from the EMP Commission.

As one example of the quality of Dr. Butt's research, he asserts that, "The methodology and conclusions of the EMP commission have already been criticized a few years ago." To substantiate his claim, Dr. Butt references articles such as "The Newt Bomb" in the *New Republic*--none are serious scientific studies but merely political cartoons, authored by persons who have no competence to judge the EMP Commission's work, and who obviously never even read the EMP Commission reports. For example, these articles condemn the EMP Commission for advocating National Missile Defense and preemptive war against Iran. Yet the EMP Commission never made any such recommendations.

EMP Commission Background

Dr. Butt neglects to tell his readers anything about the purpose and qualifications of the EMP Commission, not even offering a footnote on the EMP Commission reports so that readers can investigate the reports for themselves, presumably because this would not advance Dr. Butt's agenda.¹

Congressional Commissions, like the EMP Commission, are instruments of last resort, established when Departments and Agencies and the Congress can achieve no consensus on a

controversial issue vital to the national interest. Typically, Commissioners are senior statesman and nationally recognized scientists or experts, selected on a bipartisan basis, so that their findings will be respected by all. Congressional Commissions typically are invested with broad legal powers to carry out investigations, compel Departments and Agencies to provide any and all relevant information, hold hearings to air all points of view, and to conduct research. Congressional Commissions endeavor to arrive at a consensus that can serve as the best-informed basis for public policy.

The EMP Commission had all of the above powers and characteristics, not least in that the EMP Commissioners and staff included our nation's foremost experts on EMP, nuclear weapons, and critical infrastructures. For example, the EMP Commission Chairman, Dr. William Graham, began his career working on EMP at the Air Force Weapons Laboratory (AFWL), then Rand Corporation and later R&D Associates and later served as President Reagan's Science Advisor. EMP Commissioner Dr. John Foster is our nation's foremost nuclear weapons expert, having worked on the design of most of the nuclear weapons in the current U.S. inventory. Other EMP Commissioners and staff have equally impressive backgrounds as nationally recognized experts on the national power grid, telecommunications and other critical infrastructures, and on testing and modeling to assess their vulnerability. The EMP Commission has excellent bipartisan credentials, having been first established by a Republican majority Congress, re-established by a Democrat majority Congress, all Commissioners selected on a bipartisan basis. The EMP Commission conducted groundbreaking experiments, some never before attempted, using EMP simulators to test a wide variety of electronic systems, vital to operation of critical infrastructures, in order to assess their vulnerability to EMP. Eight years of the most comprehensive and meticulous investigation and research yet conducted on the vulnerability of modern critical infrastructures went into the EMP Commission's threat assessment. Collaborating with the EMP Commission's work and reviewing its reports were the Intelligence Community (CIA, DIA, NSA); the military services (U.S. Strategic Command, Air Force, Army, and Navy); the National Nuclear Security Administration laboratories (Lawrence Livermore, Los Alamos, and Sandia); the Department of Defense and the Department of Homeland Security.²

Given this background on the EMP Commission, the vast resources available to it, the scale and duration of its work, and the vast extent of its collaboration and review, does it really seem plausible, as Dr. Butt suggests, that the EMP Commission erred, or lied, about the nuclear EMP threat that could be posed by terrorists and rogue states?

EMP Threat From Low Yield Nuclear Weapons

Dr. Butt's chief argument against the EMP Commission is his unfounded assertion that EMP from a low-yield (1-kiloton) nuclear weapon--that he assumes would be the yield of a terrorist or rogue state nuclear weapon--is not sufficient to cause catastrophic consequences against U.S. critical infrastructures. Dr. Butt hinges his argument on the well-known fact that, for nuclear weapons of conventional design, a weapon of high yield will produce stronger EMP fields than a weapon of low yield. But this does not prove--and nowhere does Dr. Butt prove or offer compelling evidence--that EMP from a low yield nuclear weapon would be insufficient to cause a national catastrophe.

It must be noted that Dr. Butt's assumption that a terrorist or rogue state nuclear weapon could not have a yield greater than 1-kiloton is a view unique to him, and constitutes an unrealistically benign assessment of the likely nuclear threat. Proliferation of a Russian tactical nuclear weapon--of which there are many thousands, being the most numerous nuclear weapons in the world--is still considered one of the most likely pathways by which terrorists or rogue states might acquire a nuclear weapon. Russian tactical nuclear weapons typically have yields of 10-100 kilotons, and can be up to a megaton.³

But let us first deal with Dr. Butt's argument on its own terms, and consider his extraordinarily benign EMP scenario, clearly a "straw dog" constructed by Dr. Butt to support his hypothesis, where the threat is from a 1-kiloton weapon.

Tellingly, unable to offer or find test results or calculations that support his dismissal of the EMP threat from low yield weapons, Dr. Butt complains that the EMP Commission unclassified report does not divulge test data for the EMP effects of nuclear weapons of varying yield. Dr. Butt:

Although the EMP commission carried out tests of the robustness of various devices to E1, the unclassified version of the commission documents do not contain many meaningful technical details. We simply do not know the level of EMP stress applied in the quoted tests, and whether they would be appropriate to a large (greater than 100 kilotons) or a small (1 kiloton) type device.

Of course, the EMP Commission was not at liberty to disclose--and was careful not to disclose--classified data that could help terrorists or rogue states attack the American people. The EMP Commission deserves credit for sharing with the American people more unclassified information on the EMP threat to critical civilian infrastructures than ever before provided, an achievement that required the EMP Commission report to undergo several years of security review.

What of Dr. Butt's questioning the EMP threat from a 1-kiloton nuclear weapon? Since the EMP Commission warns that any nuclear weapon, including a low yield nuclear weapon, could be used to make a catastrophic EMP attack on the United States, the reader can be confident that the EMP Commission's test data supports that judgment.

The EMP Commission sponsored tests on commercial equipment and evaluated the failure levels of equipment separately from the computation of the E1 and E3 HEMP fields for different weapons and scenarios. The EMP Commission could not openly publish the results of detailed HEMP calculations for specific weapon designs, but it was clear that there would be significant effects from all types of weapons. As expected, the area coverage of larger yield weapons for E3 HEMP is larger than from lower yield weapons.

However, Dr. Butt is mistaken in suggesting that HEMP effects are somehow linearly scalable with weapon yield, especially for E1 HEMP. Yield is more of a factor for E3 HEMP, but there is a saturation effect for E3 (and E1) HEMP, and the maximum fields on the ground do not scale with total yield. Consequently, the E3 HEMP field from a 10-kiloton weapon is not 100 times smaller than for a 1-megaton weapon. It should be noted that the IEC maximum specification for E3 HEMP is 40 V/km. A field of 1 V/km is enough to create serious effects on a power grid.

Dr. Butt's statement that "significant E3 would not be expected from a low yield weapon, as would be expected from a solar storm" is misleading. It is true that a "great" geomagnetic storm could produce larger E3-like fields on the ground than a low yield weapon, but such a storm produces "overkill." The E3-like fields produced during the Hydro-Quebec blackout in 1989 can be produced by a low yield weapon.

Even Dr. Butt's own calculations, biased to minimize the threat, indicate that EMP from a 1-kiloton weapon would be significant, a fact Dr. Butt reluctantly acknowledges and tries to obfuscate rhetorically. Dr. Butt:

The bottom line is that, indeed, our infrastructure is vulnerable to significant E1 and E3 pulses...while a small weapon could certainly produce substantial destructive E1 fields, such fields would be restricted to only a small region of the country....Serious long-lasting consequences of a one-kiloton EMP strike would likely be limited to a state-sized region of the country.

Most Americans would regard the loss to EMP of an entire state to be non-trivial. Moreover, everything we know about the response of the electric grid to accidental failures and natural disasters indicates a propensity for small local problems to escalate and spread over much wider areas, and for the resulting widespread blackout to cause cascading failures in other critical infrastructures. This is so because the national electric grid is aged and often operating on the verge of failure--and everything depends upon electricity. It would be "suicidally optimistic," to borrow a phrase from Dr. Butt, to assume that an EMP attack that inflicted a state-wide blackout would not also cause cascading grid and infrastructure failures at least regionally. Indeed, such an event could well become a protracted national blackout.

Dr. Butt's calculations are deliberately biased to limit the EMP effects by first selecting a threat yield of 1-kiloton, and then claiming effects "only" in one state. He argues that terrorists or rogue states using a 1-kiloton weapon would want to optimize the EMP field strength by detonating at the lowest possible altitude, trading a gain in increased EMP field strength for a greatly reduced area of effect, limited to a radius on the ground of 725 kilometers. Dr. Butt:

...the "sweet spot" for maximizing the EMP lethality of such weapons would be a detonation altitude of about 40 kilometers--significantly higher, or lower, and the peak fields at ground level will decrease....For 40 kilometers altitude, the maximum extent of the induced EMP E1-fields is within a 725-kilometer radius.

However, contrary to Dr. Butt, terrorists or rogue states may prefer to trade reduced EMP field strength for a gain in area coverage, detonating their low yield nuclear weapon at a higher altitude, covering the Eastern part of the United States with an EMP field. Dr. Butt is mistaken that only the maximum region of the E1 HEMP field is important. That is completely wrong, as the peak electric field is not the only important parameter for coupling to cables and equipment. Extensive research has found that more horizontal angles of incidence of the E1 HEMP are much more efficient in coupling to lines, despite their lower field strengths. The many errors in Dr.

Butt's understanding of HEMP phenomenology appear to result from a lack of familiarity with some of the most basic texts on EMP, well known to all specialists, such as E.F. Vance's *Coupling to Shielded Cables* and MIL-STD-188-125, which provides a method of hardening and testing ground-based C4I facilities to HEMP. The MIL-STD-464 cited by Dr. Butt as a source is recognized among specialists as having little value for EMP aspects.

EMP from a 1-kiloton weapon, though "weak" in comparison to a megaton-range EMP, could still have catastrophic consequences for the critical infrastructures that sustain the U.S. economy and society. This is so because the U.S. electrical power grid, that supports all the other critical infrastructures, is extremely fragile and vulnerable to any EMP attack. Modern microelectronics are over one million times more vulnerable to EMP than electronic systems of the 1960s, and could be damaged or destroyed by the EMP from a low yield nuclear weapon detonated high enough to cover, for example, the Eastern United States. Safety relays and SCADAs (System Control And Data Acquisition) control everything, including the current flowing into big transformers that are indispensable to the power grid, and that currently would require years to be repaired or replaced.⁴ Dr. Butt himself provides anecdotal evidence illustrating the shocking fragility of the electric power grid, citing the August 2003 Northeast Blackout and the cascading failures that resulted when a high voltage power line was assaulted by a tree branch:

The outage affected the Northeast US and parts of Canada and more than 200 power plants, including several nuclear plants, were shut down as a result of the electricity cutoff. Other effects included loss of water pressure, possible sewage contamination, gridlock, various other transportation problems (because of secondary effects on railways, airlines, and gas stations), and disruption of oil refineries' operations. Phone service was stressed due to high call volume and several radio and television stations went off the air. It is estimated that the one-day blackout cost \$7-10 billion in spoiled food, lost production, overtime wages, and other related expenses inflicted on more than one-seventh of the US population.

All of this from a tree branch. It is not an isolated incident. The EMP Commission found many large-scale blackouts of the power grid that were started by a seemingly trivial local problem.⁴ A low yield nuclear weapon detonated to place an EMP field over the entire Eastern portion of the United States would certainly place more stress on the electric grid than a single tree branch, and multiply the above effects manifold by causing many local failures, that could cascade into a national catastrophe.

Sophistication of Rogue State and Terrorist Nuclear Weapons

Dr. Butt is fixated on disproving the EMP threat from a 1-kiloton nuclear weapon because he mistakenly thinks the EMP Commission shares his assumption that this is the likely yield for a rogue state or terrorist nuclear weapon. According to Dr. Butt:

...such missiles [as Iran's Shahab-3] have a payload capacity of approximately 1,000 kilograms corresponding to a crude U-based warhead of 1 kiloton yield--if, and when, the Iranians eventually develop nuclear weapons. Even the North Koreans, who are much further along in their weapons program, have had great

difficulty reaching even a 5 kiloton yield from their Pu-based devices in carefully orchestrated ground tests, and their 2009 test was likely a fizzle.

The historical record and the best evidence does not support Dr. Butt's view that terrorist or rogue state nuclear weapons are likely to be inferior to the first atomic bombs produced by the United States during World War II. If terrorists get a nuclear weapon, most analysts believe it will come from Russia or one of the rogue states, and so be far more sophisticated than anything the terrorists could build themselves. Dr. Butt's rosy views about nuclear proliferation notwithstanding, the Defense Department and State Department have given high priority and invested vast resources to prevent the proliferation of nuclear weapons and technology from Russia. The threat of nuclear proliferation from Russia is still very real, as President Obama made clear in his 2010 State of the Union Address.

Nuclear aspirant rogue states, like North Korea, Iran, and Syria, have a huge advantage over the United States' Manhattan Project of World War II, that invented the first atomic bombs in 3 years, relying on 1930s and 1940s era technology. Rogue states can draw upon huge quantities of unclassified and declassified literature--including the original Manhattan Project papers--for guidance on building their nuclear weapons.⁶ Rogue states can and do purchase on the international market all manner of commercial and dual-use technologies relevant to developing nuclear weapons, technologies 70 years more advanced than that available to the U.S. Manhattan Project. Rogue states can and do rely on international criminal organizations, like the A.Q. Khan network, to help them get the technology and know how they need for nuclear weapons. Rogue states help each others' nuclear weapons programs, as North Korea was recently helping Syria, and is helping Iran.⁷ Rogue states can and do buy help from Russia and China.

The record does not support Dr. Butt's assumption that rogue state nuclear weapons are likely to be primitive. Credible open source reporting, including from Mordecai Vanunu, who worked in Israel's nuclear weapons program, indicates that Israel has developed an array of sophisticated nuclear weapons, including thermonuclear weapons and miniaturized warheads for its Jericho missile--without nuclear testing.⁸ There is no reason North Korea, Iran, and Syria cannot duplicate Israel's feat, especially as they have even greater resources than Israel. Pakistan and India quickly leapt from a few nuclear tests to deployment of an array of nuclear weapons, including warheads miniaturized for delivery by ballistic missile. Pakistan claims to have tested a thermonuclear weapon. If true, it is less likely a high yield weapon, and more likely a specialized weapon, like a neutron bomb. Sam Cohen, "Father of the Neutron Bomb," credited Israel and South Africa with developing such weapons.⁹ The United Nations nuclear watchdog, the IAEA, discovered that a criminal group proliferated blueprints for a miniaturized nuclear warhead that could be delivered by Iran's Scud or Shahab-3 missiles.¹⁰

Super-EMP Weapons

Last but not least, senior Russian EMP experts warned the EMP Commission that "brain drain" from Russia enabled North Korea to make what the Russians call "Super-EMP" weapons.¹¹ According to Russian open sources, these are small, low yield nuclear weapons, that can generate extraordinarily powerful EMP fields, many times more powerful than the E1 EMP from a multi-megaton weapon.¹² Both of North Korea's nuclear weapons tests, that produced low yield "fizzles," look very like what would be expected from a "Super-EMP" weapon. According

to open source reporting, South Korean military intelligence claims North Korea is receiving Russian help developing "Super-EMP" weapons.¹³

Moreover, the EMP Commission discovered from its investigations that, as noted in the Commission's unclassified Executive Report, "Certain types of relatively low-yield nuclear weapons can be employed to generate potentially catastrophic EMP effects over wide geographic areas, and designs for variants of such weapons may have been illicitly trafficked for a quarter-century."¹⁴

On a related matter, Dr. Butt incorrectly asserts that "due to the fact that the super-EMP weapon will be directional, it is unlikely to effect a large part of the country." In fact, a "Super-EMP" weapon can be designed to be directional (the more challenging design) or to cover broad area (the simpler design). The simplest design of a "Super-EMP" nuclear weapon, configured for broad area coverage, could generate extraordinarily high EMP fields over the entire contiguous United States.

The bottom line is that no one knows how sophisticated or unsophisticated present and future terrorist and rogue state nuclear weapons may be. But it would be folly to gamble the lives of millions of Americans on Dr. Butt's unwarranted certainty that those weapons are and will remain unsophisticated.

Russia and China

Dr. Butt reassures us that the United States need not worry about any EMP threat from Russia or China, as these nations will be deterred by economic self interest. Dr. Butt:

We owe China tremendous sums of money, they need us as a market, and both the US and China require Russian oil via intertwined world markets.

Those who opposed military preparedness before World Wars I and II used this same argument--that German aggression and world war was impossible because of the economic interdependence of European states and the world. Economic interdependence did not stop the world wars from happening. Nor did China's economic partnership with the United States stop a Chinese general, during the 1996 Taiwan Straits Crisis, from threatening a nuclear strike against Los Angeles.¹⁵

While the United States no longer views Russia and China as enemies, the reverse is not also true. Russia and China in public statements and military writings continue to portray the U.S. as a potential enemy, often as a reckless aggressor seeking to impose a New World Order dominated by the United States.¹⁶ Russian and Chinese military writings are replete with scenarios and references to making EMP attacks against the United States.¹⁷ Indeed, during the 1999 Balkans Crisis, leaders of the Russian Duma raised the specter of a Russian EMP attack that would paralyze the United States, in order to stop U.S. bombing of Serbia.¹⁸ In 2009, shortly after the election of President Obama, Russian President Medvedev threatened to neutralize NATO's deploying missile shield by targeting nuclear weapons on radars and interceptors in Poland and the Czech Republic, and by "radioelectronic means"--Russian parlance for EMP.¹⁹

The EMP Commission Report warns, "China and Russia have considered limited nuclear attack options that, unlike their Cold War plans, employ EMP as the primary or sole means of attack."²⁰

America cannot afford to bet its security on the perpetual good will of Russia and China. Deterrence of an EMP attack on the United States by Russia or China only has to fail once for the American people to suffer catastrophic consequences.

ICBM EMP Threat

Dr. Butt asserts: "A state would be highly unlikely to launch an EMP strike from their own territory because the rocket could be traced to the country of origin and would probably result in nuclear or massive conventional retaliation by the U.S." Contrary to Dr. Butt, if the EMP attack works, the United States will be in no condition to retaliate. Russian open source military writings claim that "Super-EMP" weapons generate such powerful fields that even hardened U.S. strategic forces would be vulnerable.²¹ Massive conventional retaliation by the United States, which could deter such an attack, depends on the survival of U.S. civilian critical infrastructures, that are indispensable to power projection.

Moreover, if retaliation is possible, there is the dilemma of what kind of nuclear retaliatory strike the United States would make in response to an EMP attack? The EMP targets electronics, not people, and would not immediately kill millions. Mass casualties would come later, from secondary effects, if the United States continues to be unprepared. A retaliatory EMP strike on a nation like North Korea would be close to meaningless, since they are not as dependent as the U.S. on advanced electronic infrastructures. Inflicting a nuclear holocaust on Tehran or Pyongyang for an EMP attack might not seem like a proportionate response to an American president, at least not immediately.

Further, nations like North Korea and Iran may seek long-range missiles so they can credibly threaten to launch an EMP attack from their territory, rather than actually execute such an attack. The acquisition of such capability will immediately change the calculus of risk for the United States in upholding its alliance relationships, and in U.S. willingness to impose sanctions or undertake military action against the state capable of launching an EMP attack against the American homeland. Rogue states that possess a "force in being" capable of threatening the American homeland with EMP would have a promising means of deterring the United States. During the Cold War, the United States deployed hundreds of missiles and thousands of warheads to establish a Mutual Assured Destruction (MAD) relationship with the Soviet Union, that successfully deterred the USSR from invading NATO or attacking the United States. Today, with one or a few ICBMs capable of inflicting a catastrophic EMP attack on the American people, a rogue state could recreate the MAD relationship with the United States, very much to the detriment of American interests.

Finally, vengeance should not be underestimated as a motive for a rogue state launching an EMP strike from its own territory against the United States. North Korea and Iran and other rogues are probably doomed for the ash heap of history. When they collapse, if they can take their enemies with them, they will almost certainly try to do so. Rogue leaders will want the United States to know that the EMP attack came from them, when the mob is at their gate.

Nuclear Terrorism

One scenario of particular concern to the EMP Commission is that rogue states or terrorists could make an "anonymous EMP attack" by launching a short- or medium-range missile off a freighter outside U.S. territorial waters.²² This would eliminate the need for an ICBM to deliver the EMP attack. Since the EMP strike would come from no one's territory, it could also conceal the identity of the attacker. Although it would not be necessary, an additional layer of anonymity could be achieved by a state sponsor by contracting with terrorists to carry out the attack.

Dr. Butt contends "it is highly unlikely that a nation would give one of its crown jewels [a nuclear weapon] to an unpredictable terrorist cell." Dr. Butt quotes a paper done at the National Defense University that states, "Iran would not, as a matter of state policy, give up control of such weapons to terrorist organizations and risk direct U.S. or Israeli retribution."²³

Yet Iran and Syria are killing Americans and Israelis every day, by providing increasingly sophisticated weapons to Hezbollah and Hamas to attack Israel, and to terrorists in Iraq to kill Americans there, apparently without fear of U.S. or Israeli retribution.

Dr. Butt's view that not even Iran--the world's leading sponsor of international terrorism--would give a nuclear weapon to terrorists, is an opinion unique to Dr. Butt and the authors of the NDU paper, which does not represent the official view of the National Defense University. The mainstream view, so widely held that it probably deserves to be described as a consensus, is that Iran, North Korea, Russian organized crime, or other actors might transfer a nuclear weapon to terrorists. Iran's sponsorship of international terrorism is one of the chief reasons successive American presidents have made it a priority of their administrations to stop Iran's nuclear weapons program. In hearings held before the Senate Homeland Security Committee in 2008, Chairman Joseph Lieberman and the Director of Intelligence for the Department of Homeland Security, Mr. Charlie Allen, both warned that state-sponsored nuclear terrorism is a real prospect.²⁴ That is why one of the most ambitious programs sponsored by the Department of Homeland Security is to improve U.S. port security and develop new technologies capable of detecting a nuclear weapon being smuggled into a U.S. city.

The consensus view of the Congressional Commission on Weapons of Mass Destruction (reporting in 2008 and 2010), whose findings--like that of all Commissions--are supposed to provide the authoritative basis for making national security policy, warns that state-sponsored nuclear terrorism is a very real threat.²⁵ The consensus view of the Congressional Commission on the Strategic Posture of the United States (reporting May 2009), independently arrived at the same conclusion as the EMP Commission, and warns that "the United States should take steps to reduce the vulnerability of the nation and the military to attacks with weapons designed to produce electromagnetic pulse (EMP) effects....The homeland might be attacked by terrorists or even by state actors with an eye to crippling the U.S. economy and American society."²⁶

Shipborne "Anonymous" EMP Attack

Dr. Butt alleges that state sponsors of an "anonymous" shipborne EMP attack would have to be "suicidally optimistic." Dr. Butt recommends the United States deter such an attack by relying

on nothing but bluff. Such defenses as Dr. Butt recommends against shipborne EMP attack are, indeed, suicidally optimistic:

First, Dr. Butt recommends relying on presumed foreign ignorance of nuclear forensics to deter an "anonymous" shipborne EMP attack, even while acknowledging that nuclear forensics are not yet capable of identifying an attacker. Dr. Butt: "While nuclear forensics are not well enough developed to assuredly ascribe the origin of a nuclear explosion, even their current state of development would, in some measure, dissuade the leaders of a nation from seriously contemplating such an attack." Dr. Butt forgets that an EMP attack detonates the warhead at high altitude, in outer space--leaving no bomb debris on the ground for nuclear forensics detectives to collect, and so leaving no "fingerprints," even if forensics could detect them.

Second, Dr. Butt recommends relying on presumed foreign ignorance of DSP satellite capabilities to deter an "anonymous" shipborne EMP attack, even while acknowledging that DSP could not really identify the attacker. Dr. Butt: "Furthermore, the U.S. certainly has data, via its DSP satellites, on the infrared (IR) signatures of the rocket exhausts from the missiles of various countries. Though these signatures are probably virtually identical for the Scud/Shahab/No-dong family of missiles, the nations which may entertain such attacks do not necessarily know whether...the DSP data can discriminate between a KN Nodong versus an Iranian Shahabs..."

The DSP satellite was designed to provide early warning of Soviet or Chinese strategic missile launches, from their known ICBM fields, not to identify the national origins of short- and medium-range missiles. Any competent foreign intelligence service with a public library card would know this, and much else besides about the capabilities and limitations of DSP. In fact, the "signatures" of medium-range missiles from such countries as North Korea, Iran and Pakistan would be virtually identical, as they are all based on North Korea's Nodong, which itself is derived from Scud missiles of Russian design. Over 30 nations worldwide possess Scud missiles, all virtually identical, that could be used to make an EMP attack.²⁷ Anyone can purchase Scud missiles on the world market. Terrorists in North Yemen have them. Prior to 9/11, an American collector purchased a live Scud, with dummy warhead, for his museum.²⁸

Large Phased Array Radars (LPARs) are the best tools the United States has for meticulous threat assessment against an incoming missile. An EMP attack, because of its abbreviated trajectory, especially if launched from a ship, leaves too little time for warning, let alone identification of the exact make of the missile. An EMP attack launched from the Gulf Coast would avoid LPARs entirely, as there is no radar facing in that direction.

If a rogue state were really concerned about their ship-launched missile being identified as to national origins, they could always buy someone else's missile. Many of Saddam Hussein's Scuds and other missiles are missing from Iraq. Some 100 Scuds belonging to the Taliban are missing in Afghanistan, unaccounted for.²⁹ These and other missiles can probably be purchased on the black market.

Finally, rogue states are unlikely to be intimidated by DPS or LPARs, as they have seen U.S. satellites and radars fail in battle during the first Persian Gulf War. The one victory achieved by Saddam Hussein in that conflict was the survival, reloading, and repeated firing of his mobile

missile launchers, despite the best efforts of U.S. DPS satellites and AWACs radar aircraft to locate and destroy them. This failure of America's vaunted technology was seen on television and celebrated throughout the Arab world.

Dr. Butt's "deterrent" to a shipborne EMP attack, relying on technologies that he himself acknowledges will not work, would gamble the survival of the American people on the presumption that our adversaries are stupid. Even if they are, rogue states can always buy anything they need to know about our defenses from Russia. That is how the Serbs managed to shoot down the "crown jewel" of our Air Force, the F-117 Stealth Fighter, during the Balkans War.

Biggest Bang For The Buck

Dr. Butt argues that terrorists or rogue states would prefer to use a nuclear weapon "in a simple spectacular ground-burst that will destroy a large part of a city, and not risk the complications--and likely failure--of a lofted EMP strike..." Dr. Butt:

The risk versus reward calculation for both terrorist cells and so-called "rogue" states would almost certainly force their hand to a spectacular and direct ground burst in preference to an unreliable and uncertain EMP strike.

Dr. Butt assumes that smuggling a nuclear weapon into the United States, and detonating the weapon in a city, is much more easily and assuredly accomplished than an EMP attack. But this is not so.

Terrorists and rogue states are surely aware of the greatly improved and ongoing improvements to U.S. port and homeland security, including the deployment and continued development of technologies to detect smuggled nuclear weapons. They are also aware--and have probably experienced first-hand--the ever increasing effectiveness of U.S. and allied intelligence in monitoring terrorist networks and penetrating terrorist cells. Dr. Butt correctly argues that one of the biggest fears of terrorists or their state sponsors would be the capture of their nuclear weapon by the United States. This is far more likely to happen in an operation trying to smuggle a nuclear weapon into a U.S. city, than in an EMP attack. As soon as the vessel or aircraft carrying a terrorist nuclear weapon enters U.S. territorial waters or air space, the possibility of discovery and interception increases dramatically, and continues to escalate with each phase of the operation drawing closer to target: landing, off-loading, transportation. A single phone call to the U.S. Coast Guard or FBI from a CIA or allied agent who has penetrated the terrorist cell would deliver the bomb into U.S. hands.

The phone call might not come from the CIA, but from one of the terrorists themselves. Terrorists and rogue state special forces are not the Green Berets. Loyalty to their evil cause, or to the cruel regime they serve, might well be compromised by the temptation to sell their nuclear weapon to the FBI for millions of dollars.

Nor are terrorists or rogue state special forces particularly good at the kind of clandestine operations at which the Green Berets excel. The 9/11 Commission found that the terrorists of

September 11th made many mistakes, and would have failed if U.S. security was just a little more vigilant.³⁰ Rogue state special forces do not have a good record of carrying out penetrative clandestine operations beyond their borders. For example, Saddam Hussein's plot to assassinate the first President Bush in Kuwait was discovered by Kuwaiti intelligence, and failed spectacularly. A North Korean plot to conduct sabotage operations in South Korea, by landing special forces in a mini-submarine, when the sub became stranded, ended with the suicides of the operatives, and capture of the sub.³¹

Dr. Butt thinks terrorists and rogue states will give great emphasis to optimizing the use of a nuclear weapon--hence his argument that an EMP detonation occur at the optimum height of burst, "the sweet spot" in his parlance. If so, terrorists or special forces seeking to blast a city instead of EMP, should prefer to smuggle their nuclear weapon out of a port or airfield into the population center,, preferably somewhere high up, as in a skyscraper, to optimize the blast effects against people. A low yield nuclear weapon detonated shipboard, in a port, will kill surprisingly few people, compared to the optimum attack mode. For this reason, the Department of Homeland Security is looking at scenarios where nuclear terrorists offload their weapon from shipboard onto a speedboat, to avoid port security, land on some remote beach, and transport the bomb to a city. The requirements of such an operation permit only a very small terrorist team to deliver the bomb, allow only a single technician to "baby sit" the bomb, which gets bumped and jostled around so much that the technician is indispensable. A lot can go wrong.

And if everything goes right and the bomb detonates successfully after being manhandled across water, beach, and bumpy roads, things can still go very wrong. A nuclear weapon detonated in a city will leave plenty of debris, and is the optimum scenario for successful forensic analysis to identify its origins--a factor Dr. Butt thinks would deter a state actor in the first place. The blast will destroy part of a city, kill thousands of people, but not incapacitate the United States as a military superpower. Such an attack will virtually guarantee that the United States will eventually find the culprit, and destroy him.

Rogue state leaders, who tend to be paranoid about the loyalty and competence of their own people, considering the above factors, are likely less enthusiastic about smuggling a nuclear weapon into a U.S. city than Dr. Butt.

On the other hand, a shipborne EMP attack eliminates all of the operational risks described above. The ship can be manned with enough security personnel to monitor everybody, to ensure that no last minute betrayal of the operation occurs. Operating outside U.S. territorial waters greatly reduces the possibility of U.S. interdiction. Ship communications will ensure that terrorist or rogue state leaders can personally oversee and command and control the operation. A freighter can carry as many technicians as are needed to ensure that the warhead and missile are in good working order. Scuds, Shahab-3s, and Nodongs are highly reliable missiles, unlikely to fail. Will the warhead work? Early U.S. atomic bombs, though of experimental design and built with a lot of guesswork, never failed. Fuzing the warhead to guarantee detonation at high altitude can be done easily, with simple, robust, redundant, commercially available technology. The likelihood is probably greater than 90 percent that the warhead will be delivered and detonate at the correct altitude. The EMP effect is inevitable.

The most problematic part of an EMP attack is: will the EMP inflict sufficient damage on critical infrastructures to destroy the United States, to eliminate the U.S. as an actor from the world stage? Even if the EMP attack "fails," it will probably inflict far more damage, more widespread damage, kill more people, and impose a far more prolonged national recovery than anything that could be achieved by detonating the same nuclear weapon in a city. If the EMP attack "succeeds," more than two-thirds of the American people could perish within 12 months of the event, and the United States that we know today would probably never recover.

EMP attack offers by far the "biggest bang for the buck." It is the only nuclear option that offers a prospect for achieving--with a single nuclear missile--the destruction of American civilization.

Dr. Butt fails to mention in his article that Iranian military writings call for making an EMP attack against the United States; that Iran has practiced missile launching from a vessel in the Caspian Sea; and that Iran has detonated several Shahab-3 missiles at high-altitude, as if practicing an EMP attack.

E1 versus E3 HEMP

Dr. Butt's version of the history of U.S. nuclear tests is heavily skewed to give the reader a false impression that there is no evidence E1 HEMP can damage electronic systems, while E3 HEMP does most of the significant damage. Through this false history, Dr. Butt seeks to convince the reader that low yield nuclear warheads, that would use E1 HEMP as their primary damage mechanism, pose no threat, while high yield warheads, that produce both E1 and E3 HEMP, are the only nuclear EMP threat. Then nuclear E3 HEMP is dismissed by Dr. Butt on political grounds, because allegedly the only nations capable of mounting a nuclear E3 attack, China and Russia, are our economic partners.

In fact, contrary to Dr. Butt, U.S. nuclear tests produced copious evidence that E1 HEMP can damage or destroy electronics. Over 50 years of testing with HEMP simulators has also proved incontrovertibly that E1 HEMP is a serious threat, in some ways more threatening than E3. The EMP Commission also performed tests using HEMP simulators proving that E1 HEMP, even from a low yield nuclear weapon, can destroy modern electronics.

Dr. Butt's assertion that E3 poses the greatest threat because it couples to long-lines is misleading. E3 does couple well to long power transmission lines and creates a threat to the large EHV transformers. However, E1 couples well to distribution power lines and low voltage cables (as short as 10 meters) in power substations and creates a threat to the electronic controls that operate and protect equipment, including EHV transformers. Clearly, both E1 and E3 HEMP are important for their coupling to long lines, not just E3 HEMP and geomagnetic storms.

Super-EMP weapons are designed to generate E1 HEMP exclusively, and pose the greatest EMP threat in terms of field strengths.

However, even if one accepted Dr. Butt's arguments, that for physical and political reasons we do not have to worry about E1 HEMP from a nuclear EMP attack, we still need to worry about E1 or its equivalent from a non-nuclear EMP attack. Radiofrequency and microwave weapons are readily available to terrorists on the world market. Although these weapons have a much

more limited effective radius than a nuclear weapon, a single such weapon, intelligently used, could blackout a city. A few hundred such weapons, intelligently used, could blackout the entire United States.

Dr. Butt advocates protecting only against E3-like fields, that would be generated by a geomagnetic storm, because he believes geomagnetic storms pose the only "real" EMP threat. It should be noted that the protection from geomagnetic storms also provides protection from the E3 HEMP. In addition, it would cost little more to protect against E1 HEMP from nuclear or the E1-like fields from non-nuclear weapons--which are also real threats.

Dr. Butt's statement "that geomagnetic storms, on occasion, can induce more powerful pulses than the E3 pulse even from megaton type nuclear weapons" is completely wrong. The peak fields that might be produced from a once-a-century "great" geomagnetic storm might reach 20 V/km. Megaton class nuclear weapons can exceed this level. But only about 1 V/km is needed to create serious problems in power grids and long-line communications.

Dr. Butt fails to credit the EMP Commission with pioneering the work on the threat from a "great" geomagnetic storm in 2001. The EMP Commission was warning about the low-frequency electromagnetic threat to the power grid from a geomagnetic storm fully eight years before the National Academy of Sciences study independently verified the work of the EMP Commission.

Methodology

Dr. Butt makes much of the fact that there are still individuals who disagree with the EMP Commission's threat assessment. Dr. Butt's methodology appears to assume that any dissent from the EMP Commission automatically proves that the Commission is wrong. But there will always be those who disagree with any Commission's findings--no matter that the methodology, research, and analysis are excellent--just as there are those who disagree with the 9/11 Commission, the WMD Commission or any other Commission one cares to name.

The best any Commission can do is to hear all points of view, rigorously and fairly examine everyone's arguments and data, fully and fairly debate the facts, and come to a consensus judgment, submit that judgment for review by expert individuals and institutions, and based on everything learned from this process, arrive at a final consensus, if possible. This the EMP Commission did, and achieved a consensus among the Commissioners, who represented a wide array of backgrounds and viewpoints. There will always be those who disagree with the EMP Commission.

Nonetheless, the EMP Commission's threat assessment and recommendations--the product of 8 years of intensive research and analysis unprecedented for this issue--represents the best work so far produced by this nation on EMP, and is the best informed basis for national security policy.

On another point of methodology, Dr. Butt's philosophy of doing nothing to protect our nation from nuclear EMP attack is based on his belief that rogue states and terrorists would never attempt an EMP attack. Uncertainty about the effectiveness of EMP, Dr. Butt argues, would deter terrorists and rogue states from making such an attack because, as Dr. Butt puts it, they are

not "suicidally optimistic." But one of the things we know for sure about terrorists and rogue states is that they are literally "suicidally optimistic." Terrorists and rogue states have demonstrated repeatedly that they are willing to take tremendous risks, even commit suicide, in order to achieve their objectives. The 9/11 terrorists took enormous operational risks, and literally committed suicide, as did Afghanistan's Taliban, committing regime suicide to support the 9/11 operation. Saddam Hussein took suicidal risks, which ultimately cost his life, to invade Kuwait and then to defy the United States and United Nations on WMD inspections. Iran is taking suicidal risks by supporting international terrorism, waging a clandestine war against America in Iraq and against Israel, and defying virtually the entire world by pursuing nuclear weapons. North Korea is taking suicidal risks by exporting missile and WMD technologies, and provoking virtually the entire world with its nuclear and long-range missile tests.

Rogue states like Iran and North Korea are willing to run suicidal risks because they believe their own propaganda--that they are at war with a United States determined to destroy them. From their perspective, they have nothing left to lose, sooner or later will be destroyed, unless they can find a way to deter or defeat the United States. EMP, for all its uncertainties--and those uncertainties are not nearly as great as Dr. Butt would have readers believe--may well look like the answer to such desperate characters.

Dr. Butt's methodology focuses on uncertainties about the effectiveness of an EMP attack. But he never asks an equally or more important question--how certain are we that our critical infrastructures and very existence as a society would survive an EMP attack? The adversary's confidence in EMP attack is not more important than our confidence in the survivability of our infrastructures. We know that the critical infrastructures, including the keystone infrastructure--the national power grid--are unprotected from EMP. We know the national power grid is extremely fragile, because of age and reduced reliability margins, and is often operating on the edge of failure.

Uncertainty about our surviving a nuclear EMP attack does not logically support Dr. Butt's recommendation that we do nothing to ensure our survival. The EMP Commission's view is that nuclear EMP attack is one of a small number of threats that could potentially be so catastrophic that--regardless of conflicting opinions about the likelihood of the threat--the United States cannot afford to be vulnerable. Since the existence of the nation is at risk, the United States must do whatever is necessary to protect itself from EMP. Likewise, the United States must do whatever is necessary to protect itself against other potentially catastrophic threats--all forms of nuclear terrorism, biological warfare, chemical warfare, cyber attack, and a "great" geomagnetic storm. In the EMP Commission's view, the priority of these threats should not be in competition for resources. Just as the body needs air, water, and food, all three, to survive; so the minimum requirements of national security policy should be protection against these several threats that are potentially capable of destroying our civilization.

Other Errors

Dr. Butt tries hard to mislead readers that Department of Defense and other authoritative Commissions disagree with the EMP Commission, and do not regard a nuclear EMP attack as a threat--by quoting outdated or obsolete opinions. For example, Dr. Butt quotes General Marsh dismissing the EMP threat in 1997--four years before the establishment of the EMP Commission.

Dr. Butt misrepresents the views of the 2009 Strategic Posture Commission on the EMP threat, implying that the Strategic Posture Commission disagrees with the EMP Commission. Dr. Butt: "The 2009 Strategic Posture Commission puts it more delicately by saying that 'the Commission is divided over how imminent a threat this is...'" Dr. Butt quotes the Strategic Posture Commission out of context. The Strategic Posture Commissioners are unanimous that EMP is a threat, disagreeing only over whether the threat is immediate or longer term. In fact, the Strategic Posture Commission independently arrived at the same consensus view as the EMP Commission--that terrorists and rogue states could inflict a catastrophic EMP attack on the United States. The Strategic Posture Commission urges immediate implementation of EMP Commission recommendations to protect the national power grid. According to *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States*:

Lastly, the United States should take steps to reduce the vulnerability of the nation and the military to attacks with weapons designed to produce electromagnetic pulse (EMP) effects. We make this recommendation although the Commission is divided over how imminent a threat this is. Some commissioners believe it to be a high priority threat, given foreign activities and terrorist intentions. Others see it as a serious potential threat, given the high level of vulnerability. Those vulnerabilities are of many kinds. U.S. power projection forces might be subjected to an EMP attack by an enemy calculating--mistakenly--that such an attack would not involve risks of U.S. nuclear retaliation. The homeland might be attacked by terrorists or even by state actors with an eye to crippling the U.S. economy and American society. From a technical perspective, it is possible that such attacks could have catastrophic consequences....The EMP Commission has recommended numerous measures that would mitigate the damage. The Stimulus Bill of February 9, 2009, allocates \$11 billion to DOE for "smart grid activities, including to modernize the electric grid." Unless such improvements in the electric grid are focused in part on reducing EMP vulnerabilities, vulnerability might well increase.³²

Dr. Butt misrepresents the official position of the Department of Defense on the EMP Threat. The Secretary of Defense and his representatives have notified the Congress by letter and in hearings that the Department concurs with the EMP Commission's threat assessment, and will implement the Commission's recommendations. A new directorate has been created within the Office of the Secretary of Defense dedicated to EMP protection. Military training events and exercises were held in January 2010 and are scheduled for March and June 2010 featuring EMP scenarios. Under the FY2009 National Defense Authorization Act, the Defense Department is required to report to Congress until 2015 on progress toward implementing the EMP Commission recommendations.,

Dr. Butt asserts the following: "Although the EMP Commissioners have offered a Chinese-language PowerPoint presentation outlining the effects of EMP devices as evidence that China has an interest in such weapons, this presentation is actually of Taiwanese origin...and it is not pertinent to any official Chinese military document." No member or staff of the EMP

Commission has never misrepresented the Taiwanese PowerPoint on EMP as originating from the People's Republic of China. However, Taiwan is an excellent source of intelligence on China, just as Israel is on the Middle East, and South Korea is on North Korea. The briefing, from Taiwan's National Defense University, alleges that China has developed Super-EMP weapons, having very low yield, working from nuclear weapons design information stolen from the United States. There is no dearth of Chinese military doctrinal writings on EMP and its efficacy against the United States.³³

Dr. Butt's reliance on the work of Sandia Labs examining the vulnerability of nuclear power plants in the early 1980s, nearly 30 years ago, is misplaced, as the work is now obsolete. Digital controls were not as prevalent then, or as vulnerable to E1, as they are today.

Dr. Butt's statement that the "Earth's magnetic field varies across the globe and also varies with time at a given location" apparently confuses the geomagnetic field created by the Earth's core with the very minor variations in the geomagnetic field by the telluric variations (typically a few nT). The geomagnetic field variation induced by a geomagnetic storm or nuclear E3 HEMP can be on the order of several thousand nT.

Finally, Dr. Butt describes Dr. Peter Vincent Pry as one of the EMP Commissioners. Dr. Pry was not an EMP Commissioner, but was on the Commission staff. This fact Dr. Butt could discern by glancing at the cover of the EMP Commission Executive Report, that lists the names of the 9 EMP Commissioners, displayed so prominently as to be unmistakable to anyone who has read the report.

Dr. William Radasky served on the EMP Commission staff and was awarded the Lord Kelvin Medal by the International Electrotechnical Commission (IEC) for his contributions to developing standards for the protection of electronic equipment from high power electromagnetic threats, including HEMP. He is also an EMP Fellow, an IEEE Fellow, and has published over 400 reports, papers and articles dealing with high power EM transients. Dr. Peter Vincent Pry served on the staffs of the EMP Commission, the House Armed Services Committee, the Central Intelligence Agency, and currently is Director of the United States Nuclear Strategy Forum and President of EMPact America.

END NOTES

1. *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack*, Volume 1, Executive Report (Washington D.C.: 2004) hereinafter *EMP Commission Executive Summary* and *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack: Critical National Infrastructures* (Washington, D.C.: April 2008) hereinafter *EMP Commission Report*. The *EMP Commission Executive Summary* and parts of the *EMP Commission Report* may be viewed on www.empactamerica.org.

2. For the powers of the EMP Commission see *Floyd D. Spence National Defense Authorization Act, FY2001*, Public Law 106-398, Title XIV. For the Commission's methodology and

coordination with other departments, agencies, and national laboratories see *EMP Commission Report*, p. A-2.

3. Dr. Nikolai Sokov, "Russia: Status in Trends in Substrategic (Tactical) Weapons Deployment," *NTI* (Nuclear Threat Initiative: February 1999). Gunnar O. Arbman and Charles L. Thornton, *Russia's Tactical/Non-Strategic Nuclear Weapons, Part I: Background and Policy Issues*, FOI-R-1057-SE (Stockholm, Sweden: Swedish Defense Research Agency, November 2003).

4. *EMP Commission Report* see Chapter 1 "Infrastructure Commonalities" pp. 1-15, Chapter 2 "Electric Power" especially pp. 29-43.

5. *Ibid*, see for example "Historical Insights" pp. 41-43.

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10.. David Albright, "Swiss Smugglers Had Advanced Nuclear Weapons Designs," *ISIS Report* (Washington, D.C.: Institute for Science and International Security; June 16, 2008).

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12. *Russia: Nuclear Response to America Possible Using Super-EMP Factor CEP* 20061108358006; Aleksey Vashchenko, "A Nuclear Response to America is Possible," *Zavtra* (November 1, 2006).

13. Kim Min-seok and Yoo Jee-ho, "Military Source Warns of North's EMP Bomb," *JoonAng Daily* (September 2, 2009).

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15. Patrick E. Tyler, "As China Threatens Taiwan, It Makes Sure U.S. Listens," *New York Times* (January 24, 1996).
16. See for example: David Brunnstrom, "Russian Doctrine Does Not Reflect Real World: NATO," *Reuters* (February 6, 2010). Dr. Mark Schneider, *The Nuclear Forces and Doctrine of the Russian Federation*, No. 0003 (Washington, D.C.: National Institute Press, United States Nuclear Strategy Forum, 2006). Dr. Mark Schneider, *The Nuclear Forces and Doctrine of the People's Republic of China*, No. 0007 (Washington, D.C.: National Institute Press, United States Nuclear Strategy Forum, November 2007). INOBIS, *Conceptual Provisions Of A Strategy For Countering The Main External Threats To Russian Federation Security* (Moscow: Institute of Defense Studies, October 1995).
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