INL/RPT-23-72467-Revision-0

Irradiation Test Facility Assessment for Instrumentation Testing and Qualification

June 2023

Austin D Fleming

Changing the World's Energy Future

INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC

INL/RPT-23-72467-Revision-0

Irradiation Test Facility Assessment for Instrumentation Testing and Qualification

Austin D Fleming

June 2023

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

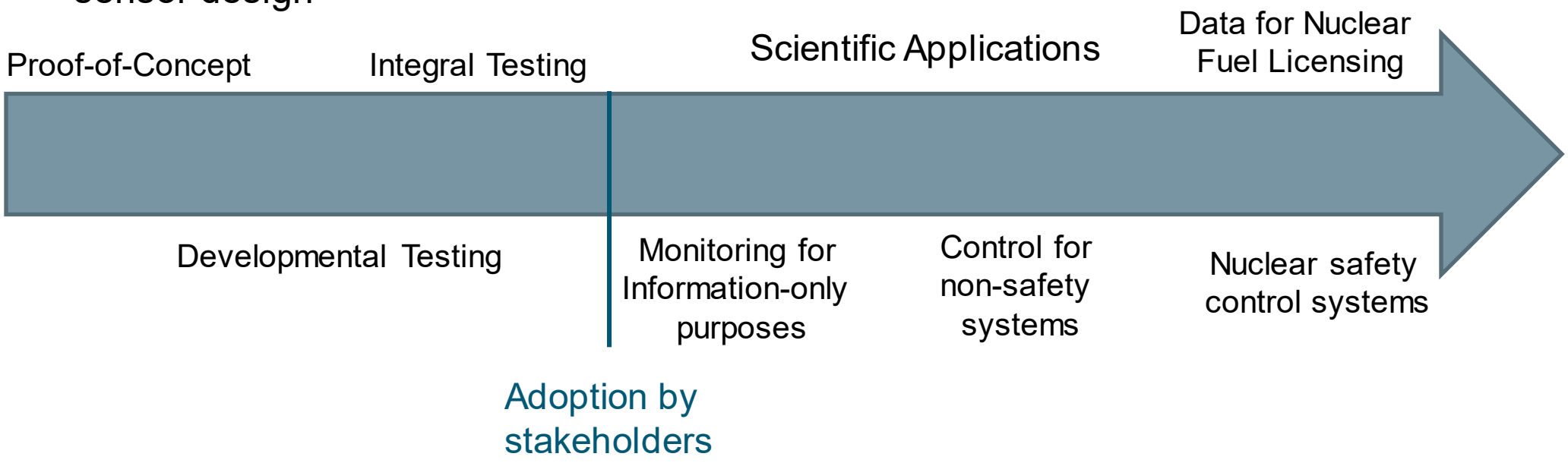
Irradiation Test Facility Assessment for Instrumentation testing and qualification

www.inl.gov

Idaho National Laboratory

Overview

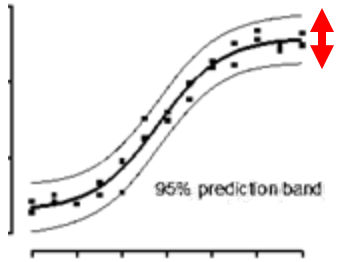
- A broad range of need exist for the development and qualification for in-core sensors
- Low Overhead Testing
  - Provide fast and affordable results on sensor performance (quick and efficient access is prioritized over control and verification of irradiation conditions)
- Qualification testing
  - Highly controlled experiments with rigorously quantified uncertainties
  - NIST traceability references where possible with statistically significant data sets for a given sensor design



Qualification Overview

- **Devices**
  - Temperature
  - Flux
  - Pressure
  - Strain/Displacement
- **Sensors Qualification**
  - Thermocouples
  - Ultrasonic Thermometry
  - Pyrometry
  - Fission Chambers
  - Self Powered Neutron Detectors
  - Fiber optics

- **Requirements**
  - House the sensor in a rigorously controlled and known environment for their specific measurand (Temperature, Flux, Pressure, Strain)



Adequate definition = GOAL!

Survey of Positions

- Where to perform qualification testing for instruments?
  - Adequate flux/fluence for the instruments application
  - Large enough irradiation position to accommodate device
  - Cost effective
  - Benefit to Others (NSUF facility)
  - Majority of device is compatible with multiple facilities (risk mitigation, price point considerations, timeline implications)

Identified Positions of Interest

- The requirement for a highly controlled environment is difficult to achieve with the limited space typical of irradiation positions.
- These 4 positions identified have diameters ≥3” which is much easier
- ATR medium I ($3.4*10^{13}$ thermal, $1.3*10^{12}$ fast, 3.25” diameter)
- MIT 3GV ($1*10^{10}$ -$1*10^{13}$ thermal, 3” diameter)
- OSU 6.5”/9.5” Tubes (~$5*10^{11}$ thermal $4*10^{11}$ fast, 6.5” or 9.5” diameter)
- NCSU standpipe ($1*10^{11}$ thermal, $5*10^{9}$ fast, 3.5” diameter)
- Ongoing discussion with facilities at Penn State & Texas A&M

Planned use of these Facilities

- Currently in discussion with all of the identified facilities to determine their feasibility to use for both
  - low over head and/or
  - qualification testing of instrumentation
- Compiling design constraints of each facility:
  - Geometry
  - Temperature Limits
  - Allowable Heat loads
  - Neutronic Worth/Activation Constraints
- Working on a conceptual design for an instrumentation testing platform which can be compatible with all of these locations