



Fusion Small Modular Reactors (SMRs)

Fusion small modular reactors (SMRs) refer to advanced nuclear facilities that are smaller than conventional nuclear power facilities, modular in design, meaning components may be factory assembled and transported for installation, and utilize nuclear fusion reactions for fuel generation.

Nuclear fusion is distinct from nuclear fission because it combines two lighter elements, such as hydrogen, to form a new nucleus. Extreme heat and pressure are required to combine the lighter elements into heavier elements. Nuclear fusion requires difficult conditions to continue the fusion process. Fusion reactions naturally stop if the conditions needed to sustain them are disrupted. Unlike fission reactors, fusion facilities cannot experience a meltdown.

Typical Characteristics

Nuclear fusion facility designs are likely to vary due to their early stage of development and continued to evolution. Based on the processes known at this time, typical components of these facilities may include the following:

- A device or chamber that creates and confines dynamic high-temperature fusion plasma;
- Equipment used to heat, compress, accelerate, and control the plasma; and
- Shielding and structural materials that are designed to withstand extreme heat, pressure, and high-energy particle exposure.
- Infrastructure to connect electricity generated to grid or end user.

Fusion SMRs are meant to be manufactured elsewhere in a controlled environment then transported to a given facility site via truck or rail transportation. Fusion SMR facilities must have safe and secure access points including, but not limited to, controlled site entrances, emergency access, and security checkpoints. Sites also need safe access highway and rail networks to plan for transportation of construction and equipment materials, which may be oversized and/or heavy hauls, and both nuclear fuel and potential nuclear waste transportation. Highway access also ensures adequate response in case of emergency situations and support for operation and maintenance needs.

Supporting systems may include equipment for fuel storage, tritium handling where tritium is used or produced, compression and temperature control systems, radiation monitoring, automatic shutdown mechanisms, and power conversion equipment. Sitewide components may include control and operations buildings, electrical switchyards and interconnection equipment, water supply and discharge systems, fire protection, perimeter security, and maintenance and monitoring areas. Because fusion technologies remain under development, the specific components, facility arrangement, and infrastructure needs would depend on the selected confinement method, heat-transfer system, power-conversion design, project scale and other project-specific design components.



Siting Considerations

General site requirements for fusion SMRs include land for the facility infrastructure, site access, safety buffers, and adequate utility connections, including water supply, wastewater treatment, interconnection for electricity, and disposal infrastructure.

Siting considerations may include seismic conditions, emergency planning zones and emergency response plans, security setbacks, environmental constraints, and compatibility with surrounding land uses. Additionally, considerations for the transportation, storage and waste management of radioactive materials can influence siting. Fusion SMRs can be grid-connected or co-located with an end-user, meaning that transmission availability may be a higher consideration for fusion SMRs seeking a grid connection.

Radioactive Materials and Waste Management

With nuclear fusion, little radioactive waste is generated and is associated with a lower risk of public health, safety, and environmental hazards when compared to nuclear fission. Fusion-related radioactive materials are anticipated to be regulated under the U.S. Nuclear Regulatory Commission's byproduct material framework, with the Washington State Department of Health (DOH) serving as the state-level licensing authority for fusion facilities. Under this framework, fusion facilities are regulated similarly to particle accelerators and medical facilities rather than nuclear fission reactors.

Radioactive Materials

Radioactive materials, including tritium, are used and produced as part of nuclear fusion. Tritium is a rare, isotope of hydrogen that is often used as a fuel source in fusion facilities.

- **Characteristics:** Usually in a gaseous state and is colorless, odorless, tasteless, and radioactive.
- **Radiation risk:** Its weak beta radiation cannot travel far in the air or penetrate human skin, meaning external exposure is generally harmless. However, it poses health risks if **swallowed, inhaled, or absorbed** as tritiated water.
- **Short Range:** The beta particles have very low energy and cannot travel more than a few millimeters in the air.
- **Limited Availability:** Naturally occurring tritium is rare, making recapture systems a design interest.
- **Uses:** Tritium can be used in self-illuminating products, including watches, firearm sights, instruments, exit signs, emergency lighting, and runway lights. It can also be used as a radioactive tracer in biomedical research.

Waste Management

Waste management, including the handling, storage, transport, and disposal of radioactive waste, would require coordination with the DOH, Washington State Department of Ecology, as well as the Department of Transportation for applicable requirements.



Early Fusion Examples

Fusion Development in Washington

Helion's "Orion" fusion facility in Malaga, WA has received environmental review and Radioactive Materials license and Radioactive Air Emissions license from the Washington State Department of Health. The generator building is still under construction. The facility is anticipated to provide energy to Microsoft, though Helion has also signed a transmission interconnection agreement with Chelan County Public Utility District to connect the fusion power plant to the grid.



Map legend: ● Assembly building ★ Generator building ● Administrative office
■ Parking lot ● New PUD access road ▲ Well + Onsite Sub

Source: Helion, [SEPA Checklist](#), 2025



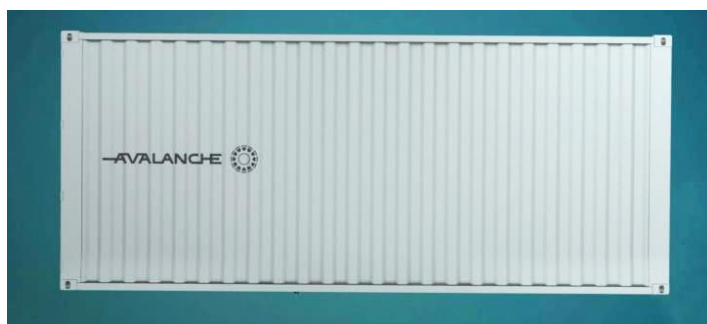
Source: Helion, [Orion](#), 2026



Source: Helion, [Technology](#), n.d.

Modular Fusion Approaches

Another fusion example in Washington is Avalanche Energy. They are exploring smaller, modular fusion systems that could be housed in containers, scaled to meet different energy needs, and designed with replaceable components. These systems are intended for remote and off-grid uses.



Source: Avalanche, n.d.