Nuclear power development in the United States has been largely stagnant after safety concerns rose out of the Three Mile Island and Chernobyl incidents. The negative public stigma surrounding nuclear technology is starting to fade, however, and there has been a resurgence in support for its use. Small modular reactors have generated significant publicity since NuScale submitted the first SMR design certification application to the Nuclear Regulatory Commission in 2016.

SMRs provide a number of benefits compared to the commercialized light water reactors, or LWRs, some of which are of particular interest to the Department of Defense. SMRs use technology that establishes dynamic safety; enhances nuclear waste management protocols that benefit nonproliferation; and generates on-site electricity and potable water on military installations.

Safety

One major advantage of SMRs is their implementation of advanced safety features. SMRs employ passive safety systems that allow natural coolant circulation pathways to control reactor conditions. Passive safety requires that indefinite self-cooling and safe shutdown is possible without operator input, electrical power and additional coolant input. SMRs are also significantly more compact than commercial LWRs. This reduces overall complexity and reduces potential modes of reactor control system failure.

The Toshiba Super-Safe, Small and Simple and the Lawrence Livermore National Laboratory Small Secure Transportable Autonomous Reactor utilize a tamper-proof system that includes remote shutdown, sealed reactor core and autonomous operation. These safety features minimize on-site personnel and allow for global SMR usage because they assist in securing the reactor core against violent non-state actors and terrorist groups seeking to gain access to nuclear material.

Nonproliferation and Waste Management

The generation of radioactive waste, such as Uranium-238 and Plutonium-239, occurs over the course of a commercial LWR fuel cycle. The production and storage of these materials is a threat to public health and inhibits nuclear armistice. Pu-239 is the most common material used in nuclear weaponry. The reduction of Pu-239 stockpiles aids the movement for nonproliferation of the global nuclear arsenal by decreasing the amount of material available for weapons production.

SMR designs powered by spent nuclear fuel are an international research focus. Developments based in the U.S. include SMR models such as the General Atomics Energy Multiplier Module; the X-energy 100; and the General Electric Hitachi Power Reactor Innovative Small Module.

Use on Military Bases

SMR designs for military base applications, such as the FLiBe Energy’s Liquid Fluoride Thorium Reactor, provide a mobile and reliable avenue for on-site electrical power generation and desalination. Storms, blown transformers or sabotage can disable power grids, which is of concern to military installations connected to them. In isolated areas or military installations, the loss of power to site infrastructure can result in significant financial loss or loss of life. Employing SMR technology on military bases will also allow for access to clean water, which is a largely unavailable resource across the globe.

Summary

The development of SMR technology is at the forefront of nuclear research. SMRs have generated global interest, and potential future applications are a subject of international research directives. Project proposals include use of SMRs for desalination, process heat generation, biofuel conversion and military base installations. Furthermore, SMR safety systems reduce threats to public health; decrease the global stockpile of weapons-grade material and radioactive waste; and provide critical infrastructure support on military installations worldwide.
REFERENCES


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