



NSUF University Research Reactor Fitness Workshop

February 2021

Changing the World's Energy Future

Brenden J Heidrich



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**Idaho National Laboratory
Idaho Falls, Idaho 83415**

<http://www.inl.gov>

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ANS Meetings

CONTE 2021

Conference on Nuclear Training and Education

A Biennial International Forum

NSUF University Research Reactor Fitness Workshop

Introduction and Background

Brenden Heidrich, PhD, PE

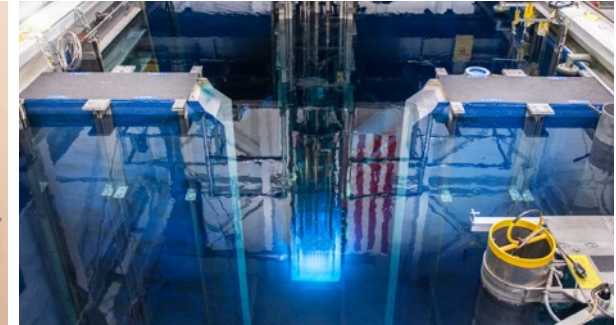
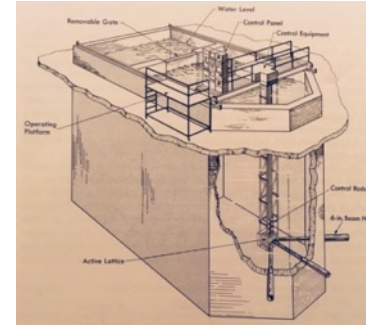
NSUF Irradiations Chief Scientist



INL/CON-21-61557

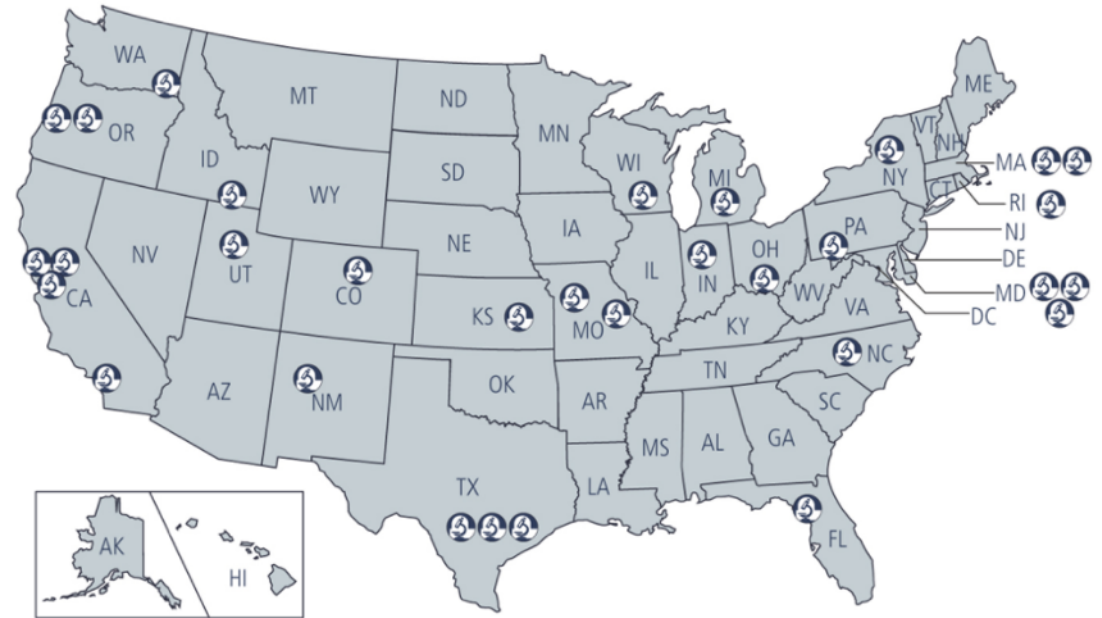
Presentation Outline

- Introduction to:
 - University Research Reactors (URR)
 - Nuclear Science User Facilities (NSUF)
 - URR Fitness Study
- Overview of Survey Results
- Panel Presentations and Discussion
- **Goals for the panel**
 - URR have a unique set of challenges and solutions in these areas that should be interesting.
 - URR also have a lower barrier to entry, more adaptability and flexibility to accommodate innovative work.



Who are these University Research Reactors?

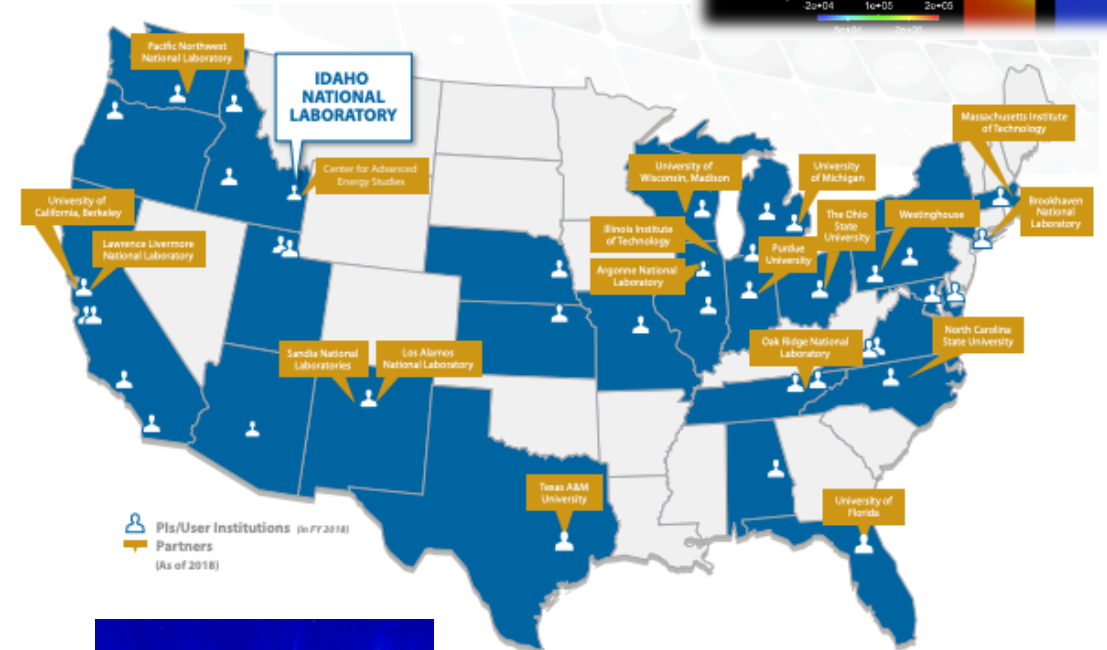
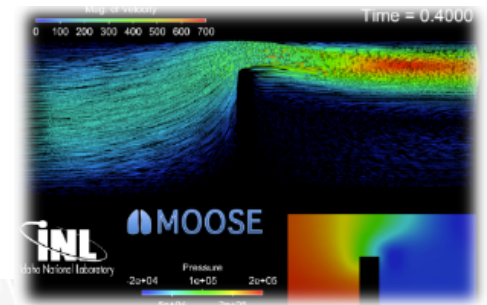
These 25 on-campus reactors serve a vital national role in both educating and providing experience to nuclear engineers, nuclear scientists, and other professionals critical to our Nation's nuclear leadership.



US University Research Reactors (nrc.gov)

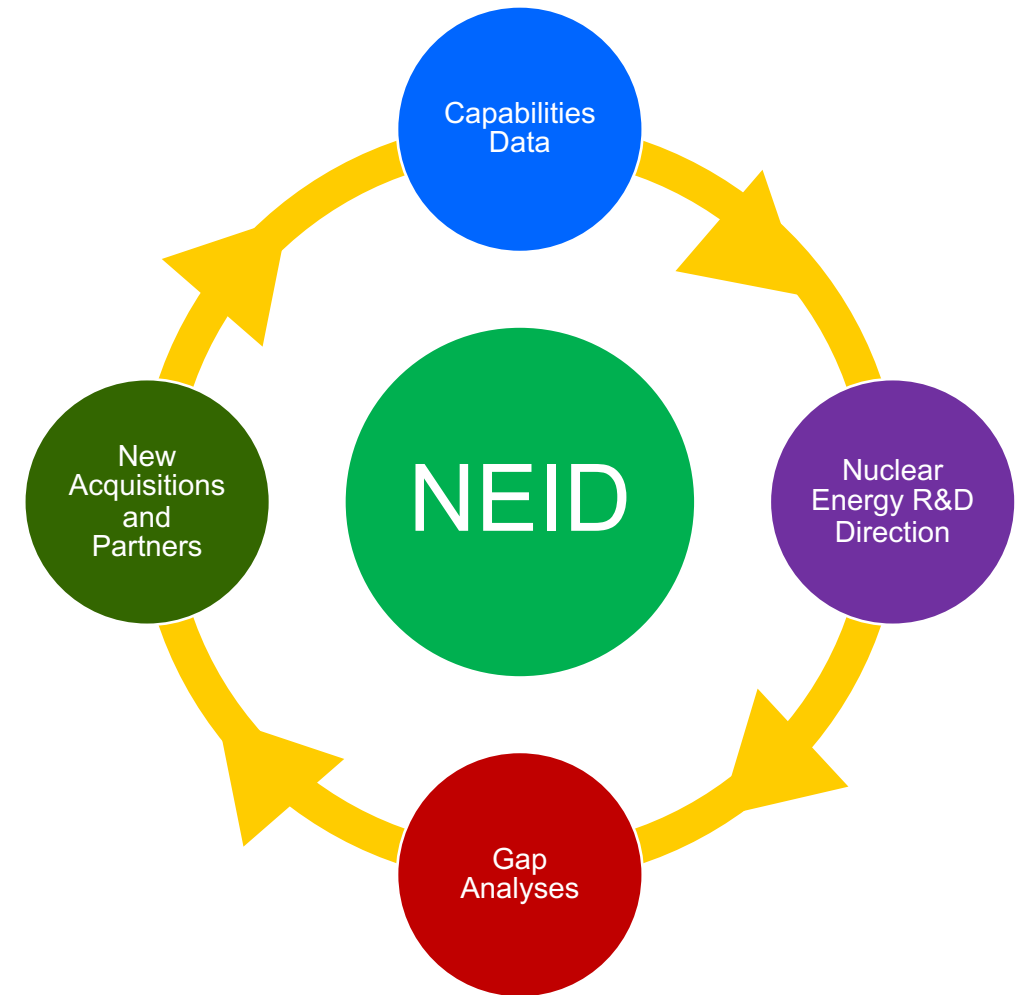
Nuclear Science User Facilities (NSUF)

- NSUF offers unparalleled research opportunities for nuclear energy researchers by providing access to:
 - world-class nuclear research facilities,
 - technical expertise from experienced scientists and engineers, and
 - assistance with experiment design, assembly, safety analysis and examination.
 - no cost to the researchers.
- Access is awarded through a competitive peer-reviewed process.
- Submitted proposals must align to the DOE Office of Nuclear Energy (DOE-NE) mission and interests.



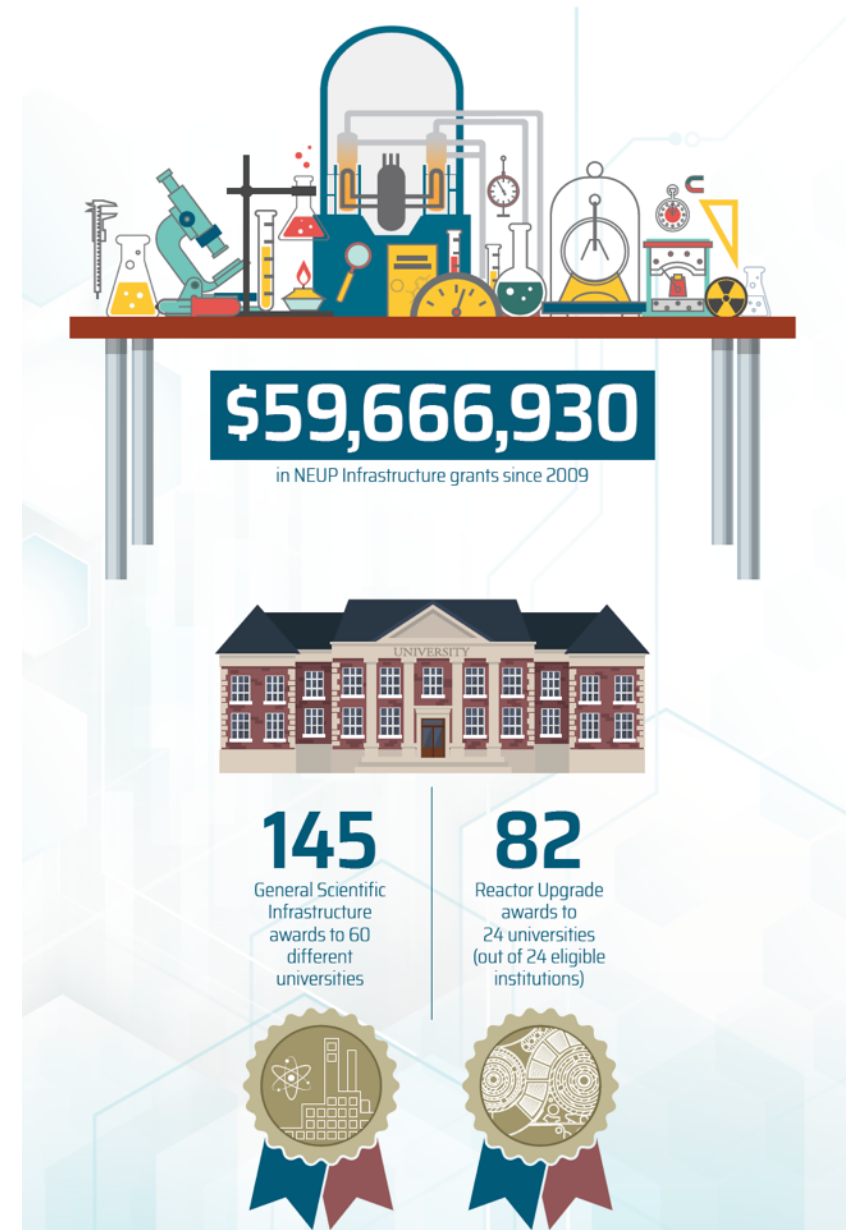
Infrastructure Analysis

- NSUF has an infrastructure management program to support the DOE-NE priorities.
- NSUF administers the University Scientific Infrastructure Funding Opportunity Announcements (FOAs), which includes Reactor Upgrades.
- This review started in FY2017 as an effort to look at US URR infrastructure, particularly control consoles, and to establish a list of needs and priorities as well as a schedule for implementation.



Current DOE-NE Support for URR

- Idaho National Laboratory (INL) manages and provides technical support for the DOE Research Reactor Infrastructure program.
- This program provides nuclear reactor fuel for all US URRs, as well as the return of the irradiated nuclear fuel after its useful life.
- Research Reactor Infrastructure (RRI) and Reactor Upgrades/General Scientific Infrastructure (RU/GSI) are funded to ~20MM\$/year.



The National Organization of Test, Research, and Training Reactors (TRTR)

- TRTR represents research reactor facilities across the nation from government, major universities, national laboratories, and industry.
- TRTR provides expert technical assistance to member institutions and others through peer reviews, audits, and assessments.



Education

Reactors around the country developing the next generation of nuclear engineers and scientists who will be leaders of the future.



Research

Performing basic research to further understanding of basic physics, improved the nuclear industry, and much more!



Outreach

Member facilities perform community and global outreach to educate members of the public about the safe uses of nuclear energy.

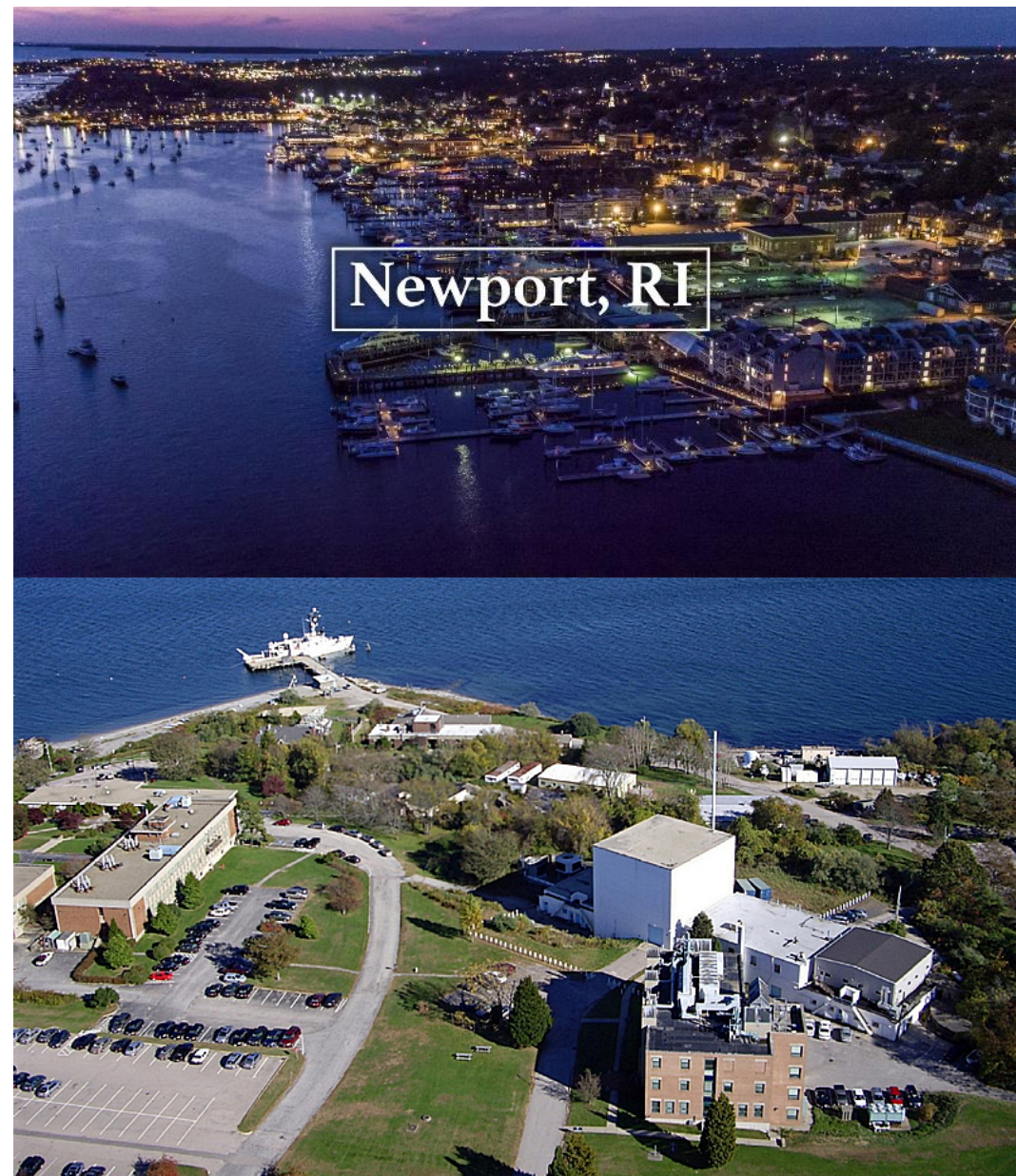


Testing

Integral testing of nuclear components is a vital means of verifying performance. The TRTR community supports this work in scaled settings.

Study Background

- Kickoff at the 2018 TRTR meeting.
- Clive Townsend (Purdue University) volunteered to work with NSUF and wrote the initial problem statement document.
- NSUF secured funding for the effort after consultation with DOE-NE.
- Expanded the mission from just infrastructure to cover any issue that could affect the continued operation of the Nation's university research reactor fleet.



URR Fitness Study Flow

1. Web Survey of US University Reactor Facilities
 - 23/25 facilities participated in the survey
2. Facility Presentations & Discussion
 - 60 minutes
3. Facilitated Discussion with ThinkTank™
 - 30 minutes
4. Working Groups
 - Elect a chairperson
 - Discuss the issues and the big challenges
 - Prioritize the issues and work on solution pathways
 - Develop a path forward with recommendations
5. TRTR Annual Meeting
 - September 22-26, 2019 (Idaho Falls)
 - Panel Session to present to the whole community
6. Formal Report to DOE-NE
 - December 2019



Survey Results – Facility Infrastructure

Four areas of inquiry

1. Control Consoles
2. Major Infrastructure
3. Safety Equipment
4. Maintenance



Overarching Issues

1. Equipment Aging
2. Equipment Obsolescence
3. Civil Engineering (building) issues
4. Digital Console Conversion
5. Critical Spare Parts

Survey Results – Regulatory Issues

Three areas of inquiry

1. Changes in Regulation
2. Facility Change Control
3. Licensing and Final Safety Analysis Report (FSAR)



Overarching Issues

1. Burden is a drain on facility resources
2. Reluctance to upgrade equipment
3. NRC use of Nuclear Power Plant (NPP) contractors for licensing reviews
4. Lack of internal Subject Matter Experts (SMEs) for analysis to support License Amendment Requests/Safety Analysis Reports (LAR/SAR) work (contractor vs. training)
5. Utility of 10CFR50.59 process for changes
6. Disproportionate Impact on smaller facilities

Survey Results – Utilization and Relevancy

Overarching Issues

1. Educational Utilization (courses and laboratories)
2. Research Utilization (graduate and faculty)
3. Commercial Service Work
4. Diversity of Customers
5. Novel Applications
6. Licensing/Regulatory Barriers to Work



Survey Results – Staffing and Knowledge Transfer

Four areas of inquiry

1. Staffing Changes
2. Staffing Requirements
3. Knowledge Transfer
4. Fuel Shipments



Overarching Issues

1. Recruiting and keeping permanent staff
2. Utilization of students (operators/interns)
3. Succession and Knowledge Retention planning
4. SME staff vs. Flexibility
5. Access to external SME resources
6. Standardized safety analyses, etc.
7. Ease of fuel shipment/receipt

Fitness Area Working Groups

- **Facility Infrastructure**
 - Matthew Lund (INL/ former University of Utah)
- **Regulatory Issues**
 - Bruce Meffert (University of Missouri)
- **Utilization & Relevancy**
 - Clive Townsend (Purdue University)
- **Staffing & Knowledge Transfer**
 - Jeff Geuther (Pennsylvania State University)



Path Forward

1. TRTR panel presentation (Sept. 2019)
 - Major issues and proposed solutions
2. NSUF Report to DOE-NE-5 (Dec. 2019)
<https://nsuf.inl.gov/Page/about>
3. Input into NSUF Capabilities Gap Analysis Report (June 2020)
4. Input into FY2021 Consolidated Scientific Infrastructure Support FOA (August 2020)
5. TRTR & DOE actions ...



Survey Results

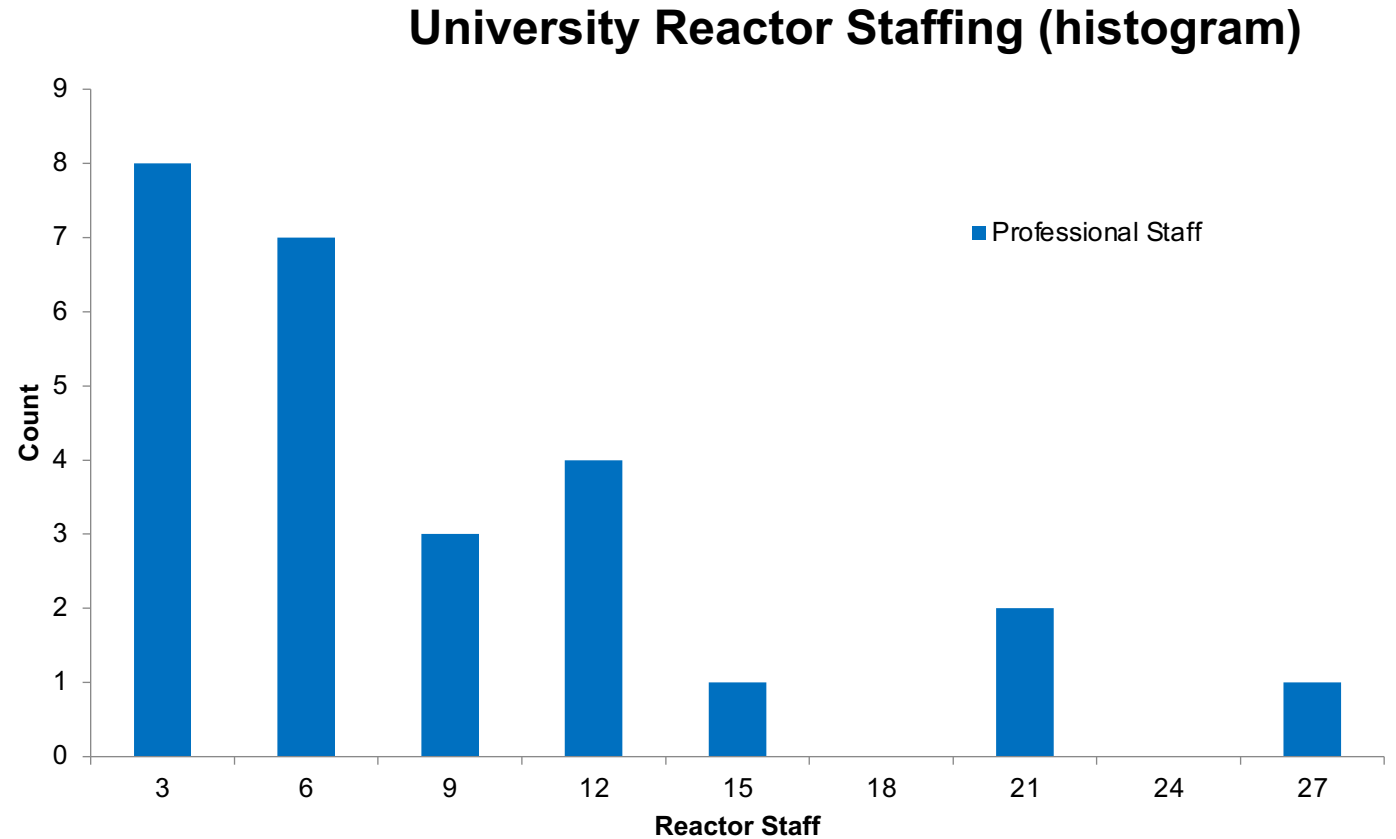
24/25 Universities Provided Data

Survey Questions for Staffing Issues

Staffing Requirements	Number of staff
	% of full-time staff
	% of teaching faculty
	Number of student operators/interns
	Please breakdown your staff members and experience. (e.g., Reactor Director = 22 years, SRO1 = 5 years, electronics technician = 2 years, etc.)
	Provide an estimate of the various time allocations facility staff must put toward education, operations, regulatory compliance, and maintenance.
Staffing Changes	What changes do you see in the coming 3 years for your facility staff?
	What changes do you see in the coming 5 years for your facility staff?
	What changes do you see in the coming 10 years for your facility staff?
Knowledge Transfer	Does your facility have a succession plan?
	Do you have the resources to perform a major licensing action coincident with a major facility update?
	What sort of help could your facility use with respect to staffing and/or knowledge transfer?
	Are you active in the TRTR community? (attendance at TRTR events, etc.)
	Do you plan to receive or ship fuel in the near future?
	Do you have the staff/resources to perform this activity?

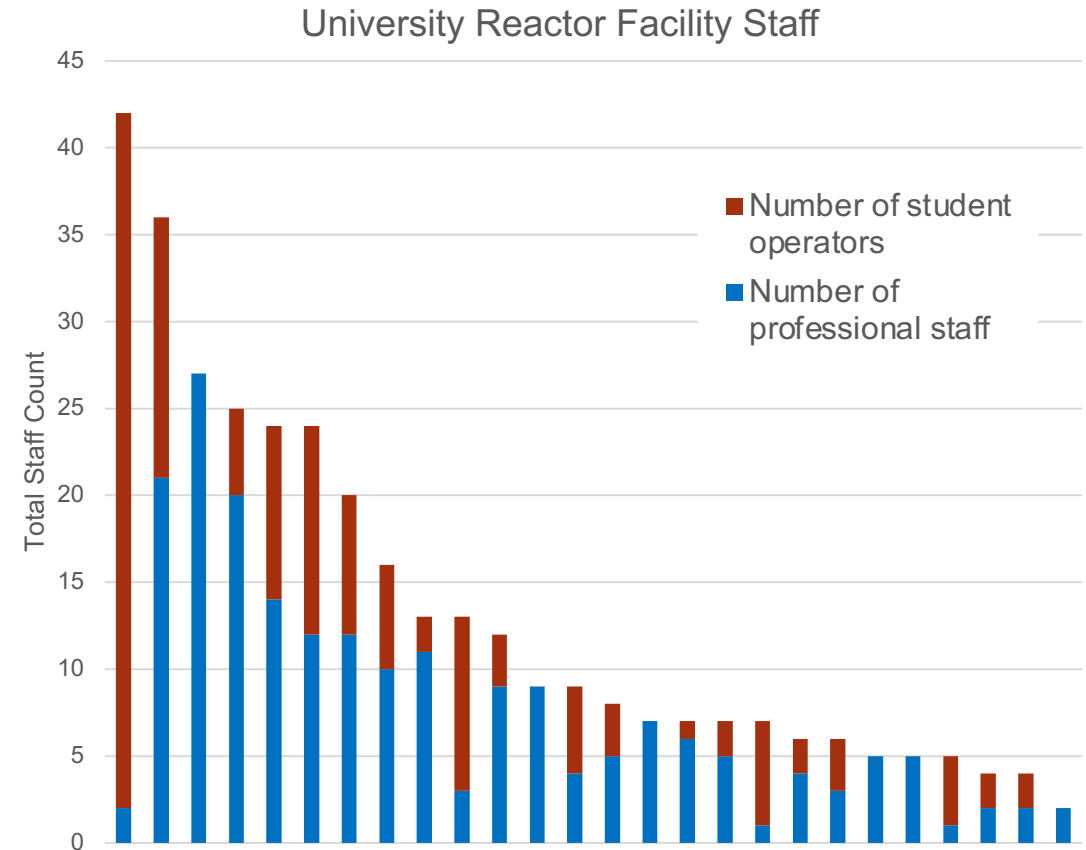
Permanent Staff

- URRs have a variety of missions, and their permanent staff size reflects that.
- Small staffs >50% with 1-6 members have a bigger challenge to accommodate 'extra' work.



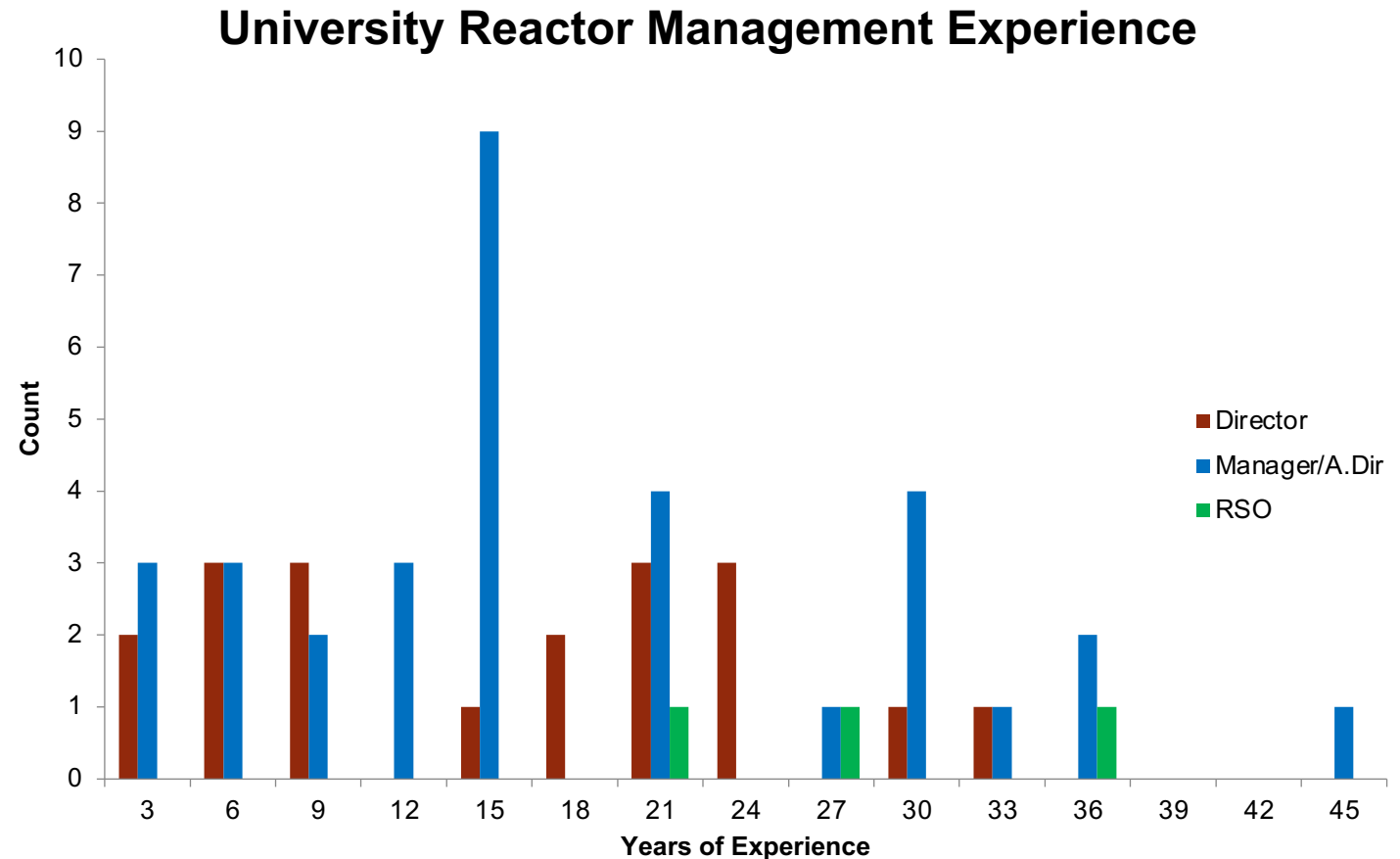
Student Operators/Interns

- Many URRs (75%) employ student operators/interns to supplement their permanent staff.
- Students are helpful, but they are not equivalent to professional staff.
- They have lower ownership of the facility and less time in residence.



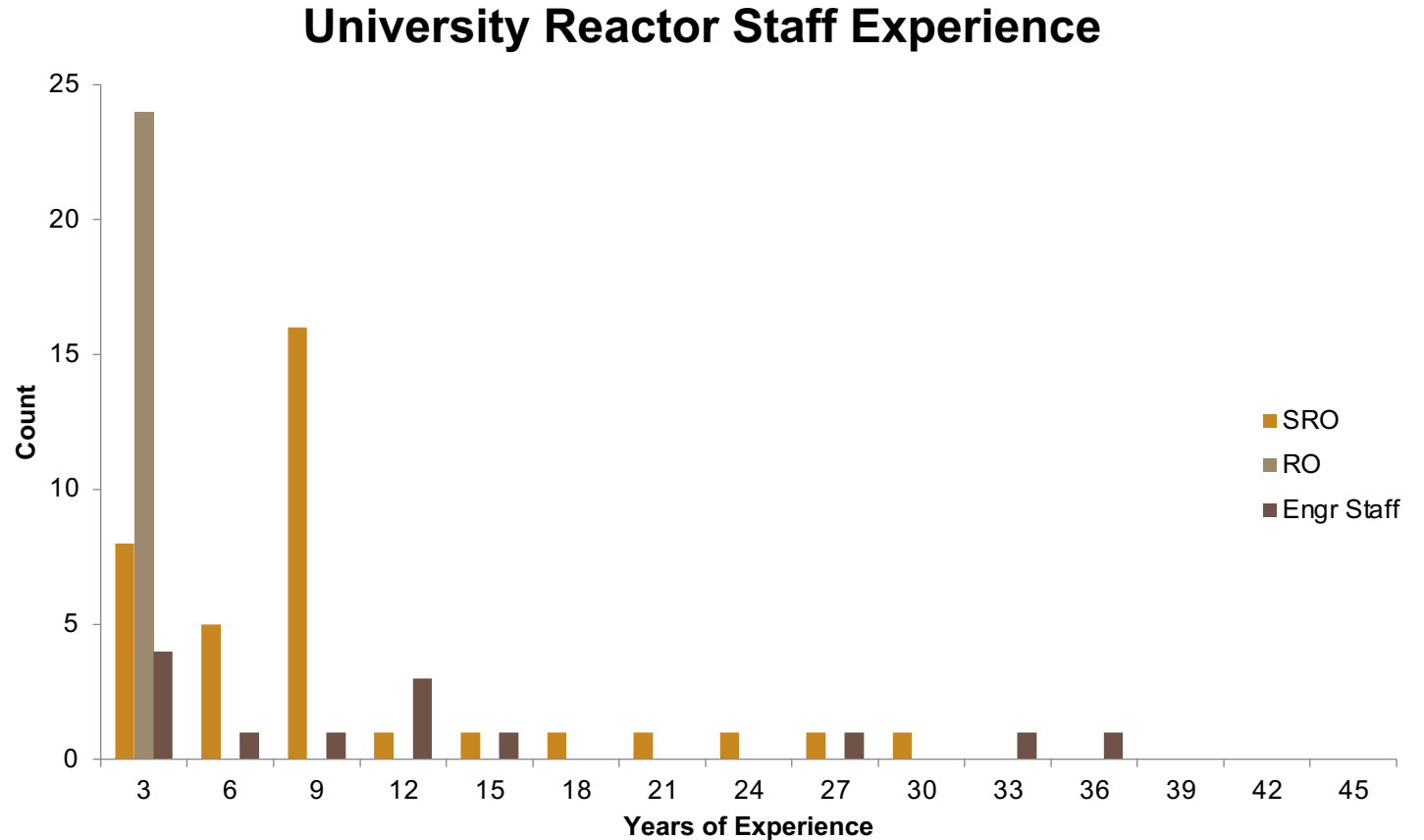
RTR Management Experience

- Managers/Directors have a wide range of experience in the field.
- Long-tenure can have the downside of concentrating knowledge in a few people.



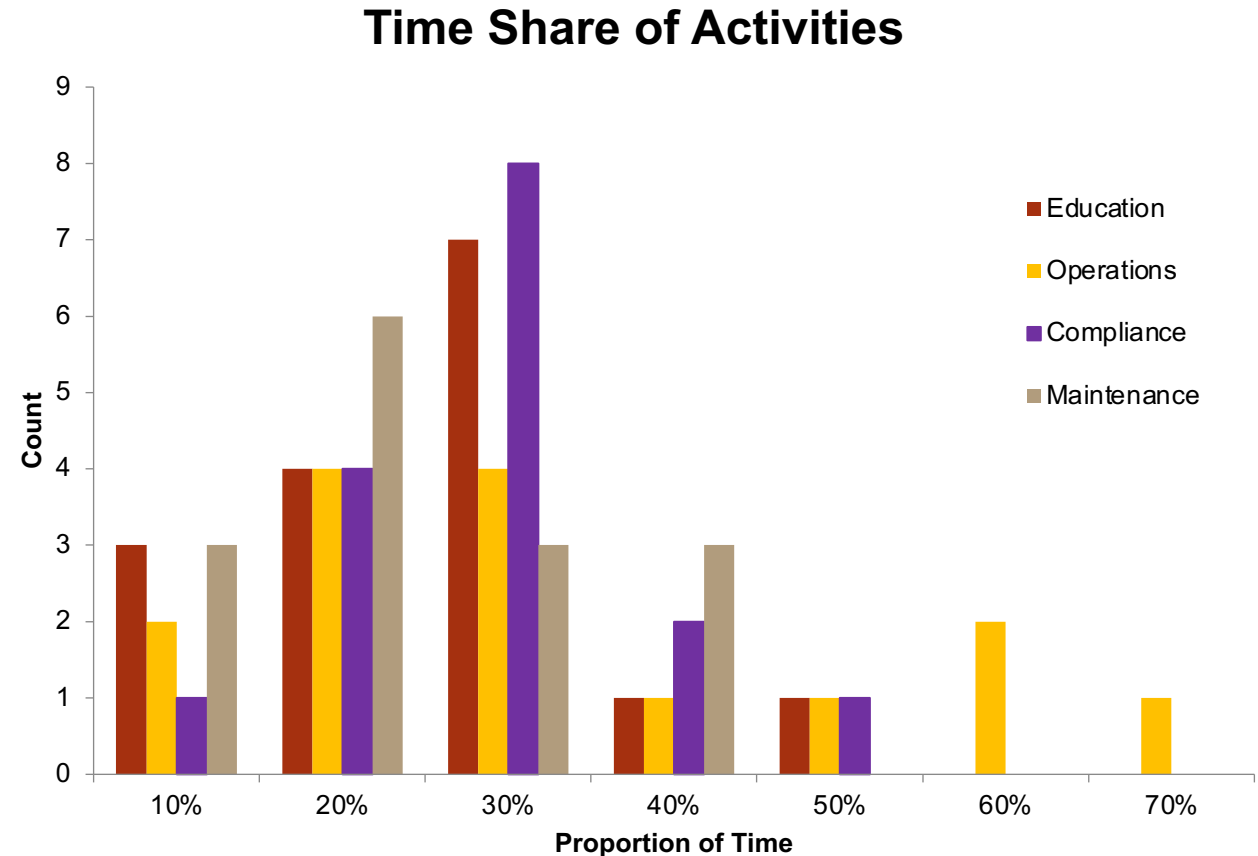
RTR Staff Experience

- URR staff have a lower level of experience than management (expected).
- This could represent a knowledge transfer challenge if there is high turnover.



Staff Time Devoted to Essential Activities

- Missions of URRs are:
 - Research
 - Education
 - Service Work
- Running a facility requires:
 - Operations
 - Compliance
 - Maintenance
- Survey results indicate that URRs are spending (roughly) as much time on each of the required activities as on education.



Staffing Changes Q&A

- What changes do you see in the coming years for your facility staff?

Planning Horizon	Turnover		Staffing Plans		
	Normal Turnover	Loss of Senior Staff	Steady	Increase Operations	Increase Research
3 years out	10	2	2	3	5
5 years out	5	9	3	3	1
10 years out	5	7	1	2	1

Knowledge Transfer Q&A

	Yes	No
Does your facility have a succession plan?	50%	50%
Do you have the resources to perform a major licensing action coincident with a major facility update?	50%	50%
Do you plan to receive or ship fuel in the near future?	50%	50%
Do you have the staff/resources to perform this activity?	75%	25%
Are you active in the TRTR community?	75%	25%

Questions to assess the ability of a URR to handle 'off-normal' but expected activities.

- Have you been planning?
- Can you handle major activities
 - Expansion of capability
 - Unusual activity
- Do you have Community support

What do URRs need?

(Staffing and Knowledge Transfer)

- **Staffing**
 - Full Time staff
 - Student interns
 - Graduate students (Research & Development)
 - Support staff
- **Knowledge**
 - Staff Training
 - SMEs for specific work
- **Collaboration**
 - Shared experiences
 - Lists of SMEs

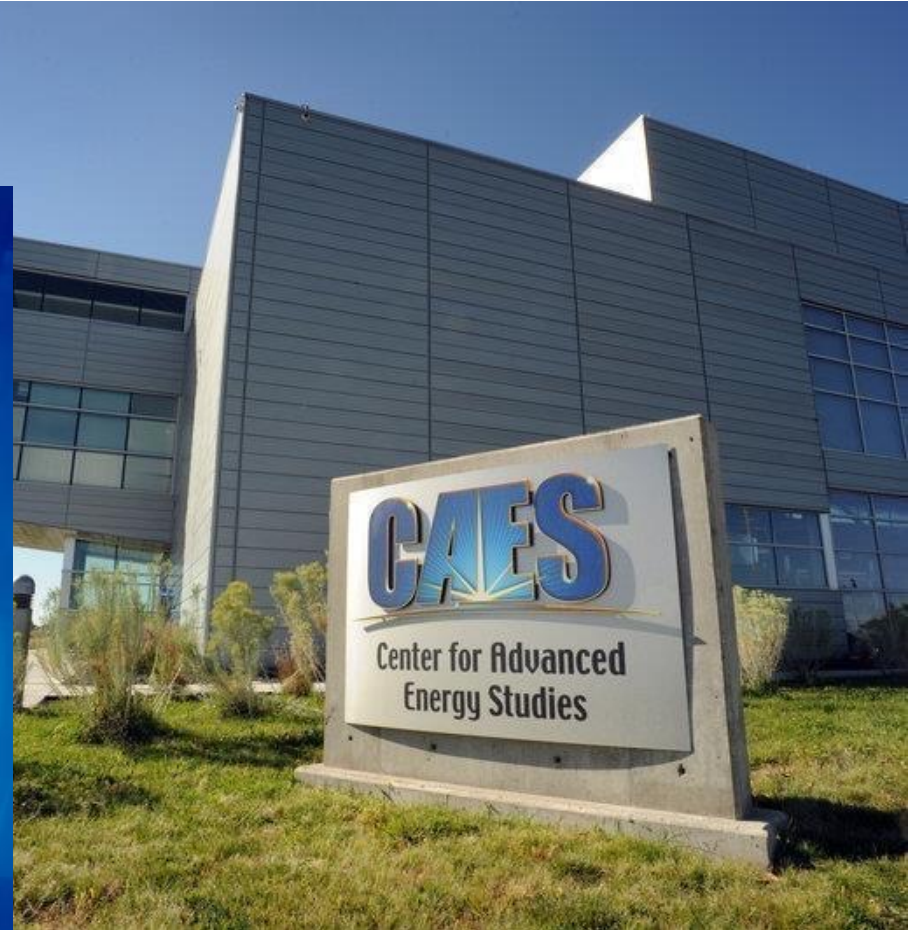
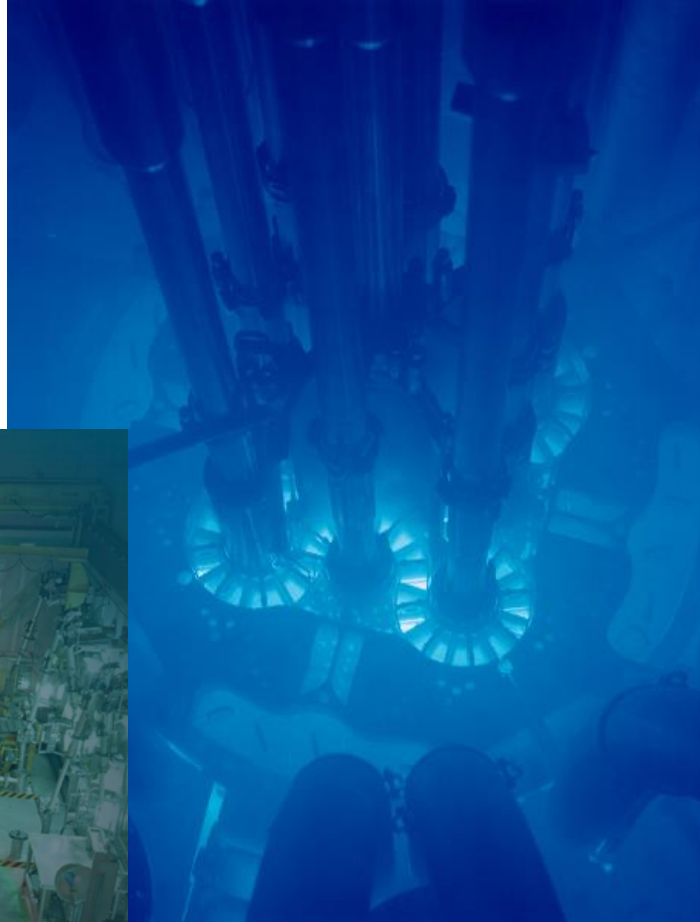
Need	Demand
More full-time staff	High
Funding to support licensing actions and regulatory compliance activities	Med.
More research funding would naturally support more staff	Med.
Funding to support off-site training for staff	Med.
List of SMEs, potential hires, and expertise	Med.
Standardized Safety Analysis Reviews (SARs), Technical Specifications (TS), data bank and analyses, maintenance knowledge for similar reactors	Med.
Continued (increased) infrastructure support to drive expansion of mission	Low
Connections to other facilities	Low
Funding to support student operator training	Low
Additional skilled trades, support engineers	Low

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Guiding Questions for Discussion

1. Do URRs face any particular challenges in hiring new/replacement staff?
 - *Small size of the community, limited pool of experienced staff, e.g.*
2. Many facilities across the US Research or Test Reactor (RTR) community have very small staffs. *A significant problem with the small staff is the loss of knowledge that can happen with a sudden retirement.* What can be done to help to mitigate the loss in knowledge?
 - *Everything costs money and personnel time.*