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Republican warnings about an electro-magnetic pulse (EMP) attack, explained

By Philip Bump January 15

A few seconds after 11 p.m. on July 9, 1962, streetlights on the Hawaiian island of Oahu blinked out. About 300 went out in total, but, happily, it didn't matter. The skies over Hawaii were lit up nearly as bright as day for the same reason that the streetlights stopped working: The test of a thermonuclear weapon nearly 1,500 kilometers away over Johnston Atoll.

The streetlights were knocked out not by the explosion or by the shock wave of the blast. They were rendered inoperative after getting hit by an electro-magnetic pulse created by the detonation.

Electro-magnetic pulse damage was a topic of conversation in both of the Republican debates on Thursday night. Rick Santorum, one-third of the warm-up debate, warned of the possibility of an EMP being used as a weapon, a "devastating explosion" that would "fry out" anything with a circuit board. "Everything is gone," he said. "Cars stop. Planes fall out of the sky." If Iran got a nuclear bomb, he warned, they could explode one in the atmosphere over the United States and break every phone, car, computer and anything else electronic underneath.

During the main debate, Ben Carson raised the same issue. "[W]e have enemies who are obtaining nuclear weapons that they can explode in our exoatmosphere and destroy our electric grid," he said, adding, "Can you imagine the chaos that would ensue at that point?"

You've probably seen the aftermath of an EMP in popular culture. Remember in "Ocean's 11," when they gang needed to shut power off in Las Vegas to break into the casino's vault? They used an EMP, hidden in the back of a cargo van. Or in "Broken Arrow" -- an EMP knocks a helicopter out of the sky.

That's fiction, though. That's not how it works. And as it turns out, the scenarios proposed by Santorum and Carson are pretty close to fiction, too.

Dr. Yousaf Butt is a senior research fellow at National Defense University who has written about the threat posed by EMPs. Such as it is. When we spoke by phone on Friday, Butt didn't seem particularly alarmed at the idea that Iran was planning to

incapacitate every car on Interstate 80.

"I'm not trying to minimize the vulnerability. The vulnerability is there," Butt said. "I'm just saying the threat, if it's being cast as a rogue nation or a terrorist trying to do this, it seems like a difficult way for them to achieve harm."

Here's why. An EMP requires a very specific combination of things coming together in order to be effective. It requires a nuclear explosion with a payload of "hundreds of kilotons or megatons," per Butt -- substantially larger than the recent test in North Korea, for example. It requires a missile that can deliver the bomb to a precise point in the atmosphere. And it requires a willingness to bear the brunt of the action.

When a nuclear explosion occurs in the atmosphere, it gives off gamma rays. Those gamma rays hit nearby atoms, knocking loose their electrons. When that happens, the electrons give off a radio pulse. The gamma rays and electrons and radio pulses travel toward the ground essentially at the speed of light, and when they arrive, electric circuits in our devices -- phones, chips in cars, etc. -- act as antennas for the pulse. "It deposits energy very quickly," Butt said. "It has a lot of power in a very short timescale and that heat cannot be dissipated, so it in effect fries the electronics."

It's sort of like this, where the tennis balls are the radio pulses. The dog's doing alright at first, and then he isn't.

There are different types of pulses, we'll note. What's described above is an E1 pulse. It happens almost instantly after the explosion; it's what happened to Oahu's streetlights. There's also an E3 pulse, which arrives substantially later and does damage to electrical infrastructure like transformers. And, as you might expect, there's E2, which is slower than an E1 and essentially acts like lightning -- making it less risky, since many electronic systems are capable of handling lightning surges.

What's important about how it works is that it dictates where the explosion needs to happen. Too high, and the process of dislodging electrons can't work. Too low, and the area that's affected is smaller. In this illustration from a 1989 assessment of the Oahu incident, you can see how the Johnston Atoll test, named "Starfish Prime," affected the Hawaiian Islands hundreds of miles away. Had it been lower, the energy would have hit the ground before reaching Hawaii.

So Iran or a terrorist would need a missile capable of delivering a large bomb to a precise point in the sky. As Butt wrote for Space Review in 2010, that's just not feasible. Rogue nations don't have nuclear capabilities of that kind or, according to Butt, the means of delivering them. If such a strike were to happen tomorrow, with a newly-built hydrogen bomb on a new type of missile, whoever launched it would be relying on an awful lot of luck that everything would go right. And it wouldn't take us long to figure out who did it.

Anyway, if you want to damage the United States, it's far easier to drop a nuclear bomb in the middle of Manhattan than to detonate it in the atmosphere. "Putting yourself in the mindframe of a terrorist that just wants to cause harm," Butt said, "it doesn't make much sense."

He agrees with Santorum, though, that we should indeed harden our infrastructural systems. But not because of a nuclear threat. Because of the Sun.

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A coronal mass ejection from the Sun could send a magnetic field toward Earth that could cause an E3-like effect on the transformers that make up our electrical grid. Butt repeatedly noted that while the threat of a nuclear EMP was small, the threat of a solar one was real. (As he noted in a 2012 article for the Times, it appears to have happened a few years ago in Quebec.)

"Let's not throw out the solar-geomagnetic baby with the EMP bathwater," he said. Preparing our infrastructure to handle an EMP from the Sun would help us prevent damage during a hostile strike, as well.

If the threat of Iran launching an EMP attack on the U.S. is small, how'd it work its way into the political conversation? In part, thanks to former Republican presidential candidate Newt Gingrich, who has been talking about the idea for some time. His concern is based in part on a report from a Congressional commission which looked at the threat in 2004 -- a report that has met with criticism.

From a political standpoint, if not a scientific one, it's compelling. A sci-fi device that could break my iPhone from space? Tell me more. But in reality, the thing we need to worry about over the short term, per Butt, isn't a midnight explosion lighting up the sky like midday. It's the thing that lights up midday.

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