RC-3: Liquid Metal Cooled Fast Reactor Technology Development and Demonstration to Support Deployment

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#INLCINRWorkshop

[RC-3] LMFR Technology

- **Focus** : Advanced Non-Light Water Reactors (Liquid Metal Cooled: Na or Pb) Cooled Fast Reactor Concept Development and Demonstration to Support Deployment)
  - Potential for significant Benefits
  - Operating Cost Reductions
    - Sensors and Monitoring means to help quantify materials degradation in liquid metal
    - Detecting Degradation Early (Structural Health Monitoring)
    - NDE Techniques
    - Inspection Techniques – Visualization in optically opaque coolants
    - Development and Application of Uncertainty Propagation Analysis Techniques to quantify impacts on key performance parameters (e.g., burnup), further leading to optimization study and being able to justify improved design and safety margins

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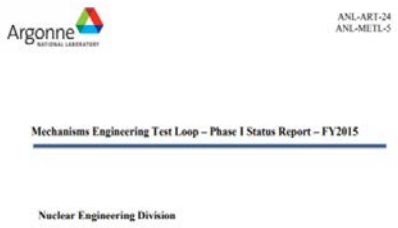
- Development of Test Articles for Testing in METL Sodium Loop Facility
  (Link: http://www.ipd.anl.gov/anlpubs/2015/09/121152.pdf)


Argonne

ANL-ART-24
ANL-METL-5

Mechanisms Engineering Test Loop – Phase I Status Report – FY2015

Nuclear Engineering Division

- Experimental Key Validation for Performance Attributes for Compact Heat Exchanger Options (microchannel configurations)

- Development of small scale testing capabilities for lead or lead bismuth for technology development and demonstration

Other potential areas: could support **VTR development efforts**

Na Cooled

- Innovative ways to **purify sodium** (i.e. control oxygen level) for in-reactor systems at prototypic sodium operating temperatures **(**via novel chemical means or possibly by a micro-filter design that provides filtration on a portion of the sodium flow circulating through the loop)
- Innovative concepts for **wireless communication** with cartridge instruments would also be a great benefit, but must factor in the high operating temperatures and long stand-off (e.g., 10 meters or more) required to communicate with instruments in the core region

Other potential areas: could support **VTR development efforts**

Pb/Pb-Bi Cooled

- Primary phenomena of interest would be **corrosion, stress corrosion and liquid-metal embrittlement** – both in pure and in fission product environments. (Past research has shown that oxygen control and utilization of on-line cleaning would decrease erosion and corrosion rates).
- Experiments for accommodating **reduced scale testing** of structures and components at prototypical velocities and temperatures
- Experiments to understand **fission product retention** in lead & lead-bismuth eutectic environment
- Seeking Innovative ways to:
  - Address **experimental structural design** (e.g., the development of miniature pumps and heaters, improved heat exchange) or instrumentation to support specific types of experiments (novel approaches to measuring corrosion on specimens, measuring specimen loss of ductility, or other parameters of research interest)
  - **Purify** Lead/LBE (i.e. control oxygen level) for in-reactor systems at prototypic operating temperatures., and consider the corrosive and high-temperature aspects of a high temperature lead environment on the proposed equipment.
  - On-Line **Cleanup** and Embedded **Sensors**

All **proposals** should specifically identify the **technological gap**, address how the work proposed may lead to an **improvement** in an existing capability.

Bonus Slide

Draft requirements/assumptions of VTR

1. Reach fast flux of approximately 4 E15 n/cm^2-s, with prototypical spectrum
2. Load factor: as large as possible *(maximize dpa/year to > 30 dpa/year)*
3. Provide flexibility for novel experimental techniques
4. Be capable of running experiments representative of typical fast reactors *(Candidate Coolants: Na, Lead, LBE, Gas, Molten Salt)*
5. Effective testing height ≤ 1 m
6. Ability to perform large number of experiments simultaneously
7. Metallic driver fuel (possible options: LEU, Pu, LEU+Pu)
8. Mature technology and advanced safety: Sodium pool type reactor, inherently safe