North Korea Nuclear EMP Attack: An Existential Threat by [DR. WILLIAM R. GRAHAM](http://www.familysecuritymatters.org/authors/detail/william-r-graham" \t "_blank)September 18, 2017

Following North Korea's apparent test of an H-Bomb that they describe as capable of a "super-powerful EMP attack" on September 2, many journalists ignorant of EMP have interviewed "instant experts" **also ignorant of EMP,** in a case of the blind leading the blind. As a corrective, Dr. William Graham, Chairman of the Congressional EMP Commission, offers his article below in its original unabridged and unvarnished version, which was significantly abridged and edited when partially published in 38 North.-Dr. Peter Vincent Pry

Analysts like Jack Liu and Jeffrey Lewis are to be commended for their interest in educating themselves and the public about North Korea's missile and nuclear programs and endeavoring to provide their readers with "informed analysis." In a series of recent articles, both analysts have dismissed the possibility of a nuclear electromagnetic pulse (EMP) attack from North Korea as "unlikely" and "science fiction" because they believe the 10 to 20 kiloton nuclear weapons currently possessed by North Korea are incapable of making an effective EMP attack.

Jack Liu correctly implies in his article that it is analytically risky to draw conclusions about the EMP threat when so much of the data is classified.  It is riskier still, with no technical training on EMP and without working professionally in the defense or intelligence communities on the EMP threat, to conclude the EMP threat is not real-dismissing the consensus view of EMP experts who have advanced degrees in physics and electrical engineering, have worked in the field for several decades, throughout that time have had access to classified data, and have conducted EMP tests on a wide variety of electronic systems, beginning in 1963.

By way of background, the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack was established by Congress in 2001 to advise the Congress, the President, Department of Defense and other departments and agencies of the U.S. Government on the nuclear EMP threat to military systems and civilian critical infrastructures.  The EMP Commission was re-established in 2015 with its charter broadened to include natural EMP from solar storms, all manmade EMP threats, cyber-attack, sabotage and Combined-Arms Cyber Warfare.  The EMP Commission charter gives it access to all relevant classified and unclassified data and the power to levy analysis upon the Department of Defense.

Jack Liu's 38 North article "A North Korean EMP Attack?...Unlikely" (May 5, 2017) draws heavily upon our EMP Commission reports to describe electromagnetic pulse phenomenology-but largely ignores our conclusions.  In the interest of better informing readers of 38 North about the EMP threat, we offer this commentary to correct errors of fact, analysis, and myths about EMP.

**Primitive and "Super-EMP" Nuclear Weapons are Both EMP Threats**

The EMP Commission finds that even primitive, low-yield nuclear weapons are such a significant EMP threat that rogue states, like North Korea, or terrorists may well prefer using a nuclear weapon for EMP attack, instead of destroying a city: "Therefore, terrorists or state actors that possess relatively unsophisticated missiles armed with nuclear weapons may well calculate that, instead of destroying a city or military base, they may obtain the greatest political-military utility from one or a few such weapons by using them-or threatening their use-in an EMP attack."[1]

The EMP Commission 2004 Report warns: "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." In 2004, two Russian generals, both EMP experts, warned the EMP Commission that the design for Russia's Super-EMP warhead, capable of generating high intensity EMP fields of 200,000 volts per meter, was "accidentally" transferred to North Korea, and that due to "brain drain," Russian scientists were in North Korea, helping with their missile and nuclear weapon programs. South Korean military intelligence told their press that Russian scientists are in North Korea helping develop an EMP nuclear weapon. In 2013, a Chinese military commentator stated North Korea has Super-EMP nuclear weapons.[2]

Super-EMP weapons are low-yield and designed to produce not a big kinetic explosion, but rather a high level of gamma rays, which generates the high-frequency E1 EMP that is most damaging to the broadest range of electronics. North Korean nuclear tests, including the first in 2006, whose occurrence was predicted to the EMP Commission two years in advance by the two Russian EMP experts, mostly have yields consistent with the size of a Super-EMP weapon.  The Russian generals' accurate prediction about when North Korea would perform its first nuclear test, and of a yield consistent with a Super-EMP weapon, indicates their warning about a North Korean Super-EMP weapon should be taken very seriously.

**EMP Threat From Satellites**

While most analysts are fixated on when in the future North Korea will develop highly reliable intercontinental missiles, guidance systems, and reentry vehicles capable of striking a U.S. city, the threat here and now from EMP is largely ignored.  EMP attack does not require an accurate guidance system because the area of effect, having a radius of hundreds or thousands of kilometers, is so large.  No reentry vehicle is needed because the warhead is detonated at high-altitude, above the atmosphere.  Missile reliability matters little because only one missile has to work to make an EMP attack against an entire nation.

North Korea could make an EMP attack against the United States by launching a short-range missile off a freighter or submarine or by lofting a warhead to 30 kilometers burst height by balloon.  While such lower-altitude EMP attacks would not cover the whole U.S. mainland, as would an attack at higher-altitude (300 kilometers), even a balloon-lofted warhead detonated at 30 kilometers altitude could blackout the Eastern Grid that supports most of the population and generates 75 percent of U.S. electricity.

Or an EMP attack might be made by a North Korean satellite, right now.

 The design of a Super-EMP weapon could be relatively small and lightweight, resembling the U.S. W-79 Enhanced Radiation Warhead nuclear artillery shell of the 1980s, designed in the 1950s.  Such a device could fit inside North Korea's Kwangmyongsong-3 (KMS-3) and Kwangmyongsong-4 (KMS-4) satellites that presently orbit over the United States, and over every other nation on Earth--demonstrating, or posing, a potential EMP threat against the entire world.

North Korea's KMS-3 and KMS-4 satellites were launched to the south on polar trajectories and passed over the United States on their first orbit.  Pyongyang launched KMS-4 on February 7, 2017, shortly after its fourth illegal nuclear test on January 6, that began the present protracted nuclear crisis with Pyongyang.

The south polar trajectory of KMS-3 and KMS-4 evades U.S. Ballistic Missile Early Warning Radars and National Missile Defenses, resembling a Russian secret weapon developed during the Cold War, called the Fractional Orbital Bombardment System (FOBS) that would have used a nuclear-armed satellite to make a surprise EMP attack on the United States.[3]

Ambassador Henry Cooper, former Director of the U.S. Strategic Defense Initiative, and a preeminent expert on missile defenses and space weapons, has written numerous articles warning about the potential North Korean EMP threat from their satellites.  For example, on September 20, 2016 Ambassador Cooper wrote:

*U.S. ballistic missile defense (BMD) interceptors are designed to intercept a few North Korean ICBMs that approach the United States over the North Polar region.  But current U.S. BMD systems are not arranged to defend against even a single ICBM that approaches the United States from over the South Polar region, which is the direction toward which North Korea launches its satellites...This is not a new idea.  The Soviets pioneered and tested just such a specific capability decades ago-we call it a Fractional Orbital Bombardment System (FOBS)...So, North Korea doesn't need an ICBM to create this existential threat.  It could use its demonstrated satellite launcher to carry a nuclear weapon over the South Polar region and detonate it...over the United States to create a high-altitude electromagnetic pulse (HEMP)...The result could be to shut down the U.S. electric power grid for an indefinite period, leading to the death within a year of up to 90 percent of all Americans-as the EMP Commission testified over eight years ago.****[4]***

Former NASA rocket scientist James Oberg visited North Korea's Sohae space launch base, witnessed elaborate measures undertaken to conceal space launch payloads, and concludes in a 2017 article that the EMP threat from North Korea's satellites should be taken seriously:

*..there have been fears expressed that North Korea might use a satellite to carry a small nuclear warhead into orbit and then detonate it over the United States for an EMP strike.  These concerns seem extreme and require an astronomical scale of irrationality on the part of the regime.  The most frightening aspect, I've come to realize, is that exactly such a scale of insanity is now evident in the rest of their ‘space program."  That doomsday scenario, it now seems, has been plausible enough to compel the United States to take active measures to insure that no North Korean satellite, unless thoroughly inspected before launch, be allowed to reach orbit and ever overfly the United States.****[5]***

Kim Jong-Un has threatened to reduce the United States to "ashes" with "nuclear thunderbolts" and threatened to retaliate for U.S. diplomatic and military pressure by "ordering officials and scientists to complete preparations for a satellite launch as soon as possible" amid "the enemies' harsh sanctions and moves to stifle" the North.[6]  An earlier generation immediately understood the alarming strategic significance of Sputnik in 1957, yet few today understand or even care about the strategic significance of North Korea's satellites, perhaps because of widespread ignorance about EMP.

**Addressing Misinformation**

In recent assessments by Jeffrey Lewis and Jack Liu regarding North Korea's EMP capabilities, there are some fundamental flaws to their uninformed speculations.[7]

For starters, Jeffrey Lewis's claims that during the 1962 STARFISH PRIME high-altitude nuclear test, "just one string of street lights failed in Honolulu" and that this proved EMP is no threat. In fact, the EMP knocked-out 36 strings of street lights, caused a telecommunications microwave relay station to fail, burned out HF (High-Frequency) radio links (used for long-distance communications), set off burglar alarms, and caused other damage. The Hawaiian Islands did not experience a catastrophic protracted blackout because they were on the far edge of the EMP field contour, where effects are weakest; are surrounded by an ocean, which mitigates EMP effects; and were still in an age dominated by vacuum tube electronics. In addition, the slow pulse (E3) component of the EMP waveform couples effectively only to very long electric power transmission lines present on large continents that were in short supply in Hawaii.

**STARFISH PRIME** was not the only test of this kind. Russia in 1961-62 also conducted a series of high-altitude nuclear bursts to test EMP effects over Kazakhstan, an industrialized area nearly as large as Western Europe.[8] That test destroyed the Kazakh electric grid.[9] Moreover, modern electronics, in part because they are designed to operate at much lower voltages, are much more vulnerable to EMP than the electronics of 1962 exposed to STARFISH PRIME and the Kazakh nuclear tests. A similar EMP event over the U.S. today would be an existential threat.[10]

In his article, Lewis also suggested that vehicle transportation would continue after an EMP event based on the fact that only 6 of 55 vehicles were shut down by a single simulated EMP test on vehicles.  However, during that test, one of the vehicles was damaged and could not be operated until repaired, indicating that at least 2 percent of vehicles were severely affected by EMP damage.  Moreover, the EMP test protocol limited testing vehicles only to upset, not to damage, because the EMP Commission could not afford to repair damaged cars; however, one vehicle was damaged by EMP despite best efforts to limit the effects to upset. Over 50 years of EMP testing indicates that full field damage to vehicles would probably be much higher than 2 percent. Modern vehicles are even more susceptible to EMP attack because of their much larger complement of electronics than present in the vehicles tested by the Commission more than a decade ago. Furthermore, vehicles cannot run without fuel.  Gas stations cannot operate without electricity, which would be unavailable in a protracted electrical blackout, and gas pumps could also be damaged, in an EMP attack.

In an article by Jack Liu, he asserts (in a footnote) that because EMP from atmospheric nuclear tests in Nevada did not blackout Las Vegas, therefore EMP is no threat, according to Liu.  The nuclear tests he describes were all endo-atmospheric tests that do not generate appreciable EMP fields beyond a range of about 5 miles. The high-altitude EMP (HEMP) threat of interest requires exo-atmospheric detonation, at 30 kilometers altitude or above, and produces EMP out to ranges of hundreds to thousands of miles. Las Vegas was not affected by the Nevada tests because they were endo-atmospheric nuclear tests that generated no HEMP.

In his article, Liu also miscalculates that "a 20-kiloton bomb detonated at optimum height would have a maximum EMP damage distance of 20 kilometers" in part, because he assumes "15,000 volts/meter or higher" in the E1 EMP component is necessary for damage.  This figure is an extreme overestimate of system damage field thresholds.  Damage and upset to electronic systems will happen from E1 EMP field strengths far below Liu's "15,000 volts/meter or higher." A one meter wire connected to a semiconductor device, such as a mouse cord or interconnection cable, would place hundreds to thousands of volts on microelectronic devices out to ranges of hundreds of miles for low-yield devices. Based on our experience with many EMP tests, semiconductor junctions operate at a few volts, and will experience breakdown at a few volts over their operating point, allowing their power supply to destroy exposed junctions.

Liu also ignores system upset as a vulnerability. Digital electronics can be upset by extraneous pulses of a few volts. For unmanned control systems present within the electric power grid, long-haul communication repeater stations, and gas pipelines, an electronic upset is tantamount to permanent damage. Temporary upset of electronics can also have catastrophic consequences for military operations. No electronics should be considered invulnerable to EMP unless hardened or tested to certify survivability. Some highly critical unprotected electronics have been upset or damaged in simulated EMP tests, not at "15,000 volts/meter or higher," but at threat levels far below 1,000 volts/meter.

Therefore, even for a low-yield 10-20 kiloton weapon, the EMP field should be considered dangerous for unprotected U.S. systems. The EMP Commission 2004 Report warned against the U.S. military's increasing use of commercial-off-the-shelf-technology that is not protected against EMP: "Our increasing dependence on advanced electronics systems results in the potential for an increased EMP vulnerability of our technologically advanced forces, and if unaddressed makes EMP employment by an adversary an attractive asymmetric option."[11]  The North Korean missile test on April 29, which apparently detonated at an altitude of 72 kilometers, the optimum height-of-burst for EMP attack by a 10 KT warhead, would create a potentially damaging EMP field spanning, not Jack Liu's miscalculated 20 kilometers radius, but to about 930 kilometers radius [Kilometers Radius = 110 (Kilometers Burst Height to the 0.5 Power)].

**US Vulnerabilities to EMP**

When assessing the potential vulnerability of US military forces and civilian critical infrastructures to EMP, it is necessary to be mindful of the complex interdependencies of these highly-networked systems, because EMP upset and damage of a very small fraction of the total system can cause total system failure.[12]

Real world failures of electric grids from various causes indicate that the Congressional EMP Commission, U.S. Department of Defense, U.S. Federal Energy Regulatory Commission (FERC), U.S. Department of Homeland Security, and U.S. Defense Threat Reduction Agency are right that a nuclear EMP attack would have catastrophic consequences. Significant and highly disruptive blackouts have been caused by single-point failures cascading into system-wide failures, originating from damage comprising far less than 1 percent of the total system.  **For example**:

--The Great Northeast Blackout of 2003--that put 50 million people in the dark for a day, contributed to at least 11 deaths, and cost an estimated $6 billion-originated from a single failure point when a powerline contacted a tree branch, damaging less than 0.0000001 (0.00001%) of the system.

--The New York City Blackout of 1977, that resulted in the arrest of 4,500 looters and injury of 550 police officers, was caused by a lightning strike on a substation that tripped two circuit breakers.

--The Great Northeast Blackout of 1965, that effected 30 million people, happened because a protective relay on a transmission line was improperly set.

--India's nationwide blackout of July 30-31, 2012-the largest blackout in history, effecting 670 million people, 9% of the world population-was caused by overload of a single high-voltage powerline.

--India's blackout of January 2, 2001-effecting 226 million people-was caused by equipment failure at the Uttar Pradesh substation.

--Indonesia's blackout of August 18, 2005-effecting 100 million people-was caused by overload of a high-voltage powerline.

--Brazil's blackout of March 11, 1999-effecting 97 million people-was caused by a lightning strike on an EHV transformer substation.

--Italy's blackout of September 28, 2003-effecting 55 million people-was caused by overload of two high-voltage powerlines.

--Germany, France, Italy, and Spain experienced partial blackouts on November 4, 2006-effecting 10-15 million people-from accidental shutdown of a high-voltage powerline.

--The San Francisco blackout in April 2017 was caused by the failure of a single high voltage breaker.

In contrast to the above blackouts caused by single-point or small-scale failures, a nuclear EMP attack would inflict massive widespread damage to the electric grid causing millions of failure points.  With few exceptions, the U.S. national electric grid is unhardened and untested against nuclear EMP attack.

In the event of a nuclear EMP attack on the United States, a widespread protracted blackout is inevitable.  This commonsense assessment is also supported by the nation's best computer modeling:

--Modeling by the U.S. Federal Energy Regulatory Commission (FERC) reportedly assesses that a terrorist attack that destroys just 9 of 2,000 EHV transformers--merely 0.0045 (0.45%) of all EHV transformers in the U.S. national electric grid--would be catastrophic damage, causing a protracted nationwide blackout.

--Modeling by the Congressional EMP Commission assesses that a terrorist nuclear EMP attack, using a primitive 10-kiloton nuclear weapon, could destroy dozens of EHV transformers, thousands of SCADAS and electronic systems, causing catastrophic collapse and protracted blackout of the U.S. Eastern Grid, putting at risk the lives of millions.[13]

Thus, even if North Korea has only primitive, low-yield nuclear weapons, and likewise if other states or terrorists acquire one or a few such weapons, and the capability to detonate them at 30 kilometers or higher-altitude over the United States, as the EMP Commission warned over a decade ago in its 2004 Report: "The damage level could be sufficient to be catastrophic to the Nation, and our current vulnerability invites attack."[14]

[1] Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, *Executive Report*, 2004, p. 2.

[2] U.S. Senate, Hearing, Statement for the Record, Dr. Peter Vincent Pry, "Foreign Views of Electromagnetic Pulse (EMP) Attack" testimony on behalf of EMP Commission before the Subcommittee on Terrorism, Technology, and Homeland Security, Senate Committee on the Judiciary (Washington, D.C.: March 9, 2005); Kim Min-sek and Yoo Jee-ho, "Military Source Warns of North's EMP Bomb" JoonAng Daily (September 2, 2009); Li Daguang, "North Korean Electromagnetic Attack Threatens South Korea's Information Warfare Capabilities" Tzu Chin, No. 260 (June 1, 2012) pp. 44-45.

[3] Miroslav Gyurosi, *The Soviet Fractional Orbital Bombardment System Program*, (January 2010) Technical Report APA-TR-2010-010.

[4] Ambassador Henry F. Cooper, "Whistling Past The Graveyard..." High Frontier (September 20, 2016) [highfrontier.org/sept-20-2016-whistling-past-the-graveyard/](http://highfrontier.org/sept-20-2016-whistling-past-the-graveyard/)  See also: [highfrontier.org/category/fobs](http://highfrontier.org/category/fobs).  On up to 90% U.S. fatalities from an EMP attack, during a congressional hearing, Rep. Roscoe Bartlett asked me if such high fatalities could result, and I responded: "We don't have experience with losing the infrastructure in a country with 300 million people, most of whom don't live in a way that provides for their own food and other needs.  We can go back to an era when people did live like that.  That would be-10 percent would be 30 million people, and that is probably the range where we could survive as a basically rural economy."  U.S. House of Representatives, Hearing, "Threat Posed By Electromagnetic Pulse (EMP) Attack" Committee on Armed Services (Washington, D.C.: July 10, 2008), p. 9.

[5] Jim Oberg, Space Review (February 6, 2017) [www.thespacereview.com/article/3164/1in](http://www.thespacereview.com/article/3164/1in) a 2017 aricle

[6] Alex Lockie, "North Korea Threatens ‘Nuclear Thunderbolts' As U.S. And China Finally Work Together" American Military News (April 14, 2017);  Fox News, "U.S. General: North Korea ‘Will' Develop Nuclear Capabilities To Hit America" (September 20, 2016) [www.foxnews.com/world/2016/09/20/north-korea-says-successfully-ground-tests-new-rocket-engine.html](http://www.foxnews.com/world/2016/09/20/north-korea-says-successfully-ground-tests-new-rocket-engine.html)

[7] Jeffrey Lewis, "Would A North Korean Space Nuke Really Lay Waste to the U.S.?" New Scientist [www.newscientist.com/article/2129618](http://www.newscientist.com/article/2129618);  Lewis quoted in Cheyenne MacDonald, "A North Korean ‘Space Nuke' Wouldn't Lay Waste To America" Daily Mail, May 3, 2017;  Lewis interviewed by National Public Radio, "The North Korean Electromagnetic Pulse Threat, Or Lack Thereof" [www.npr.org/2017/04/27/525833275](http://www.npr.org/2017/04/27/525833275);  [www.naturalnews.com/2017-05-01-npr-laughs-hysterically-north-korean-emp-nuclear-attack.html](http://www.naturalnews.com/2017-05-01-npr-laughs-hysterically-north-korean-emp-nuclear-attack.html)

[8] High-altitude EMP (HEMP), the phenomenon under discussion, results from the detonation of a nuclear weapon at high-altitude, 30 kilometers or higher.  All nuclear weapons, even a primitive Hiroshima-type A-bomb, can produce levels of HEMP damaging to modern electronics over large geographic regions.

[9] According to Electric Infrastructure Security Council, *Report: USSR Nuclear EMP Upper Atmosphere Kazakhstan Test 184*, ([www.eiscouncil.org/APP\_Data/upload/a4ce4b06-1a77-44d-83eb-842bb2a56fc6.pdf](http://www.eiscouncil.org/APP_Data/upload/a4ce4b06-1a77-44d-83eb-842bb2a56fc6.pdf)), citing research by Oak Ridge National Laboratory, a comparable EMP event over the U.S. today "would likely damage about 365 large transformers in the U.S. power grid, leaving about 40 percent of the U.S. population without electrical power for 4 to 10 years."

[10] EMP Commission *Executive Report*, op. cit., pp. 4-8.  [11]Ibid, p. 47.

[12] Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, *Critical National Infrastructures*, 2008, passim.

[13]For the best unclassified modeling assessment of likely damage to the U.S. national electric grid from nuclear EMP attack see: U.S. Federal Energy Regulatory Commission (FERC) Interagency Report, coordinated with the Department of Defense and Oak Ridge National Laboratory: *Electromagnetic Pulse: Effects on the U.S. Power Grid, Executive Summary* (2010); FERC Interagency Report by Edward Savage, James Gilbert and William Radasky, *The Early-Time (E1) High-Altitude Electromagnetic Pulse (HEMP) and Its Impact on the U.S. Power Grid* (Meta-R-320) Metatech Corporation (January 2010); FERC Interagency Report by James Gilbert, John Kappenman, William Radasky, and Edward Savage, *The Late-Time (E3) High-Altitude Electromagnetic Pulse (HEMP) and Its Impact on the U.S. Power Grid* (Meta-R-321) Metatech Corporation (January 2010).

[14] EMP Commission *Executive Report*, op. cit., p. 1.

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