# CFS Regulatory Presentation

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# CFS path to commercial fusion energy

**COMPLETED**
Proven science
Alcator C-Mod

**COMPLETED**
**October 2020**
Published peer-reviewed SPARC physics basis in Journal of Plasma Physics

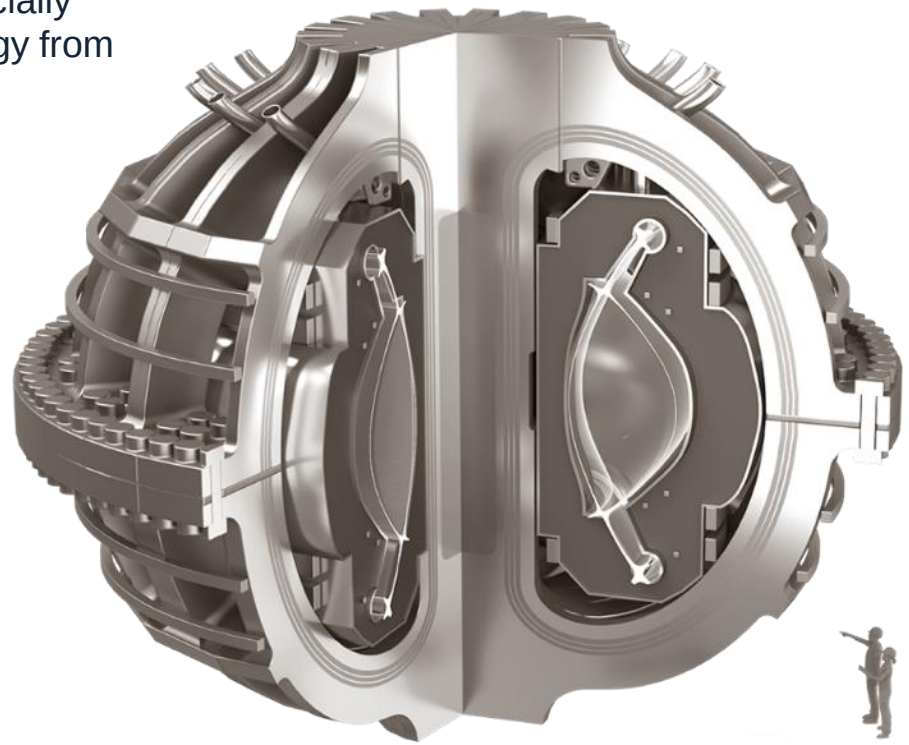

**COMPLETED**
**September 2021**
Demonstrate groundbreaking magnets

HTS Magnets

**CONSTRUCTION UNDERWAY**
**Operational in 2025**
Achieve commercially relevant net energy from fusion

SPARC

**Early 2030s**
Fusion power on the grid $P_{electric}$~400MW

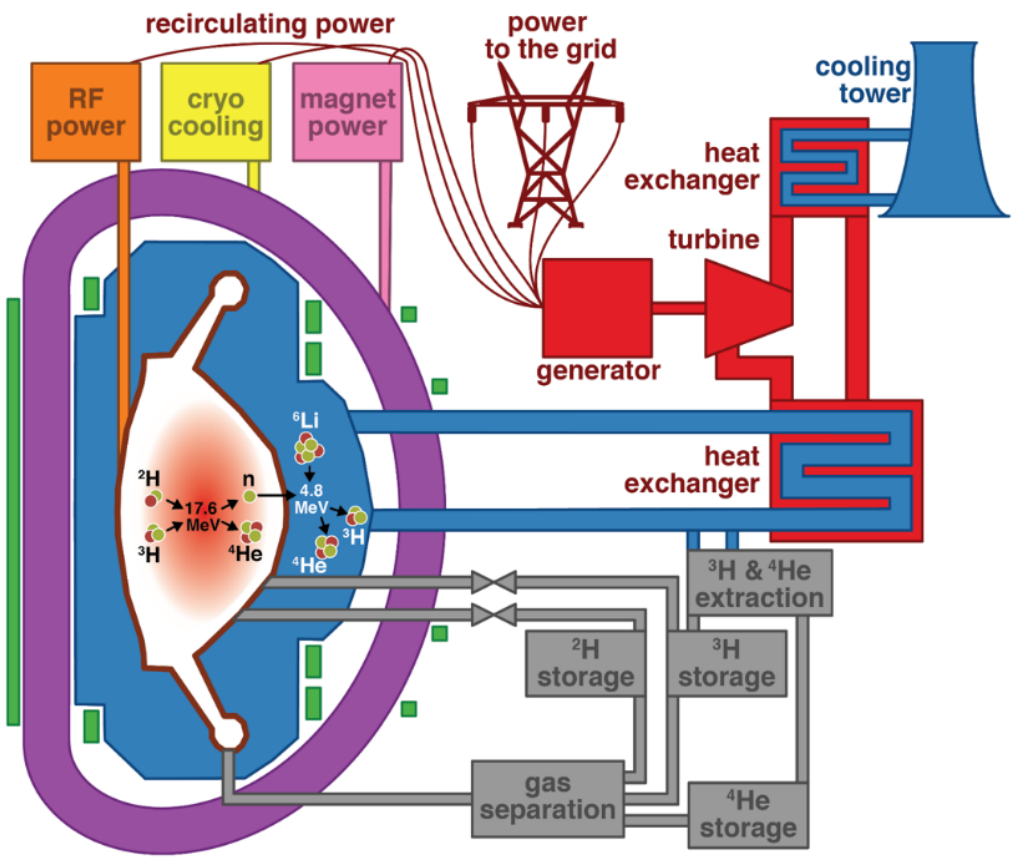


ARC

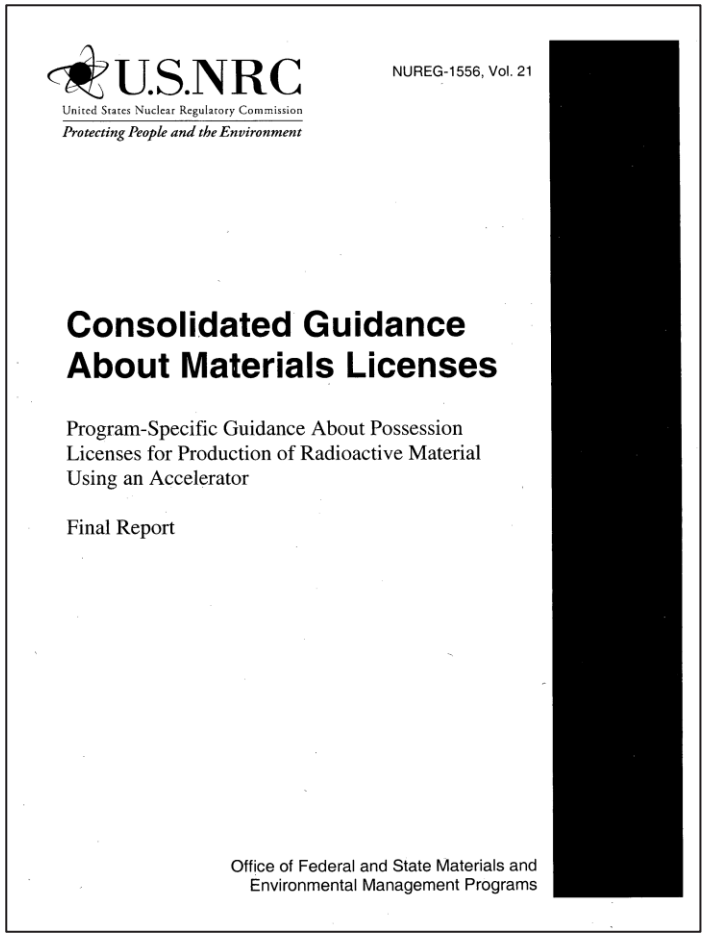
# Construction of SPARC and magnet factory in Devens, MA

# 10 CFR Part 30 can effectively regulate fusion energy

- Fusion aligns well with Part 30 regulation because in an off-normal scenario, the reaction stops instantaneously, and the hazard doesn't grow
  - Similar to particle accelerators, direct dose stops within a fraction of a second, and the potential radiological hazard from activated material/tritium stays constant or decreases
  - In a fission system, sufficient control systems and cooling need to be maintained to prevent a growing radiological hazard which is why it's regulated under 10 CFR 50/52



# 10 CFR Part 30 already contains a graded approach


U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

NUREG-1556, Vol. 21

**Consolidated Guidance About Materials Licenses**

Program-Specific Guidance About Possession Licenses for Production of Radioactive Material Using an Accelerator

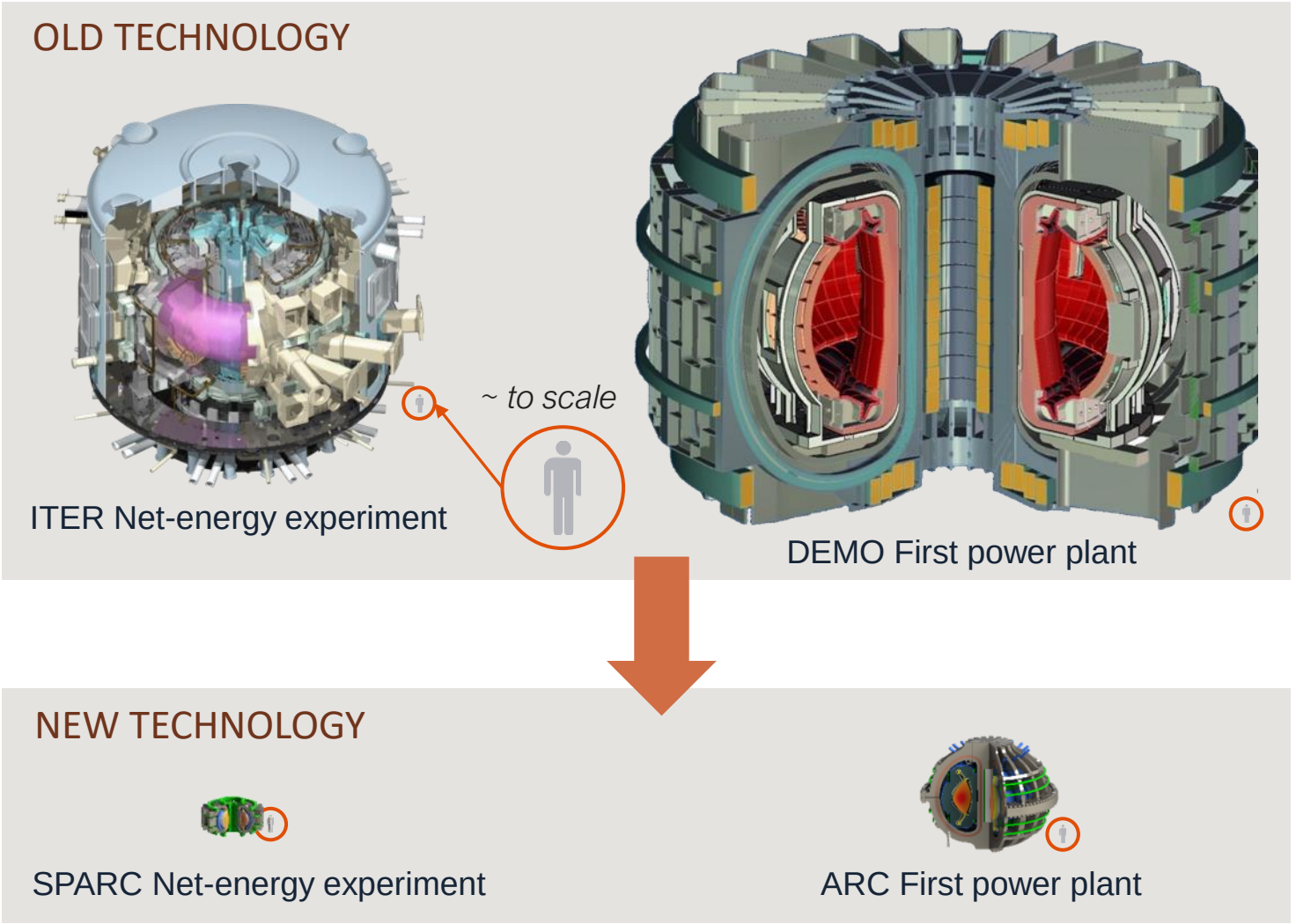
Final Report

Office of Federal and State Materials and Environmental Management Programs

- Part 30 contains a graded approach based on radiation dose hazard, establishing arbitrary thresholds for tritium or activated material inventory is not necessary
- Part 30 doesn't need any additional safety requirements in order to effectively regulate fusion energy facilities
- As the fusion industry matures additional guidance can be provided through modifications to NUREG documents (like NUREG-1556 Vol 21)

# Private fusion facilities are much smaller than ITER/DEMO

- Private US fusion facilities utilize novel technologies to dramatically reduce the scale of fusion facilities compared to ITER/DEMO
- This results in lower tritium inventories, radiological hazards and low-level waste production
- New technologies like HTS magnets have rendered ITER to be a one-of-a-kind machine, so it should not be a basis for regulatory decisions today



# Fusion has much lower radiological hazards than fission

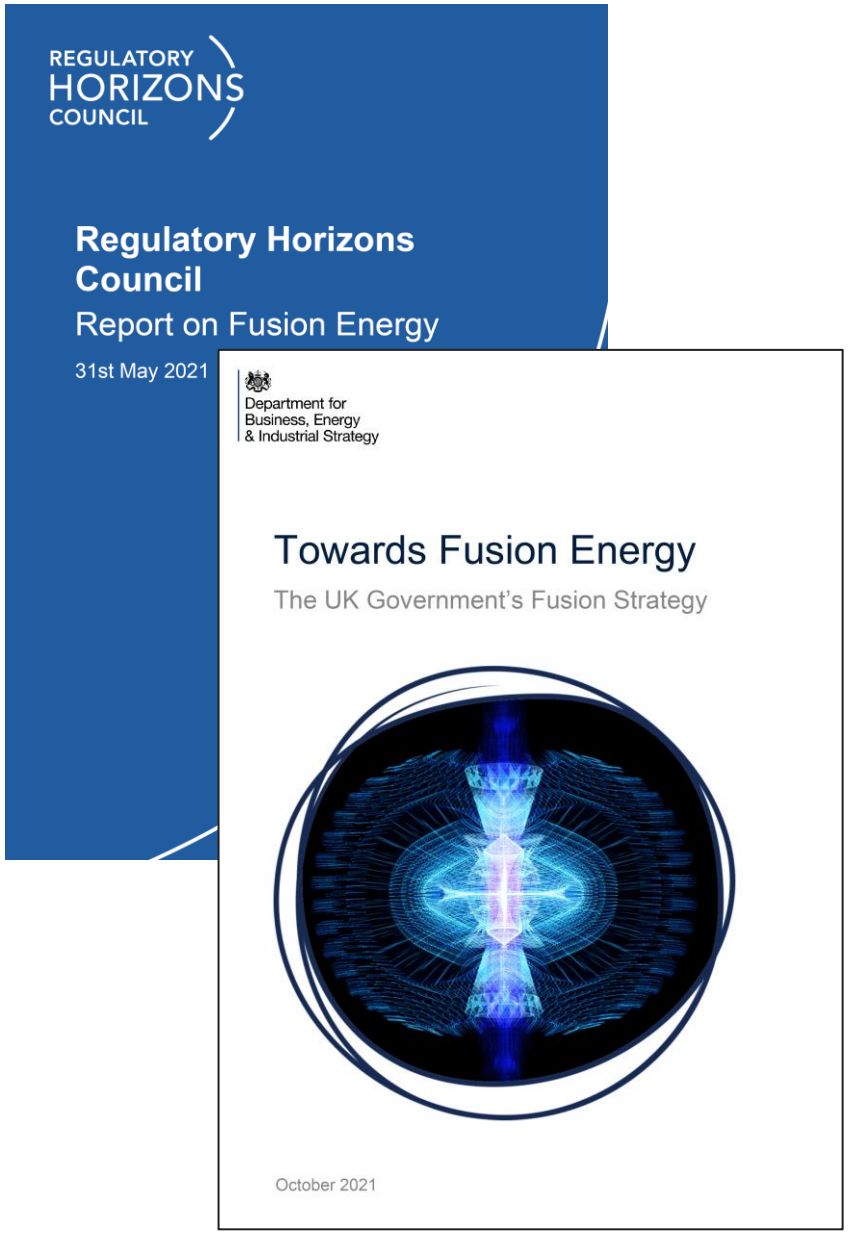
| Mode | Dose Pathway to Off-site Public | Regulatory Limit or Guideline (mrem) |
|---|---|---|
| **Chronic** | Annual effluent | 10 |
| **Chronic** | Annual effluent plus direct | 100 |
| **Chronic** | Direct dose in any hour | 2 |
| **Accident** | Accident | 1,000 |

Reference: 10 CFR 20

- Fusion energy facilities:
  - can maintain radiological dose levels within 10 CFR 20 limits
  - will have minimal environmental impact
  - can be designed to produce Class C and lower low-level waste
  - do not need active cooling to remove decay heat in plasma facing components after a discharge

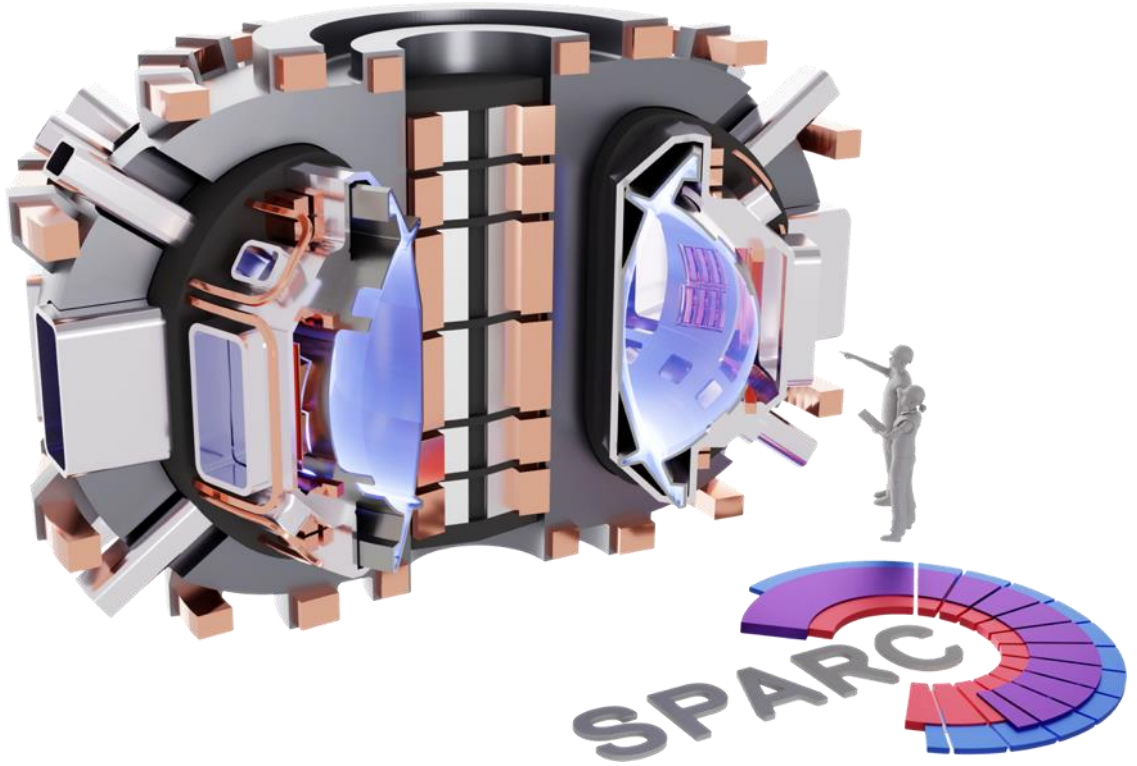
# Part 30-like approach is gaining momentum globally

- UK has recently decided upon a regulatory strategy for fusion which is similar to the 10 CFR 30 approach
- IAEA has organized several groups to evaluate how the emerging private fusion concepts should be regulated
- Several other countries (e.g. Canada) are exploring how to regulate emerging private fusion concepts
- Recently developed, small private fusion concepts are vastly different from ITER/DEMO so the safety studies from 20-30 years ago have limited applicability



# Agreement States are building fusion regulatory expertise

- Through a close working relationship, CFS and the MA Radiation Control Program (MRCP) have progressed significantly on licensing SPARC
- Several pre-application discussions had covered a wide variety of topics to pave the path for a comprehensive license application
- These efforts are building valuable fusion licensing experience at the Agreement State level with MRCP to add to the other existing experience with states such as Wisconsin (SHINE) and New York (OMEGA)



# Summary

- CFS believes regulating fusion energy systems under a Part 30 materials focused framework using existing NUREG-1556 Volume 21 provides sufficient guidance to ensure a safe fusion energy industry
- Minor updates to the existing regulations in Parts 20 and 30 (i.e., explicitly placing fusion energy machines within the particle accelerator framework) can resolve any residual confusion in NRC's materials licensing program
- This process of regulating new technologies under Part 30 and updating guidance as needed after sufficient operational experience has been gained, is consistent with how the NRC treated several previous technologies such as irradiators and well-loggers

# The fastest path to limitless, clean energy

Commonwealth Fusion Systems