The Nuclear Space Age: Solving for Regulatory Hurdles

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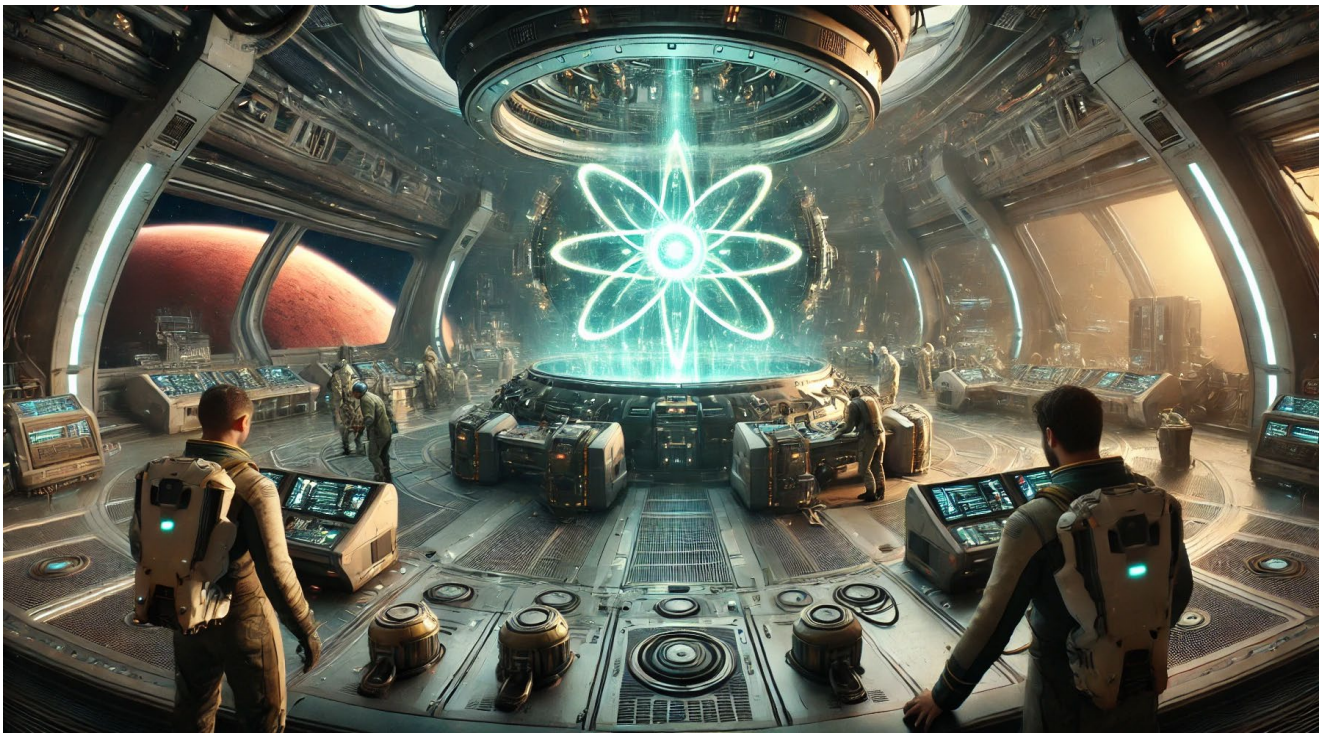

Nuclear power is essential for long-duration, high-energy missions beyond Earth's orbit, providing continuous power when solar energy is insufficient. The expanding role of nuclear technology in space missions has prompted an in-depth examination of the regulatory landscape surrounding Space Nuclear Systems (SNS) in the United States. The U.S. regulatory framework for space launch, primarily overseen by the Federal Aviation Administration (FAA), aims to manage SNS in commercial launches safely and effectively. If you ask industry, some big gaps still remain before we have a clear regulatory path.

Key Challenges in the Current Regulatory Environment for Nuclear Space Launch

1. **Unclear definitions and thresholds.** Radiation is present in our everyday environment in varying quantities. We, as a society, have established many ways to measure varying types of radiation and have set thresholds for what we consider to be a reasonable exposure level. No such limit yet exists for SNS per the tiers established in Presidential Memorandum 20 ("NSPM-20") or per a follow-on FAA Advisory Circular (AC 450.45-1).

   Prior to the publication of NSPM-20, there was no feasible path for a purely commercial mission to use nuclear power in any form because the regulatory path was undefined. Since its issuance, there has been a flurry of activity around developing various nuclear technologies such as

radioisotope batteries, new fuel types, etc. to support long duration space missions. Much of this technology is extremely safe[i] and poses little radioactive risk to life or property. However, the regulations and supporting guidance are written in a way that does not account for minimal risk but rather captures all radioactivity, even levels of radioactivity that are accepted in everyday life or other modes of transportation.[ii] Several nuclear space companies have pointed out that an ongoing issue is the lack of a bottom limit for radioactivity in NSPM-20 or the FAA Advisory Circular 450.45-1. The definition of SNS needs to be cleaned up and scoped down to account for non-threatening levels of radiation. Until this happens, companies are unsure of whether certain regulations and guidance apply to them or not. Per the U.S. Space Nuclear Policy Summit which happened in October 2024, FAA representative, Steph Earle, stated that they were aware of the problem and would be revising AC 450.45-1 to create clarity in what systems the guidance is intended to capture.

2. **Unclear Regulatory Processes, Timelines, and Costs**. Obtaining a launch license for SNS involves lengthy, multi-agency review processes that can extend for years. Here's a few examples:

   Per the National Environmental Policy Act ("NEPA"), all federal agencies must assess environmental impacts of proposed actions. This also applies to the FAA's launch licensing process for commercial launches and the licensing of spaceports. Notably, the requirements and reviews are specific to the launch vehicle or spaceport rather than the mission overall. This means that a commercial company could end up going through the same NEPA-driven reviews multiple times for various aspects of the same mission, or in the case that they switch launch vehicles. Alternatively, if a license and review process is government-led, only one NEPA review is conducted on the entirety of the mission (vehicles, spaceports, payloads, etc.) which greatly reduces the timelines, redundancies, and overall burden.

   Another point of contention between industry and the FAA, specifically, seems to be the safety review requirements and exactly how much data is required and the source of the data. The launch authorization process requires that a safety review be conducted, and approval issued. If there are hazardous materials, which includes radioactive materials, extra steps are required. The requirements for a safety review application require a validity of the analysis where, essentially, the operator must show how they arrived at their conclusion.[iii] There is no requirement for third party or objective analysis. It does appear that there's a strong trend on the government side to prefer objective testing data to support the safety review approval. This sounds reasonable on the surface, but the reality is that, to date, a company ends up paying one of the national labs or equivalent to provide this testing or verification of data. The national labs are a very expensive resource and can add an unpredictable level of cost and time. The alternate solution would be for the FAA to internalize the capability to verify operator data. Unfortunately, there is a workforce challenge: in recent years the government was challenged to attract and hire nuclear technical experts who wish to work in a regulatory environment. The hiring pool isn't sufficient to meet the need.

3. **Insurance and Risk Barriers**. Due to the perceived long-term risks of radiation, some founded and some not, securing adequate liability protection for a SNS is challenging. A commercial

launch is required to cover this risk through insurance or some equivalent method. There are few, if any, insurance companies currently willing to underwrite a SNS. Without insurance, a launch license will not be issued.[iv]

Alternate means are available to protect against financial risk. Indemnification provisions are the primary method of meeting this criterion for government sponsored launches. They are applied to the mission contractually through Federal Acquisition Regulations and relevant supplements. Alternately, there is also another approach to indemnification that the terrestrial nuclear industry uses- the Price-Anderson Act. This Act, administered by the Department of Energy, was established to provide a system of financial protection for persons who may be liable for or injured by terrestrial nuclear incidents.[v] Some proponents of space nuclear technology have suggested an expansion of Price-Anderson to cover space as well as terrestrial citing that the additional risk would be minimal. [vi]

4. **Export Controls and Commerciality.** SNS have long been restricted through the International Traffic in Arms Regulations (ITAR) governed by the U.S. Department of State. While nuclear arms proliferation is certainly a concern, this limits the competitiveness of U.S. companies in the nuclear market as well as restricting their access to talent.

   With certain items such as nuclear batteries available abroad, the lengthy and uncertain timelines for approval of exports or deemed exports contribute to the international market settling for what is available external to U.S. jurisdiction. Additionally, there have been many advancements in nuclear fuel. Some of these advancements make it much more difficult for nuclear fuel to be used for nefarious purposes. The ITAR is currently undergoing reforms, and the public can weigh in on what technologies continue to provide a critical military or intelligence advantage. Certain space nuclear systems such as Radioactive Heater Units ("RHUs"), arguably , do not.

   A more targeted regulatory approach towards nuclear hardware and technology could enhance commercial viability and market for this sector while still protecting national security and nonproliferation goals. The nuclear space sector will absolutely need viable international terrestrial markets to sustain itself. The U.S. space sector is not a large enough customer to maintain the competitive commercial ecosystem we need to see SNS innovate and thrive.

Conclusion

The nuclear and space sectors have gotten a lot of attention lately and are gaining traction. If we want to pave the way for long duration space missions, we need to start paving now. Here are four ways we can start.

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[i] U.S. Department of Energy, Safety of Radioisotope Power Systems, NASA (Apr. 2015), https://www.nasa.gov/wp-content/uploads/2015/04/safety_of_radioisotope_power_systems.pdf.
[ii] The Annual Maximum Exposure Proposed by the U.S. FAA is 5 mSv, Nat'l Ctr. for Biotechnology Info. (2001), https://pmc.ncbi.nlm.nih.gov/articles/PMC153688.
[iii] 14 CFR 450.101(g)
[iv] 14 CFR 440.9
[v] Public Law 85-256
[vi] Pillsbury Winthrop Shaw Pittman LLP, Expanding the PAA to Private Sector SNPPs, Pillsbury Law (Dec. 19, 2024), https://www.pillsburylaw.com/en/news-and-insights/expanding-paa-private-sector-snpp.html.