

SPARC PROGRESS AND CONTINUED DEVELOPMENT OF THE CODE OF RECORD FOR THE DEVELOPMENT OF ARC

In March 2023, the U.S. Nuclear Regulatory Commission (NRC) unanimously agreed to regulate fusion energy facilities under the byproduct materials framework of 10 CFR 30—commonly applied to particle accelerators and medical irradiation systems—rather than the 10 CFR 50/52 framework for fission reactors. This approach mirrors that of the U.K., where fusion facilities are overseen by the Health and Safety Executive and the Environment Agency, rather than the Office for Nuclear Regulation. Both countries have now codified these regulatory decisions into law [1,2]. This shift reflects a growing global consensus to regulate fusion based on its risk profile, which is more similar to that of particle accelerators than fission reactors. The goal is to apply appropriate regulations from the start, adjusting as needed, rather than imposing fission regulations and stripping away irrelevant requirements. Other countries, including Canada, Japan, Germany, and Italy, are also moving toward a similar regulatory approach for fusion facilities, aligning with the private sector's developments in this field.

Most literature on tritium, waste, and safety in fusion energy is based on large public projects like ITER and DEMO. However, no privately funded companies are pursuing such large-scale facilities due to cost and different missions. This makes relying on this literature inaccurate for current private fusion designs. Advances like high-temperature superconducting magnets now enable tokamaks to be built about 40 times smaller than ITER. Private developers are also designing tritium handling systems to optimize processing and minimize on-site inventories. For instance, SPARC, our experimental tokamak, will use about 10 grams of tritium, compared to ITER's 4,000 grams for a similar mission. Focused on public acceptance, private fusion designs aim to use less tritium, produce less waste, and avoid emergency off-site evacuation plans. Therefore, applying ITER-based regulations to these smaller, safer private facilities is not appropriate. Commonwealth Fusion Systems (CFS) has actively participated in NRC public meetings [3] to emphasize these differences and highlight the safety features of private fusion approaches [4, 5, 6, 7, 8].

The NRC's Staff Requirements Memo on SECY-23-0001 [9] called for a new Volume 22 of NUREG-1556 to provide regulatory guidance specifically for fusion energy systems, ensuring consistent guidance across the National Materials Program. NUREG-1556 Volume 21 has been a solid foundation for creating fusion-specific guidance in Volume 22. In collaboration with the NRC and Agreement State partners, Volume 21 guided the SPARC materials license application, granted in October 2024 [10]. This broad-scope radioactive materials license for SPARC marks a key milestone toward operating the world's first commercially viable net-energy fusion machine. The license permits CFS to possess, use, and store radioactive materials on the SPARC site. Given the shared subsystems between SPARC and ARC (CFS's future fusion power plant in Chesterfield County, Virginia [11]), the guidance from the SPARC licensing process will be broadly applicable to future fusion machines. In preparing the SPARC application, CFS has gathered lessons learned and ideas for improving the new fusion-specific NUREG-1556 volume, including tritium systems design, material accountancy, and security...

Technical Categories Addressed

Other Systems

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Session Classification: Applicability to Regulation Frameworks and Safety