Electronic Fuzes Advance Modern Weapon Systems

Electronic fuzes are safe and reliable, making them increasingly preferred to legacy mechanical and electro-mechanical fuzes for the benefits they bring to modern weapons systems.

Electronic Fuzes are Designed to Withstand Vulnerabilities

Electronic Safe and Arm Devices (ESADs), also known as electronic fuzes, follow stringent design safety and test requirements[1] to withstand all credible vulnerabilities.

- **Hacking / Cyber Attacks**
  Per Fuzing Safety Standards, alterable memory devices are not permitted in fuzes. ESADs have a processor that includes embedded code which cannot be reprogrammed or modified. Because **ESADS are not reprogrammable**, they are not vulnerable to external programmable interfaces. Likewise, ESADs are not connected devices, therefore they do not interact with the internet, wireless networks, Bluetooth, or other media.
- **Jamming and Electromagnetic Threats**
  Since ESADs are embedded, stand-alone devices, they are not prone to jamming environments. They are tested in stringent electromagnetic environments[2] and additional testing and analyses for lightning effects are often required. As part of qualification, ESADs must prove that they cannot be spoofed by these environments.
- **Key Technologies Prevent Failures**
  ESADs use an Exploding Foil Initiator (EFI), a key enabling technology for the detonator used in the nuclear weapons programs for decades. On the conventional weapons front, a Low-Energy EFI (LEEFI) has been the only approved technology for ESADs since the mid-1990s. The internal nature of the EFI and its firing circuit makes it resistant to lightning and credible electromagnetic environments such as radars and mechanical environments such as heat or friction.

Electronic Fuzes Provide Significant Benefits Over Mechanical Fuzes

Perhaps the greatest benefit of an ESAD is its **inherent reliability,** as they have **no moving parts**. It is possible to build and test an ESAD to ensure that 100% of the electronics will perform as intended. Mechanical fuzes can be only partially tested for functionality without destroying the components, increasing the risk of malfunction. The moving parts, which arm a mechanical fuze, reduce reliability by introducing unintended vulnerabilities such as thermal binding, stiction, and mechanical breakage – common failure modes for mechanical fuzes.

ESADs are **very small** and much **easier to manufacture**, **assemble and test** than legacy mechanical and electro-mechanical fuzes. By using less space for the fuze, there is more capacity for key components of the munition such as propellant, which helps to extend its range. ESADs are also used in penetrating and harsh-environment weapons, and present no unexploded ordnance (UXO) issue. Once weapon power is removed from an ESAD, it is as safe as the day it left the factory. On the contrary, once a mechanical fuze is armed, it is in an armed condition forever, even when it is a dud and did not function.

All safety boards are recommending the ESAD as the primary fuze for weapon systems today.

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[1] MIL-STD-1316, MIL-STD-331B, various NATO/STANAG documents and other tri-service guidelines
[2] MIL-STD-461/462 EMI, ESD, JOTP-53 electrical stress testing, and MIL-STD-1385 HERO environments