



September 23, 2026 | TRTR-2026

High Flux Isotope Reactor Code of Record Project Overview

Carol Sizemore

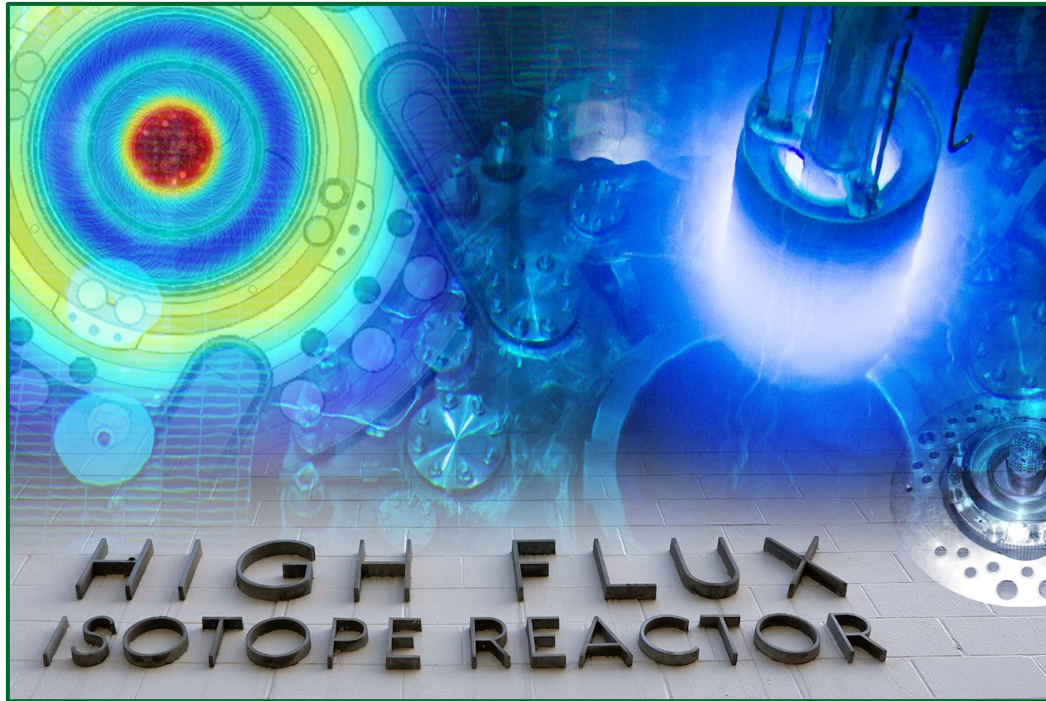
Project Manager, Research Reactors Division,
Neutron Sciences Directorate



U.S. DEPARTMENT
of **ENERGY**

ORNL IS MANAGED BY UT-BATTELLE LLC
FOR THE US DEPARTMENT OF ENERGY

Outline



Thanks to Code of Record team: Nick Brackett,
David H. Cook, Sandra De La Cruz-Herrera,
Cyndi Esau, Doug Reed, Carol Sizemore

HFIR Overview and Mission

Thinking back to 1965

HFIR 2026 and beyond

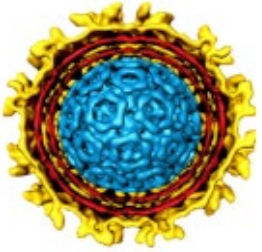
Codes and Standards in 1961 versus today

Code of Record for HFIR projects

HFIR Code of Record Project Timeline

SREL review and HFIR COR Methodology

HFIR is a versatile, multi-mission research reactor with neutron science capabilities at ORNL



Neutron scattering

Cold/thermal neutrons to study structure and dynamics of materials

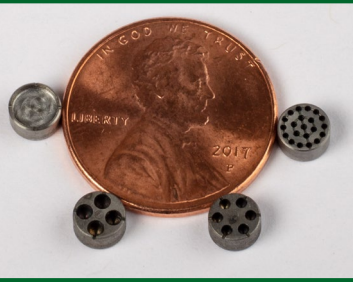
- Physics
- Chemistry
- Materials science
- Engineering
- Biology



Radioisotope production

For use in energy, industry, security, medicine

- ^{252}Cf
- ^{238}Pu
- ^{227}Ac
- ^{188}W
- ^{75}Se
- ^{63}Ni



Materials/fuels irradiation

≤ 14 dpa/year

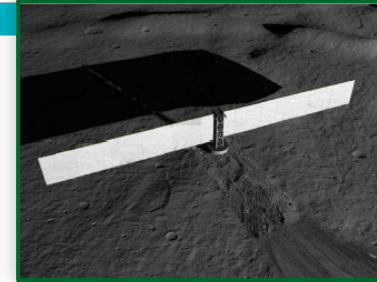
- Fission reactor materials
- Fusion reactor materials
- Accident-tolerant fuels
- Fuel cladding
- Advanced alloys
- Tensile testing
- Post-irradiation examinations



Neutron activation analysis

2 pneumatic tubes

- Nuclear forensics
- Criminal forensics
- Impurity analysis
- Geology
- Environment
- Nonproliferation



Gamma irradiation

- Used fuel
- Up to 10^8 rad/h
- Radiological damage studies
- NASA material tolerance
- Resin for ^{137}Cs removal in waste
- Insulators
- Wear resistance



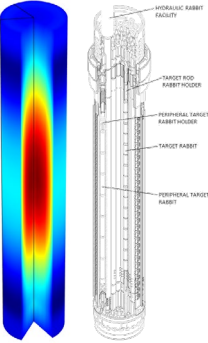
Neutrino research

- Pure ^{235}U spectrum
- Neutrino spectrum and oscillations
- Short baseline
- Reactor monitoring
- Nuclear safeguards

HFIR's core geometry consists of series of concentric cylinders

HFIR's compact size and unique geometry results in flexibility and intense fluxes

Flux trap target region



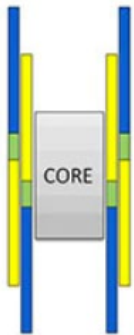
- 37 vertical target positions
- Isotope production
- Materials irradiation
- Hydraulic tube

85 MW (1.7 MW/L average)
 2.5×10^{15} n/cm²-s peak thermal
23 to 26-day cycle length

Fuel assembly:
Inner fuel element (IFE)
Outer fuel element (OFE)

- Involute-shaped Al clad plates
- 171 IFE plates
- 369 OFE plates
- HEU₃O₈-Al dispersion fuel
- 9.4 kg ²³⁵U and 2.7 g ¹⁰B

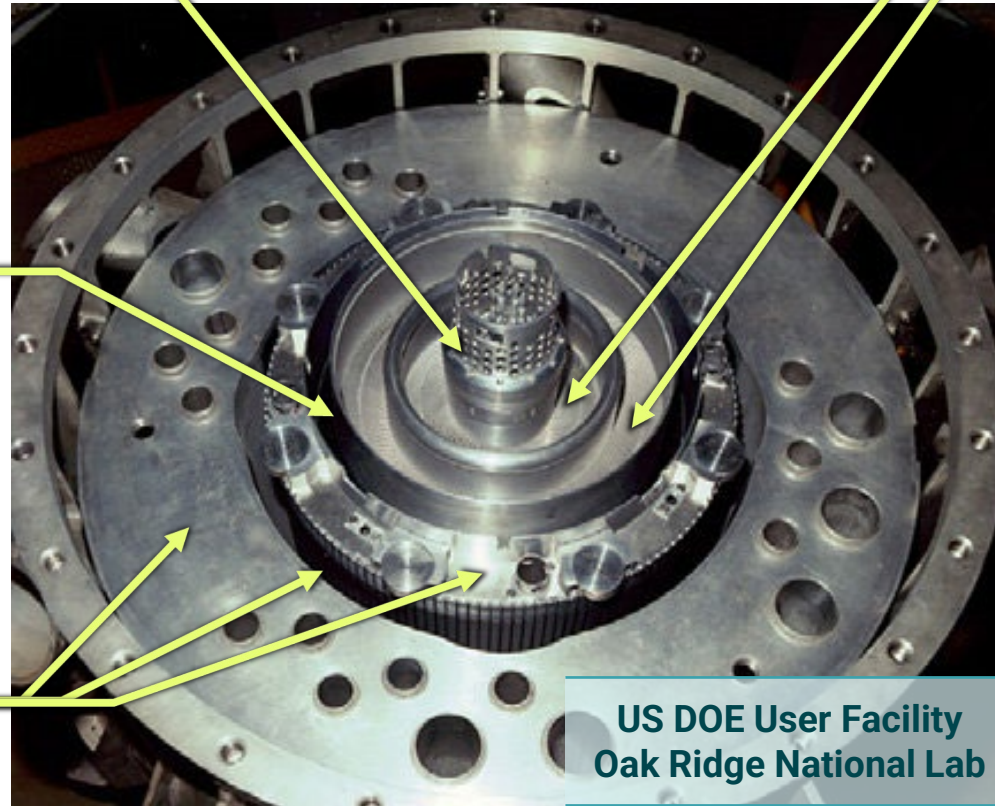
Control element region



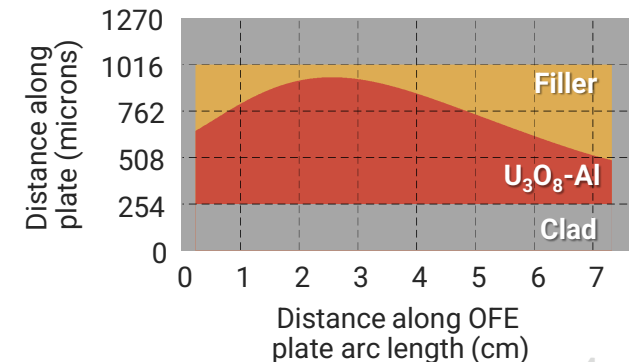
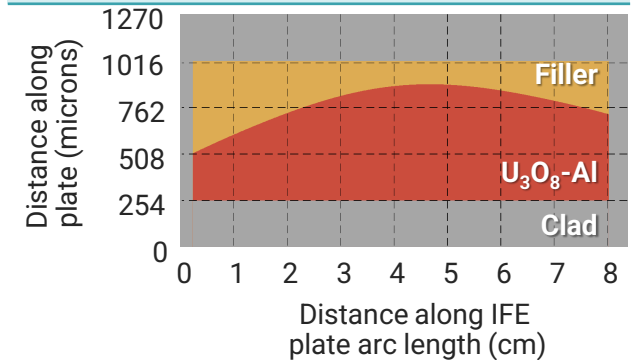
- 2 concentric cylinders
- Outer control element (OCE) for safety and regulation
- Inner control element (ICE) for regulation
- Eu, Ta, Al

Beryllium reflectors

- 4 beam tubes for scattering
- 42 vertical experiment facilities
- 2 pneumatic tubes for NAA



Light water cooled and moderated
16,000 GPM primary coolant flow (120°F, 468 psig)



Thinking back to 1965...

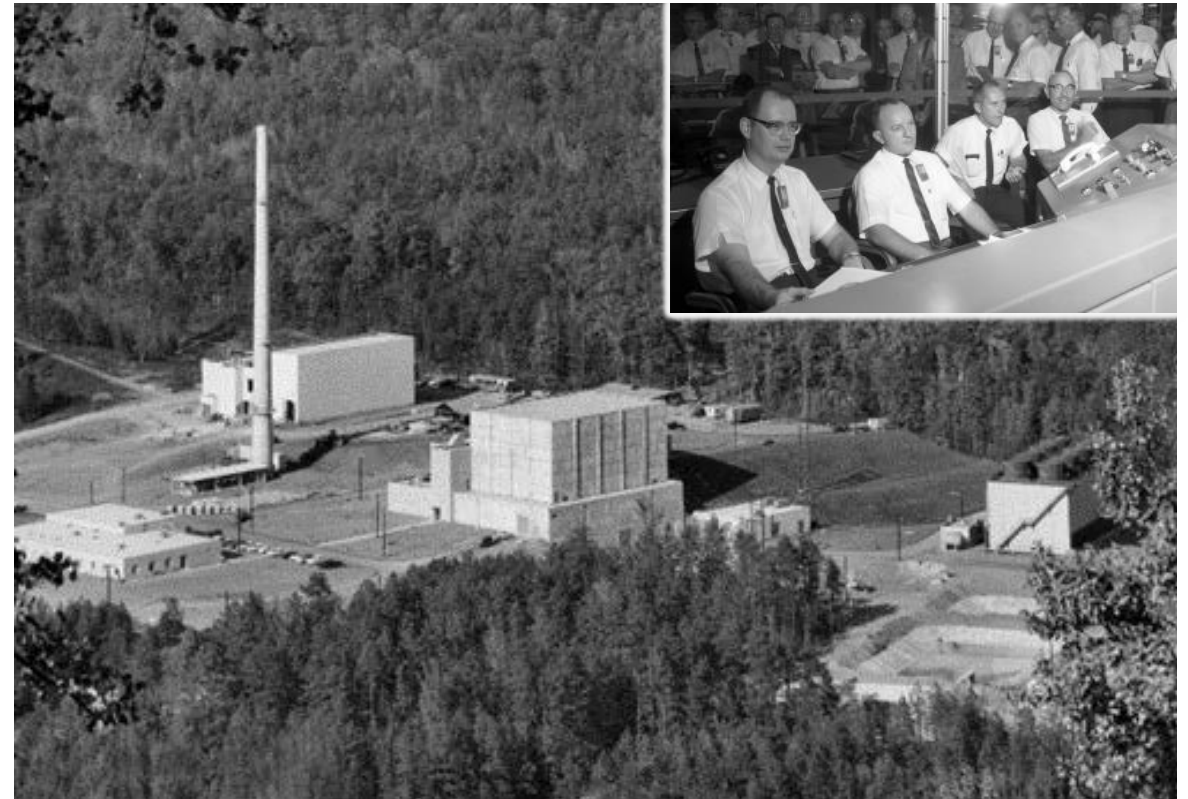
1965 Cost of Living and HFIR milestones

\$6,900 = annual household income
\$7,636 = Entry-level engineer salary
\$11,500 = Median engineer salary
\$21,500 = median new home cost
\$2,663 = 1965 Mustang convertible
\$500 = average annual college tuition
\$118 = average monthly rent
\$0.53 = cost of a dozen eggs
\$0.35 = cost of a cup of coffee
\$0.31 = cost of a gallon of regular gas
\$0.05 = first-class postage



High Flux Isotope Reactor construction completed in 1965,
and criticality was achieved on August 25, 1965.

HFIR site -1965 At-the-controls for Initial Criticality (inset)



HFIR 2026 and beyond

2026 Cost of Living and HFIR milestones

\$87,600 = annual household income
\$69,400 = Entry-level engineer salary
\$98,500 = Median engineer salary
\$393,800 = median new home cost
\$40,440 = 2026 Mustang convertible
\$30,990 = average annual college tuition
\$1,700 = average monthly rent
\$2.19 = cost of a dozen eggs
\$3.50 = cost of a cup of coffee
\$4.09 = cost of a gallon of regular gas
\$0.82 = first-class postage



High Flux Isotope Reactor celebrated 60th Anniversary and recently completed cycle 516.

HFIR today

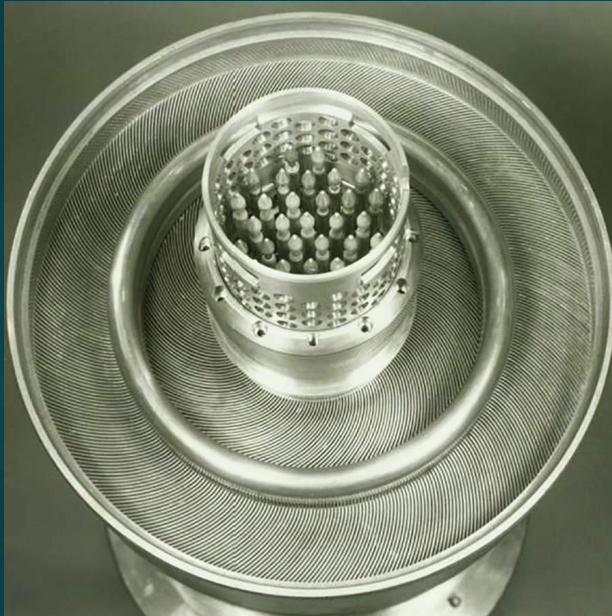


Codes and Standards in 1961 versus today

For American nuclear construction in 1961, the practical code framework was U.S. Atomic Energy Commission (AEC) requirements + ASME + ASA + AISC + ACI + ASTM + AWS + NFPA + NEMA

Area	1961	2026
Federal authority	U.S. Atomic Energy Commission (AEC)	Nuclear Regulatory Commission, US Dept. of Energy
Main regulations	Early 10 CFR Part 50	10 CFR Part 50, Part 52, Part 21, Part 26, Part 50 Appendix A, Appendix B, Appendix J, etc. for NRC 10 CFR 830, etc. for DOE
Safety criteria	Largely project-specific, evolving	Formalized and codified through regulations, Standard Review Plan, Regulatory Guides, endorsed consensus standards
Design certification	Not in modern form	Mature framework for design certification, COLs, manufacturing licenses, standardized designs

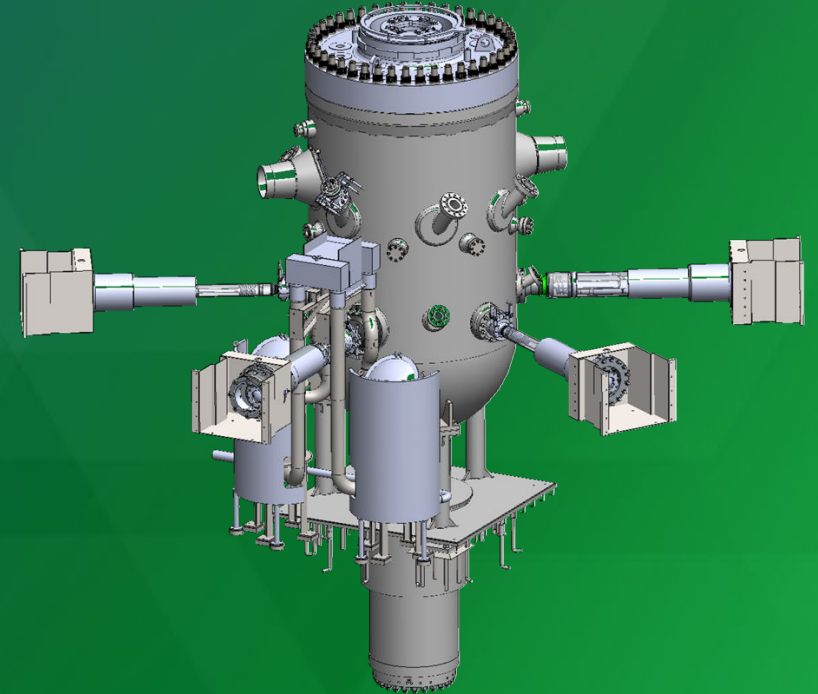
Code of Record developed per DOE-STD-1189-2016 for HFIR major modification projects



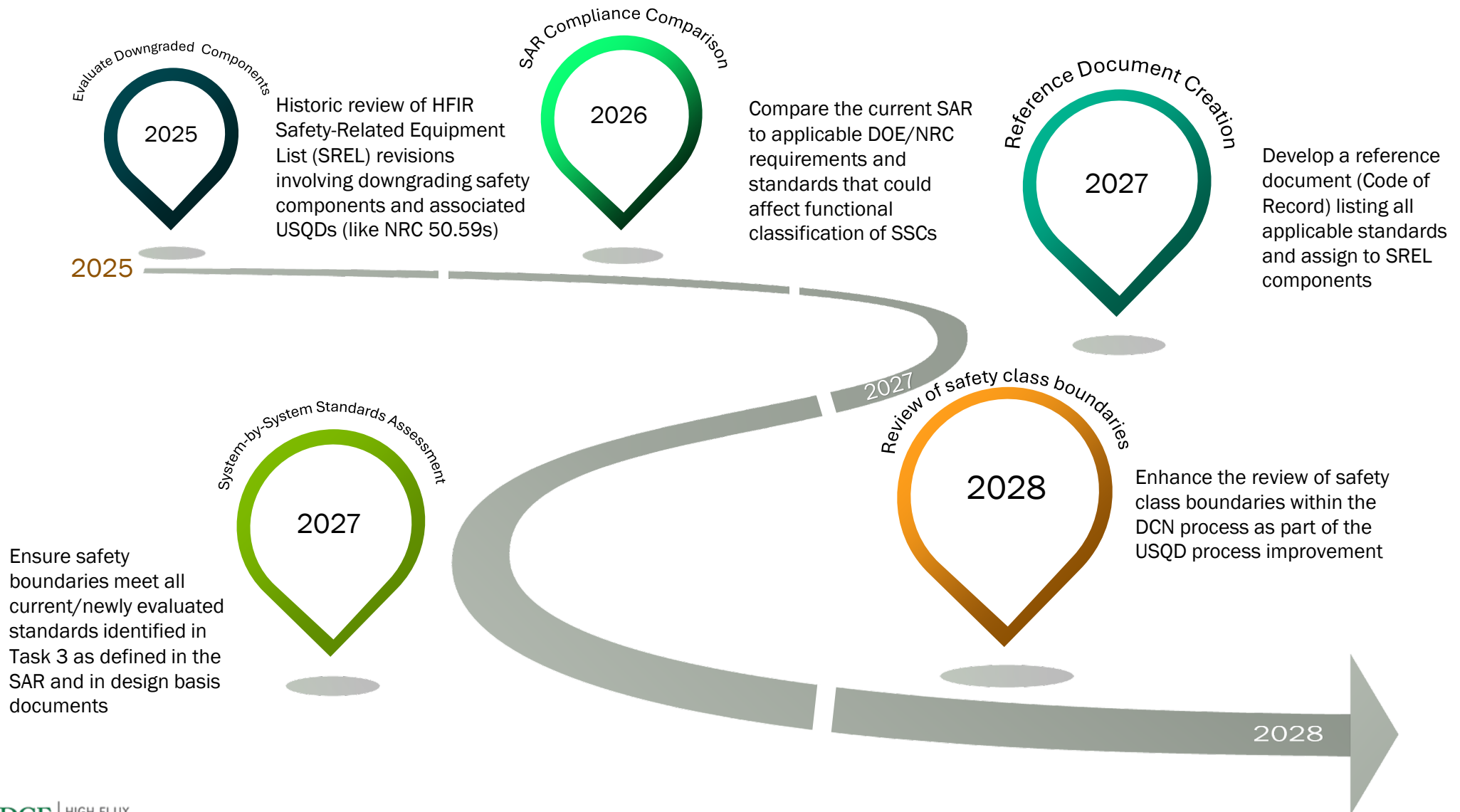
Low-Enriched Uranium
(LEU) Conversion



HFIR Pressure Vessel Replacement (PVR)



HFIR Code of Record Project Plan Overview - Timeline



Methodology to evaluate SREL Downgrades and Develop Reference Document – aka HFIR Code of Record

Evaluate HFIR SREL downgrades & deletions

- Review SREL documentation
- Highlight the definition changes over time
- Ensure all downgrades have proper USQD review and justification
 - If USQD screening worksheet or Expert USQD was performed, review the safety analysis to determine if selection was appropriate
- Prepare evaluation, perform independent review, approve

Document HFIR Code of Record

- Review codes and standards within engineering specifications and SAR to develop a comprehensive reference document listing applicable standards for future modifications, deviations, and revisions.
- Hold working meetings to assign applicable codes and standards to safety-related items within the HFIR Master Equipment List.

Key Acronyms: Safety Related Equipment List (SREL), Unresolved Safety Question Determination (USQD), Safety Analysis Report (SAR)

Questions?

