Westinghouse Lead Fast Reactor Program

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Genesis of Westinghouse Lead Fast Reactor Program

• Challenge: **Identify the technology with best potential to meet the key requirements for global commercialization:**
  • Safety
  • Economics
  • Marketability

• Other evaluation criteria also considered – e.g., enhancement in natural resource utilization, technology readiness level, etc.

• **Clean sheet approach: no legacy from the past**

• All the most well-known technologies, and beyond, were screened

• LFR emerged as the best technology to meet our commercialization requirements, based on the evaluation criteria we considered
Success Criterion for an Advanced Reactor Program

- An advanced reactor program can only be considered successful if it leads to construction of more than 1 or 2 reactors
  - We must aim at commercialization. We must aim at a fleet
- Forty years ago, requirements for commercialization were qualitatively the same as today’s, but their weights were different. Today:
  - More competitive markets
  - More emphasis on safety that, in the absence of design simplicity and inherent safety features, results in increased costs
- We have set some key requirements for an advanced reactor design
Westinghouse Advanced Reactor Requirements

- **Competitive economics**
  - Competitive levelized cost of electricity (LCOE) but also reduced front-end investment to promote plant’s “affordability” by a large number of customers

- **Safety**
  - Simple and robust design
  - Passive and inherent safety

- **Broader marketability**
  - Non-electricity applications to fulfill needs of diverse future markets (e.g., variable electricity generation, desalination, process heat, waste management)

- **Licensing assurance**
  - Simple and robust design
  - Limited number of first-of-a-kind features

- **Predictability in technical feasibility, development time and cost**
  - Sufficiently high technology readiness level
  - Streamlined technology development roadmap based on scalability
Key Features of the Westinghouse LFR

**Economic Potential**
- Compact Nuclear Island
- High power density core
- High plant efficiency
- Design simplicity and modularity (shorter construction)

**Unparalleled Safety**
- Integral configuration
- Atmospheric pressure
- No pressure-driven LOCA
- High boiling point coolant
- Chemically-inert coolant
- Strong reactivity feedback
- Enhanced defense in depth barriers (FP retention capability by Pb)

**Global Marketability**
- All plant sizes: battery-type, SMR, GWe-size
- Energy storage capability for variable electricity output
- Non-electric applications
- Reduced Emergency Planning Zone (EPZ) size
- Potential for long-life core
- Potential to close fuel cycle (improve waste management and public acceptance)

Promising combination of safety, performance and marketability, combined with adequate technology readiness.
Common Misbeliefs and Facts on LFR Technology

**MISBELIEFS**

LFR technology OFTEN PICTURED AS:

- Low Technical Readiness Level
- Having insurmountable corrosion challenges
- Very long-term deployment

**FACTS**

LFR technology IS:

- Seriously pursued in EU & Russia
- $< \sim 480^\circ C$ corrosion is addressed using tested and demonstrated materials. Promising results are being obtained with new materials up to $700^\circ C$ (more testing to confirm)
- LFR technology readiness is compatible with demonstration by 2030, with higher performance evolutions to be deployed later as materials and advanced fuel are proven and qualified
LFR Key Challenges

- **Corrosion**
  - addressed by material development

- **High melting point**
  - addressed by innovations in refueling scheme and system design

- **Opaque**
  - addressed by advancements in inspection and viewing technology

- **Weight**
  - addressed by design compactness

Challenges are not inherent showstoppers and can be addressed through development programs.
Westinghouse LFR Program

• Program key elements:
  • Westinghouse broad experience in nuclear
  • Collaboration with organizations having know-how and expertise in lead technology and fast reactor design, domestically and internationally

• Informing / stimulating / involving the global community on LFR technology

• Currently working on the LFR design best suited for the demonstration-to-commercialization path. Key activities include:
  • Plant layout development
  • Assessment of demo-to-commercial transition
  • Cost assessment
Demonstration and Commercial LFR

- **Demonstration LFR**: focus on proven materials
  - $T_{\text{hot}} \leq 500^\circ\text{C}$ to manage corrosion (yet with ~40-42% efficiency)
  - Proven materials (D9, SS316) and fuel ($\text{UO}_2$), from SFR experience

- **Commercial follow-on units**: higher efficiency for best economics and broader range of applications beyond baseload electricity
  - Temperature increase up to 700°C (efficiency in the upper 40s)
  - Advanced fuels (we will leverage our Accident Tolerant Fuel [ATF] program)
Global Engagement in the Advanced Non-LWR Arena

- Participated in the Advanced Test & Demonstration Reactor study
- Collaborating with National Laboratories and Universities to advance key technologies
- Actively engaged with key industry groups
- Continued support of U.S. Department of Energy (DOE) initiatives
- Supporting enhancement of experimental facilities for lead technology research and development in the U.S.
- Presented vision/program on LFR technology development to LFR Steering Committee of the GenIV International Forum
- Ongoing discussions with European organizations that are leading Pb-based technology development
Conclusions

- Westinghouse selected LFR as its advanced reactor technology because of the *economic* and *market potential*, the *outstanding safety case*, and the *confidence in engineering and licensing viability*
- We are informing / stimulating / involving the community on LFR technology
- We look forward to collaboration opportunities for accelerating LFR development
- We have a demonstration-to-commercial LFR roadmap that we are continuing to evolve
Thank-you