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Revision 0

Results and Analysis of the Infrastructure Request for Information (DE-SOL-0008318)

Brenden Heidrich

July 2015

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Results and Analysis of the Infrastructure RFI (DE-SOL-0008318)

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July 2015

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SUMMARY

The Department of Energy (DOE) Office of Nuclear Energy (NE) released a request for information (RFI) (DE-SOL-0008318) for "University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments" on April 13, 2015. DOE-NE solicited information on five specific types of capabilities as well as any others suggested by the community. The RFI proposal period closed on June 19, 2015.

From the 26 responses, 34 individual proposals were extracted. Eighteen were associated with a DOE national laboratory, including Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Idaho National Laboratory (INL), Los Alamos National Laboratory (LANL), Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratory (SNL). Oak Ridge National Laboratory (ORNL) was referenced in a proposal as a proposed capability location, although the proposal did not originate with ORNL.

Five US universities submitted proposals (Massachusetts Institute of Technology, Pennsylvania State University, Rensselaer Polytechnic Institute, University of Houston and the University of Michigan). Three industrial/commercial institutions submitted proposals (AREVA NP, Babcock and Wilcox (B&W) and the Electric Power Research Institute (EPRI)).

Eight major themes emerged from the submissions as areas needing additional capability or support for existing capabilities. Two submissions supported multiple areas. The major themes are: Advanced Manufacturing (AM), High Performance Computing (HPC), Ion Irradiation with X-Ray Diagnostics (IIX), Ion Irradiation with TEM Visualization (IIT), Radiochemistry Laboratories (RCL), Test Reactors, Neutron Sources and Critical Facilities (RX) , Sample Preparation and Post-Irradiation Examination (PIE) and Thermal-Hydraulics Test Facilities (THF).

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ACRONYMS

ATR	Advanced Test Reactor
DOE	Department of Energy
DRP	Database Review Panel
FIMS	Facility Information Management System
FY	fiscal year
GIS	Geographical Information System
IAEA	International Atomic Energy Agency
IM	Information Management
INL	Idaho National Laboratory
NE	Nuclear Energy
NEID	Nuclear Energy Infrastructure Database
NSUF	Nuclear Science User Facilities
POC	point of contact
R&D	research and development
RFI	Request for Information

Introduction

The Department of Energy (DOE) Office of Nuclear Energy (NE) released a request for information (RFI) (DE-SOL-0008318) for "University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments" on April 13, 2015. DOE-NE solicited information on five specific types of capabilities as well as any others suggested by the community. The full RFI will be attached as an appendix.

The five specific categories are:

1. Dedicated High Performance Computing Capability;
2. Powder Metallurgy coupled with Hot Isostatic Processing Scale-up Demonstration Facility;
3. In-situ transmission electron microscopy with integrated ion beam irradiation;
4. Low Power Critical Facility;
5. Thermal Hydraulic Test Facility

The RFI posed fourteen questions to better describe the proposed capabilities. The questions were divided into four sections; capability selection, research areas affected, capability location and capability funding support. The questions are summarized below.

Capability Selection

Clearly define your proposed capability and specifically identify why it is a priority for the nuclear energy community. Responses to this section of the RFI should address, but are not limited to:

1. What is the necessary capability and its essential features? If applicable, include manufacturer and model numbers.

2. Does a similar capability exist domestically (or internationally, if appropriate for consideration) and if so, why is additional investment required?

3. If there is an existing capability but it is currently inadequate, could it be refurbished or upgraded to meet the identified need?

4. What is the anticipated utilization of this capability by the host organization and as a user facility? Please specify in hours per year.

5. Why should the proposed capability be a priority investment for DOE-NE?

Research Areas

6. The new capability could be a facility or a specific instrument.

   Please use the following lists to determine the most appropriate category. If the capability does not fit with any of the identified categories, please specify its benefit to nuclear energy research.

Table 1: Capability Categories

Number	Abbreviation	Category
1	ACF	Accelerator Facilities
2	FDF	Fuel Development Facilities
3	HCF	Hot Cell Facilities
4	NBF	Neutron Beam Facilities
5	IPBF	Ion/Gamma Beam Facilities
6	PIE	PIE/Materials
7	RCL	Radiochemistry Lab.
8	RX	Reactor Facilities
9	SPF	Sample Preparation
10	SL	Special Laboratories
11	THF	Thermal-Hydraulic Fac.
12	CH	Chemical Testing
13	GB	Containment (Glove Boxes)
14	DEX	Dimensional Examination
15	EM	Electromagnetic Testing
16	FF	Fuel Fabrication
17	IBI	Ion Beam Instruments
18	MT	Mechanical Testing
19	MS	Microscopes and Detectors
20	NBI	Neutron Beam Instruments
21	PBI	Photon Source Facility Instruments
22	IMG	Radiography/Imaging
23	SPG	Sample Preparation Gear
24	CSK	Shipping Containers (Casks)
25	SPEC	Spectrometry & Spectroscopy
26	SUR	Surface Techniques
27	TT	Thermal Testing
28	XRD	X-ray Diffraction Instruments
29	HPC	High Performance Computing
30	AIN	Advanced Instrumentation
31	INC	NPP Instrumentation and Control
32	AM	Advanced Manufacturing

Note that the original RFI segmented the categories into "facility" (1-11) and "instrument" (12-28). Based on respondent input, four more categories were added (29-32). There are redundant categories in the list. This will be addressed in the data analysis. The abbreviations were also added later to aid in readability of the summary data tables.

7. In terms of relevance to NE's mission, please identify which of the following objectives the proposed capability would support.

Table 2: Office of Nuclear Energy Missions

Number	Abbreviation	Category
1	LWRS	Improve the reliability and performance, sustain the safety and security, and extend the life of current reactors by developing advanced technological solutions.
2	ARC	Meet the Administration's energy security and climate change goals by developing technologies to support the deployment of affordable advanced reactors.
3	FC	Optimize energy and waste generation, safety, and nonproliferation attributes by developing sustainable fuel cycles.
4	RD&D	Enable future nuclear energy options by developing and maintaining an integrated national RD&D framework.
5	INTL	Maintain U.S. leadership at the international level by engaging nations that pursue peaceful uses of nuclear energy.

The abbreviations in Table 2 were added later to aid in readability of the summary data tables.

8. In terms of overall NE-related research, identify which of the following research areas the proposed capability would support.

Table 3: Research Areas Supported by the Proposed Capability

Number	Abbreviation	Category
1	STM	Structural Materials
2	NFL	Nuclear Fuels (including cladding)
3	NSY	Nuclear Systems Design Studies
4	PCS	Power Conversion Systems
5	DRY	Dry Heat Rejection Systems
6	PRO	Process Heat Transport Systems
7	INC	Instrumentation and Controls
8	REC	Material Recovery Processes
9	WST	Waste Forms
10	SST	Safeguards and Security Tech.
11	UNF	Used Fuel Disposition
12	RSK	Safety and Risk Assessment
13	AM	Advanced Manufacturing Technologies
14	SYS	Systems Analysis
15	SDP	Space and Defense Power Systems

The abbreviations in Table 3 were added later to aid in readability of the summary data tables.

Capability Location

9. What type of institution should host this new capability and why?

10. Where should this capability be located and why? Please specify the preferred institution or region(s) as appropriate. Preference should be given to regions with the most need or best synergy with existing capabilities.

Table 4: Capability Location Categories

Category	Definition
University	A US academic institution of higher learning.
National Laboratory	A government-owned contractor-operated entity.
Industry	An entity that is not a University or National Laboratory. This can be a for-profit entity, like a utility or a vendor, or a not-for-profit entity, like EPRI.

Note that Table 4 was not part of the RFI, but created later to aid in the data summary and analysis.

Capability Funding Support

The following questions are specific to the initial investment:

11. What is an estimated cost and schedule for establishing the capability?

12. What costs should DOE bear?

13. What costs should the hosting institution bear?

The following is specific to continued maintenance and operation of the capability:

14. Rank the following options in order of preference.

Table 5: Operations and Maintenance Funding Options

Preference	Annual Funding Support from DOE-NE	Duration (e.g. 5 years, 10 years, permanent)
	Operations and Maintenance Costs to support the capability	
	Pre-pay (or buy) some amount of the usage schedule for DOE-NE programs, ensuring continued operations.	
	Payroll support for operations and maintenance staff for the capability.	
	Provide no-cost or low-cost access to the new capability for non-DOE users (similar to the current NSUF model)	

Data Summary

The RFI proposal period closed on June 19, 2015. At this point, 26 institutions had submitted complete responses. The quality of the responses varied, with only partial adherence to the suggested format supplied in the RFI. In particular, much of the requested cost data was missing, with only nine of 26 respondents supplying both capital and operations cost estimates.

From the 26 responses, 34 individual proposals were extracted. While most respondents proposed one capability per response, three respondents included three, three and five capabilities in their responses. Nine of the 34 proposals suggested support for existing capabilities. Nineteen more proposed support for refitting or construction of specific new facilities. The remaining six proposals were for generic capabilities without specific designs.

Respondents

Of the 26 respondents to the RFI, 18 were associated with a DOE national laboratory, including Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Idaho National Laboratory (INL), Los Alamos National Laboratory (LANL), Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratory (SNL). Oak Ridge National Laboratory (ORNL) was referenced in a proposal as a proposed capability location, although the proposal did not originate with ORNL.

Five US universities submitted proposals (Massachusetts Institute of Technology, Pennsylvania State University, Rensselaer Polytechnic Institute, University of Houston and the University of Michigan). Three industrial/commercial institutions submitted proposals (AREVA NP, Babcock and Wilcox (B&W) and the Electric Power Research Institute (EPRI)).

Proposal Type

The proposals ranged in scope from construction of a completely new facility to the addition of a single instrument at an existing facility. In order to simplify the analysis, the proposals were grouped into four categories, based on the scope. The capital cost upper limits are provided as representations of the data only, not limits based on any other factor. Most categories can include the purchase of instruments as well as provide O&M support following construction.

Table 6: Capital Intensity of Projects

Category	Description	May Include Instruments	May Include O&M Support	Upper Limit [MM$]
New Construction	The project involved substantial new construction, including real estate, buildings, etc.	X	X	4,000
Refit	The project involves reworking of an existing facility. This may be done to facilitate the installation of instruments.	X	X	10
Instrument only	The project involves very minor reworking of an existing facility only for the installation of a new instrument.	X	X	2
O&M Support only	The project involves only funding for continued operation and maintenance costs for the capability.		X	0

Figure 1 shows the distribution of the types of proposed projects. The following Table 7 shows the breakdown in project type by proposing institution type.

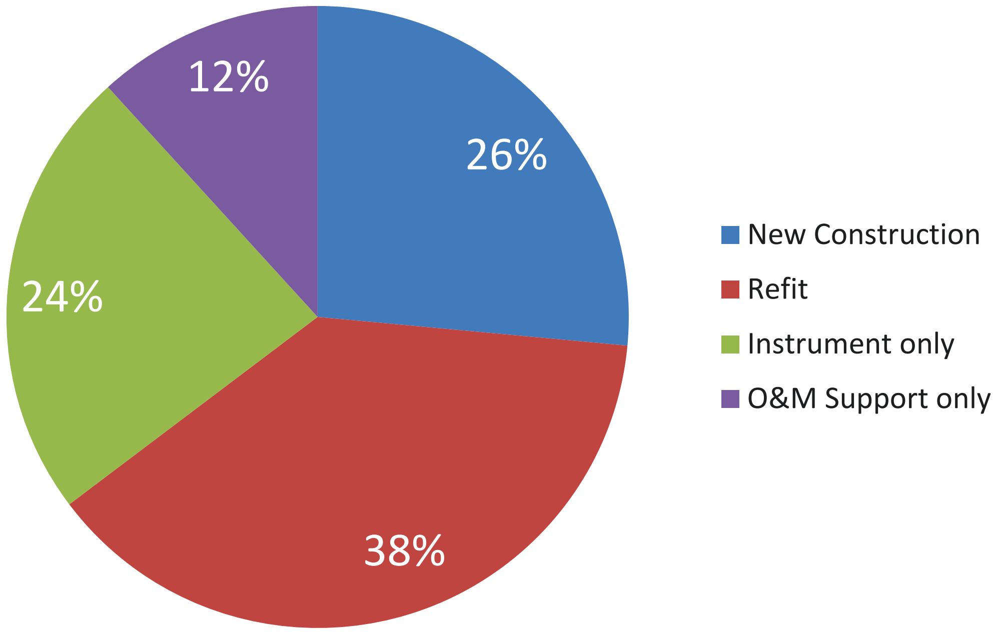

Figure 1: Proposal Type (capital intensity)

Table 7: Proposal Type Filtered by Proposing Institution Type

Institution Type	New Construction	Refit	Instrument	O&M Support
National Laboratories	6	10	4	2
Universities	1	2	4	2
Industry	2	1	0	0
Total	9	13	8	4

Major Themes

Eight major themes emerged from the submissions as areas needing additional capability or support for existing capabilities. Two submissions supported multiple areas. The major themes are shown in Table 8. Note that the number of institutions proposing in a given area is relevant to this RFI only and does not reflect on the general support for a type of capability. The second column in each case shows the percentage of proposals submitted by that institution type (e.g. national laboratory) that were devoted in part or in whole to that capability area. Areas receiving zero submissions were removed from the table to increase readability. Note that there were three proposals that did not group with the others, i.e. they were a specialized individual area.

Table 8: Capability areas Requiring Additional Resources or Continued Support

Capability Area	Institutions Proposing [#/%]					
	National Laboratory		University		Industry	
Advanced Manufacturing (AM)	2	10%			1	33%
High Performance Computing (HPC)	2	10%				
Ion Irradiation with X-Ray Diagnostics (IIX)	3	15%	3	30%		
Ion Irradiation with TEM Visualization (IIT)	3	15%	2	20%		
Radiochemistry Laboratories (RCL)	2	10%				
Test Reactors, Neutron Sources and Critical Facilities (RX)	3	15%	1	10%	1	33%
Sample Preparation and Post-Irradiation Examination (PIE)	4	20%	3	30%		
Thermal-Hydraulics Test Facilities (THF)	1	5%	1	10%	1	33%

Table 9 lists the proposing institutions and the areas they proposed to. The primary proposing institutions were the Argonne National Laboratory (7 proposals) and the Idaho National Laboratory (5 proposals). The national laboratories were split relatively evenly among the functional areas. Universities and commercial institutions tended to focus on specific areas, likely associated with either their specific requirements or their perceived capabilities.

Table 9: Summary Table of Institutions and Proposed Capability Areas

Institution	AM	HPC	IIX	IIT	RCL	RX	PIE	THF	Other
AREVA NP						1			
Argonne National Laboratory		1	1	1	1	1	2		
Babcock & Wilcox								1	
Brookhaven National Laboratory			2			1			
Electric Power Research Institute	1								
Idaho National Laboratory	1	1			1			1	1
Los Alamos National Laboratory			1	1		1	1		
Massachusetts Institute of Technology			1				1		
Pacific Northwest National Laboratory	1						1		1
Pennsylvania State University			1	1		1	2		
Rensselaer Polytechnic Institute								1	
Sandia National Laboratory				1					
University of Houston									1
University of Michigan				1					

Functional Areas (Fine Detail)

Question 6 asked the proposers to pick a primary and secondary functional area for their proposal. Several proposers selected multiple areas, so this analysis only includes the top three choices, at most. Of the 32 possible areas, nine were not chosen by any proposer. Table 10 and Figure 2 show the functional areas that were chosen, ranked from most popular to least popular. The data is also segregated by the total list of choices provided by the proposers as well as by their stated ‘primary’ choice.

Table 10: Summary Table of Functional Areas (Q6)

Name	Abbrev.	Total Count	Total Frequency	Primary Count	Primary Frequency
Accelerator	ACF	10	15.4%	10	31.3%
Microscope	RX	7	10.8%	1	3.1%
Reactor	SPF	5	7.7%	5	15.6%
Post-Irradiation Examination	PIE	5	7.7%	2	6.3%
Sample Preparation	THF	4	6.2%	3	9.4%
Thermal-Hydraulic	HPC	4	6.2%	2	6.3%
Ion/Photon Beam Facility	FDF	4	6.2%	1	3.1%
Fuel Development	HCF	3	4.6%	1	3.1%
Ion Beam Instrument	NBF	3	4.6%	0	0.0%
High-Performance Computing	IPBF	2	3.1%	2	6.3%
Hot Cell Facility	RCL	2	3.1%	1	3.1%
Neutron Beam Facility	CH	2	3.1%	1	3.1%
Radio-chemistry Laboratory	MS	2	3.1%	1	3.1%
Chemical Testing	PSI	2	3.1%	1	3.1%
Mechanical Testing	CSK	2	3.1%	0	0.0%
Photon Beam Instrument	AIN	1	1.5%	1	3.1%
Shipping Cask (UNF)	AM	1	1.5%	1	3.1%
Advanced Instrumentation	DEX	1	1.5%	1	3.1%
Advanced Manufacturing	FF	1	1.5%	1	3.1%
Dimensional Examination	IBI	1	1.5%	0	0.0%
Fuel Fabrication	MT	1	1.5%	0	0.0%
Thermal Testing	TT	1	1.5%	0	0.0%
NPP I&C	INC	1	1.5%	0	0.0%

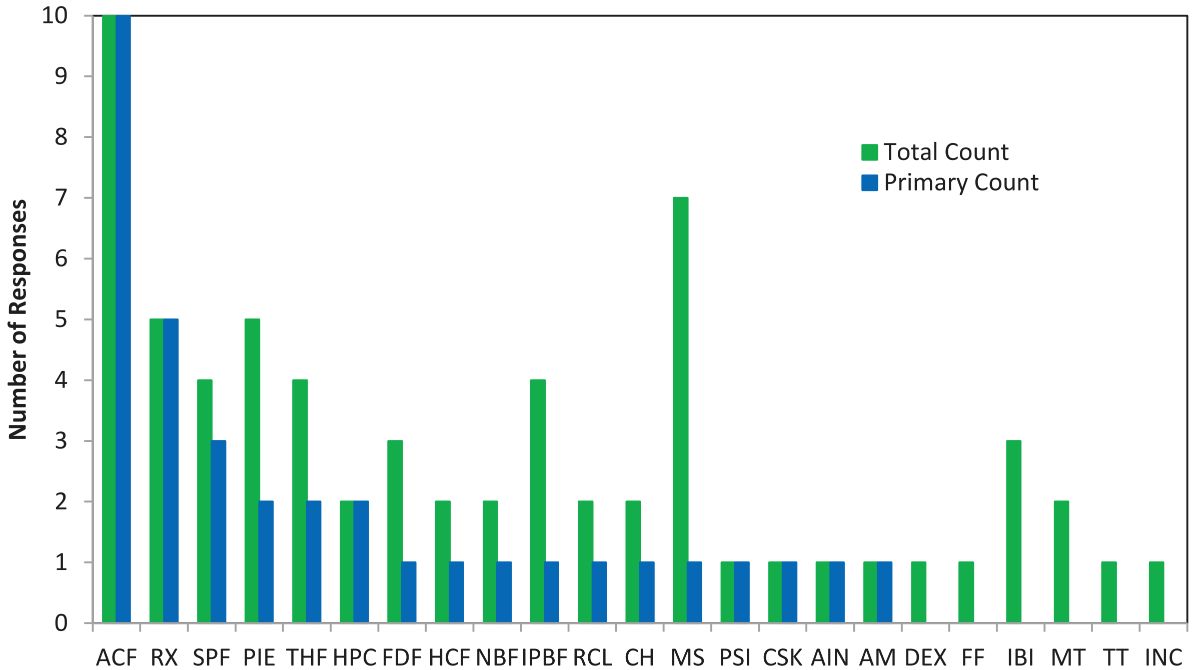

Figure 2: Distribution of Functional Areas listed in RFI Reponses (Q6)

Figure 3 presents the same data from a different point of view. The plot shows the percentage of all proposals that listed a given functional area.

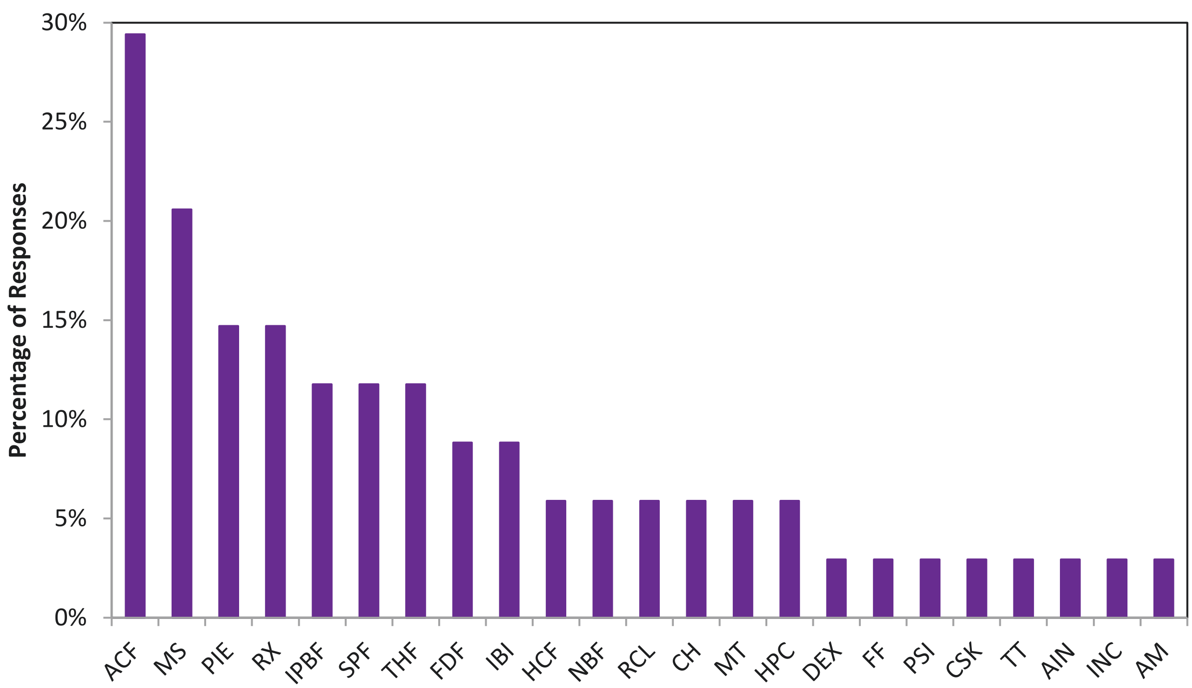

Figure 3: Percentage of Proposals that Included each Functional Area (Q6)

It can be seen that there are nearly as many categories as RFI responses, so the data is sparse in some areas. In order to get a better handle on the data, the 23 categories containing responses were condensed into 12 combined functional areas that include both the facility and instrumentation fields. Table 11 and Figures 4 and 5 mirror Table 10 and Figures 2 and 3 for the combined functional areas.

Table 11: Summary Table of Combined Functional Areas (Q6)

Name	Abbrev.	Total Count	Total Frequency	Primary Count	Primary Frequency
Ion/Photon Beam Facility	IPBF	20	31%	13	38%
Materials Examination	MatEx	15	23%	6	18%
Reactor	MS	5	8%	5	15%
Radio-chemistry Laboratory	RX	4	6%	2	6%
Thermal-Hydraulic	FDF	4	6%	2	6%
High-Performance Computing	RCL	2	3%	2	6%
Microscope	THF	7	11%	1	3%
Fuel Development	HPC	4	6%	1	3%
Advanced Instrumentation	AIN	1	2%	1	3%
Advanced Manufacturing	AM	1	2%	1	3%
Shipping Cask (UNF)	INC	1	2%	1	3%
NPP I&C	CSK	1	2%	0	0%
Concrete and Seismic	CON	1	2%	1	3%

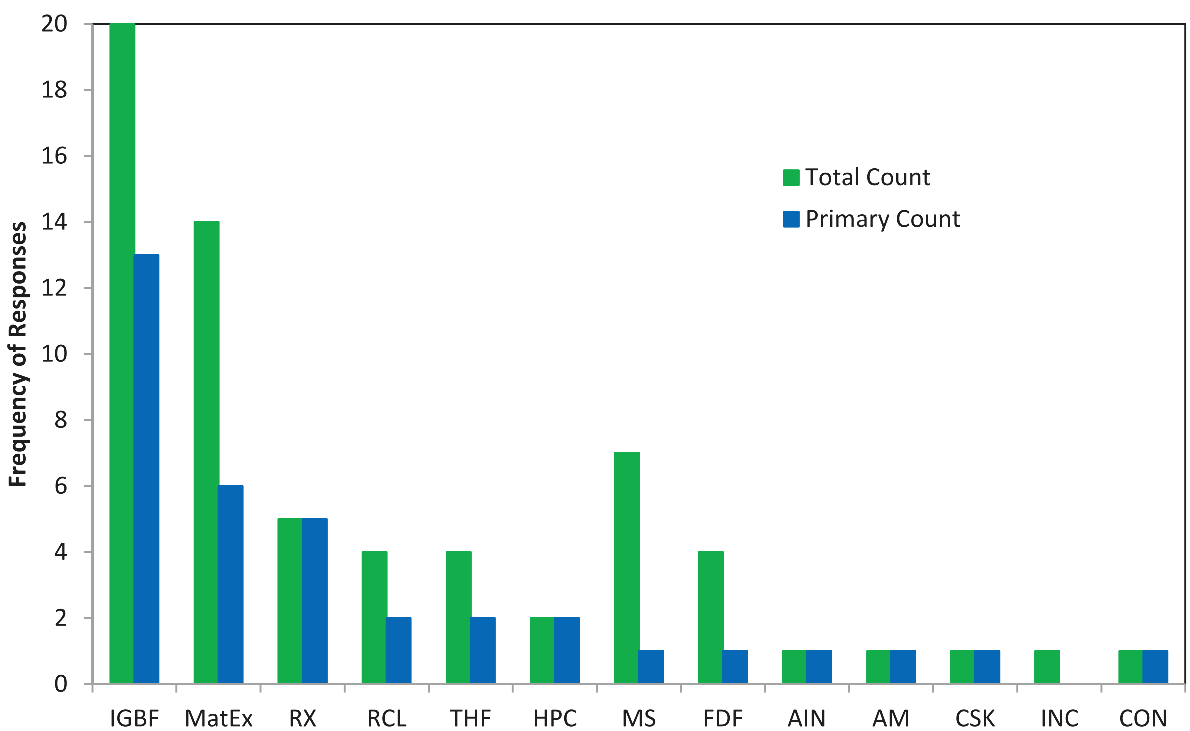

Figure 4: Distribution of Combined Functional Areas listed in RFI Reponses (Q6)

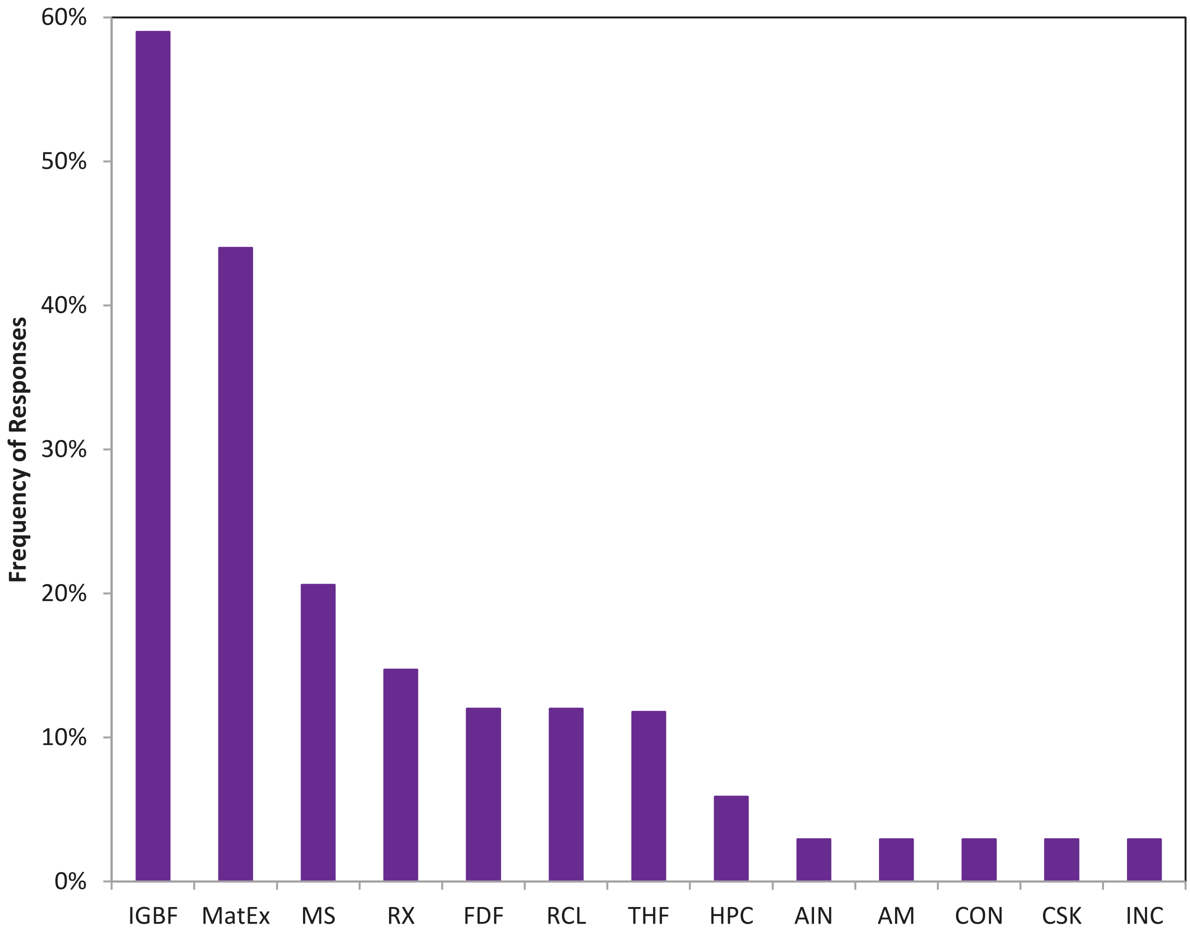

Figure 5: Percentage of Proposals that Included each Combined Functional Area (Q6)

Application to NE Missions

Question 7 asked the respondents to state where their proposed facility would fit into the larger set of NE missions. They were asked to choose a primary and a secondary mission that was supported by their proposed capability. There was a variety in the quality of response, so only the top three choices were recorded here. Table 12 summarizes the data from the respondents and Figures 6 and 7 show the distribution of all claims and primary mission support claims as well as the percentage of proposals that referenced each of the NE missions.

Table 12: Summary Table of Responses to Office of Nuclear Energy Missions (Q7)

Name	#	Total Count	Total Frequency	Primary Count	Primary Frequency

LWRS	1	25	26%	20	59%
ARC	2	24	25%	6	18%
FC	3	17	18%	3	9%
RD&D	4	24	25%	5	15%
INTL	5	6	6%	0	0%

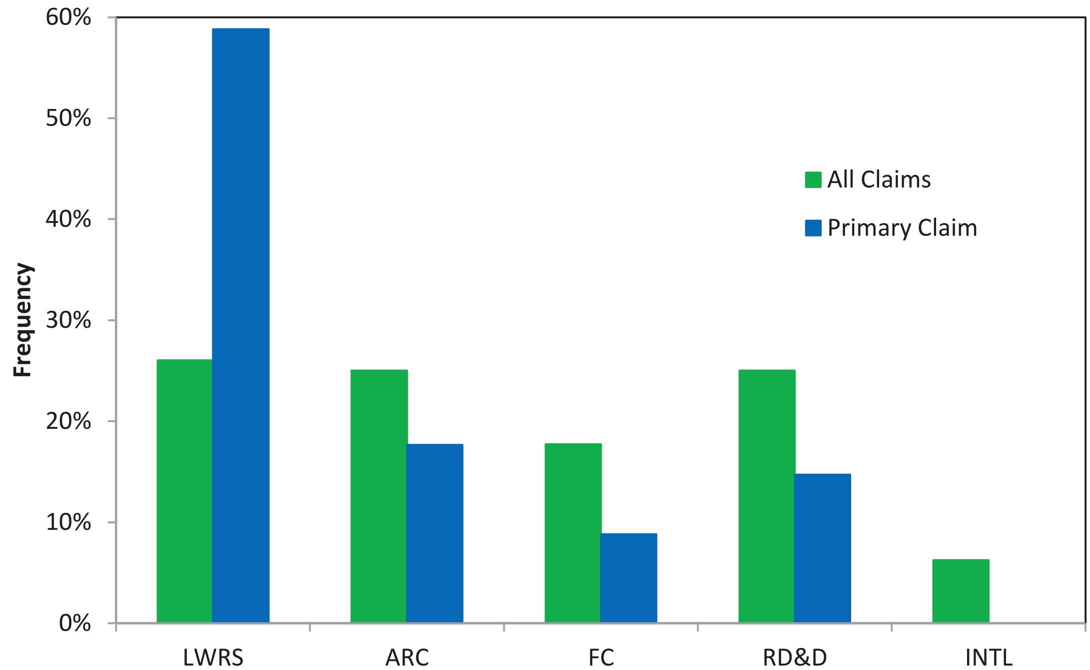

Figure 6: Distribution of NE Missions listed in RFI Reponses (Q7)

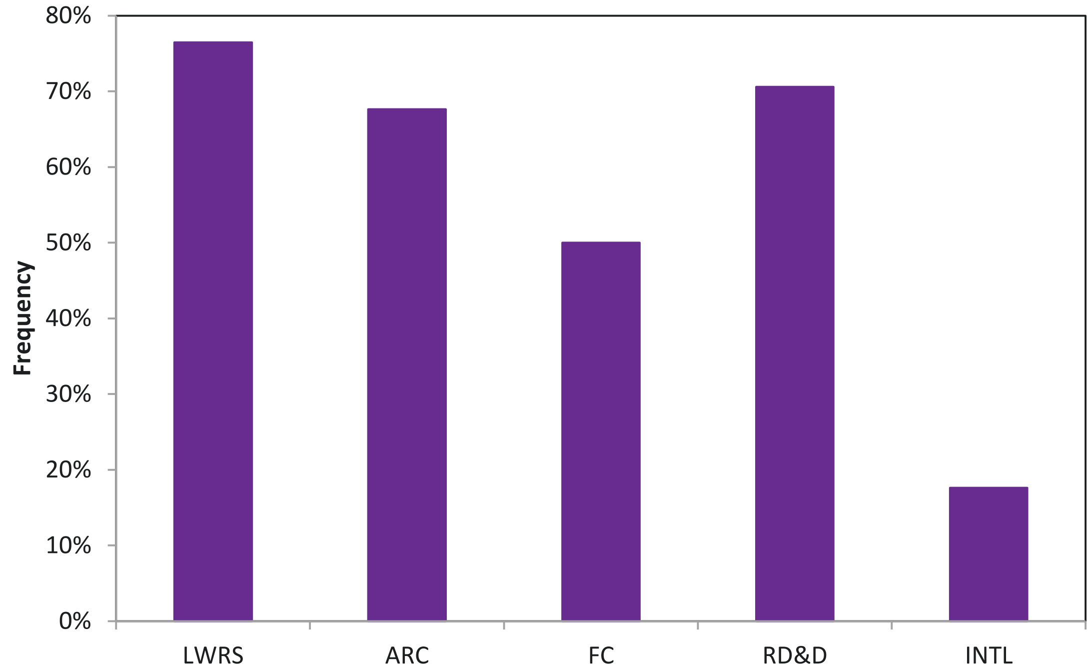

Figure 7: Percentage of Proposals that Included each NE Mission (Q7)

NE Research Areas

Question 8 asked the respondents to state which NE research areas would be supported by their proposed capability. The respondents were expected to choose two areas, many supplied more, so the top three, at most, were included in this analysis. Table 13 lists the data for each R&D area by total count as well as by primary choice. Figure 8 shows the distribution of choices for each area and Figure 9 shows the frequency of a particular R&D area appearing in any proposal.

Table 13: Summary Table of Responses for NE R&D Areas (Q8)

Research Area	Abbrev.	Total Count	Total Frequency	Primary Count	Primary Frequency
Structural Materials	STM	23	25%	21	62%
Nuclear Fuels (including cladding)	NFL	25	27%	5	15%
Nuclear Systems Design Studies	NSY	9	10%	3	9%
Material Recovery Processes	REC	2	2%	2	6%
Advanced Manufacturing Technologies	AM	2	2%	1	3%
Instrumentation and Controls	INC	4	4%	1	3%
Used Fuel Disposition	UNF	5	5%	1	3%
Dry Heat Rejection Systems	DRY	1	1%		
Power Conversion Systems	PCS	1	1%		

Process Heat Transport Systems	PRO	2	2%	
Safeguards and Security Tech.	SST	4	4%	
Safety and Risk Assessment	RSK	5	5%	
Space and Defense Power Systems	SDP	1	1%	
Systems Analysis	SYS	1	1%	
Waste Forms	WST	7	8%	

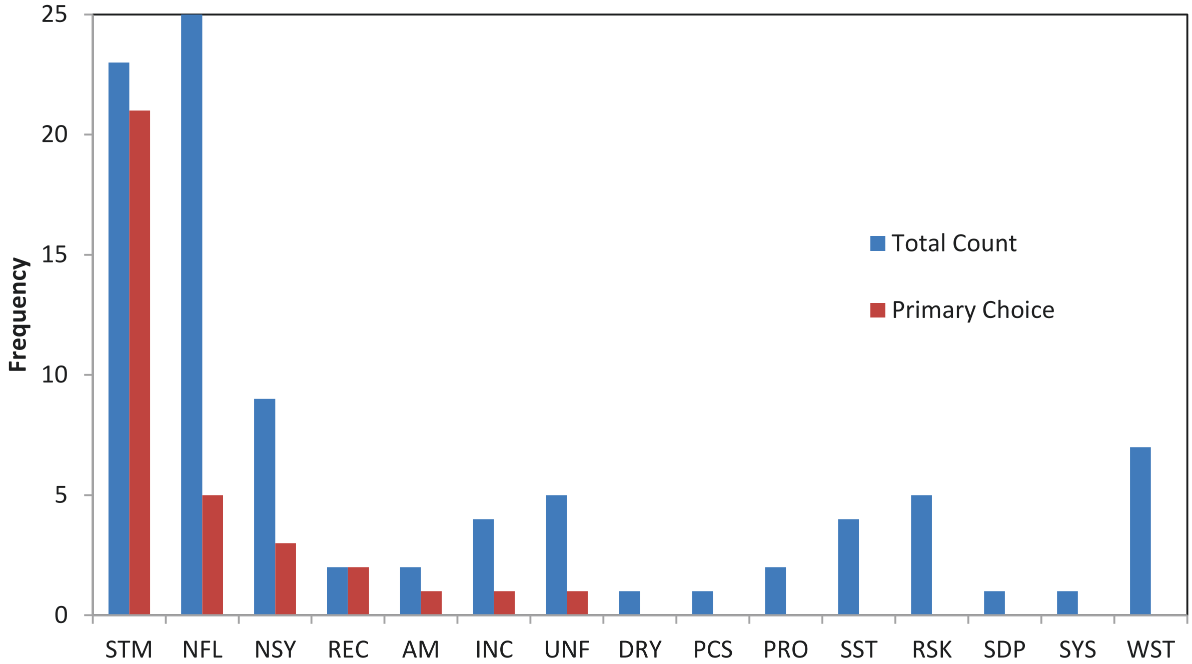

Figure 8: Distribution of NE R&D Areas listed in RFI Reponses (Q8)

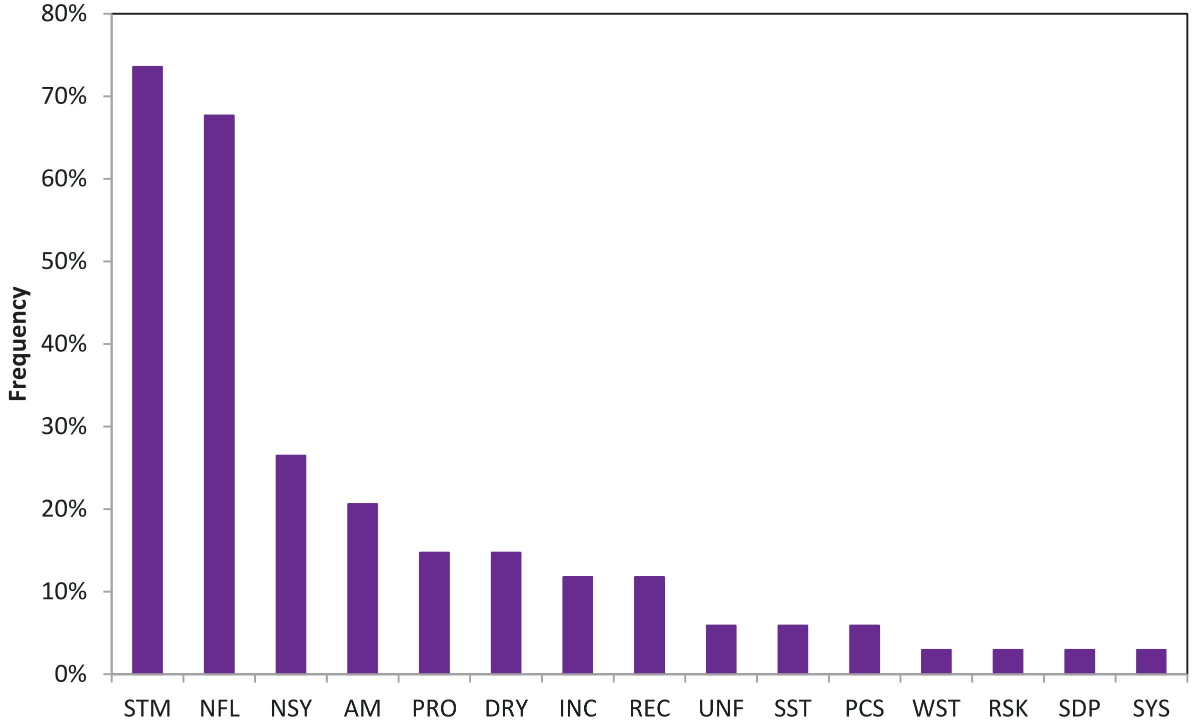

Figure 9: Percentage of Proposals that Included each NE R&D Area (Q8)

Hosting Location

Questions 9 and 10 asked the respondents to propose a location for the new capability. Many of the proposals referenced facilities that already existed (32%) or would be built onto existing facilities (29%). These were, by design, at the proposer's institution. The remaining 39% could be built at any suitable site. Figure 10 shows the type of proposed hosting institution and Figure 11 breaks this down further to the specific location.

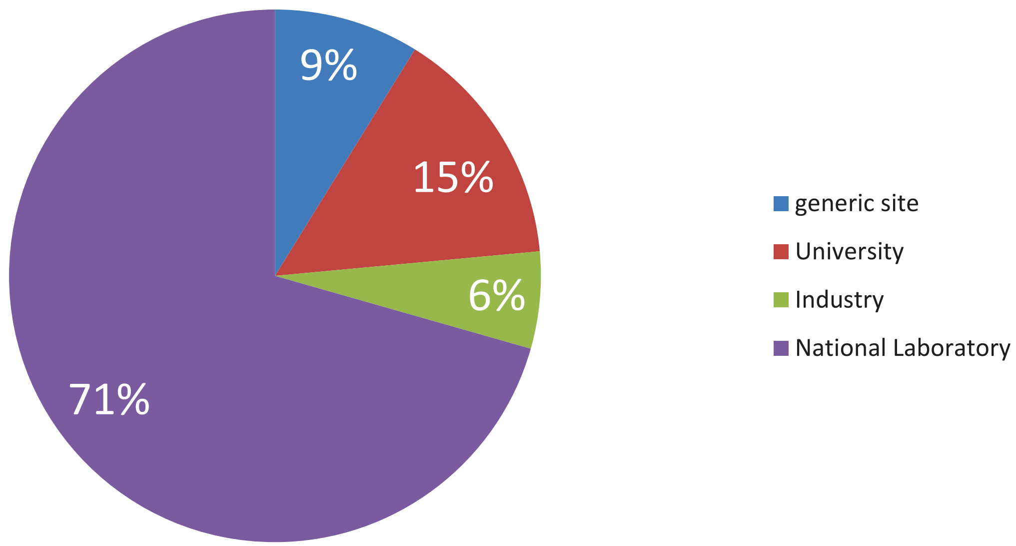

Figure 10: Distribution of Hosting Institution Types (Q9)

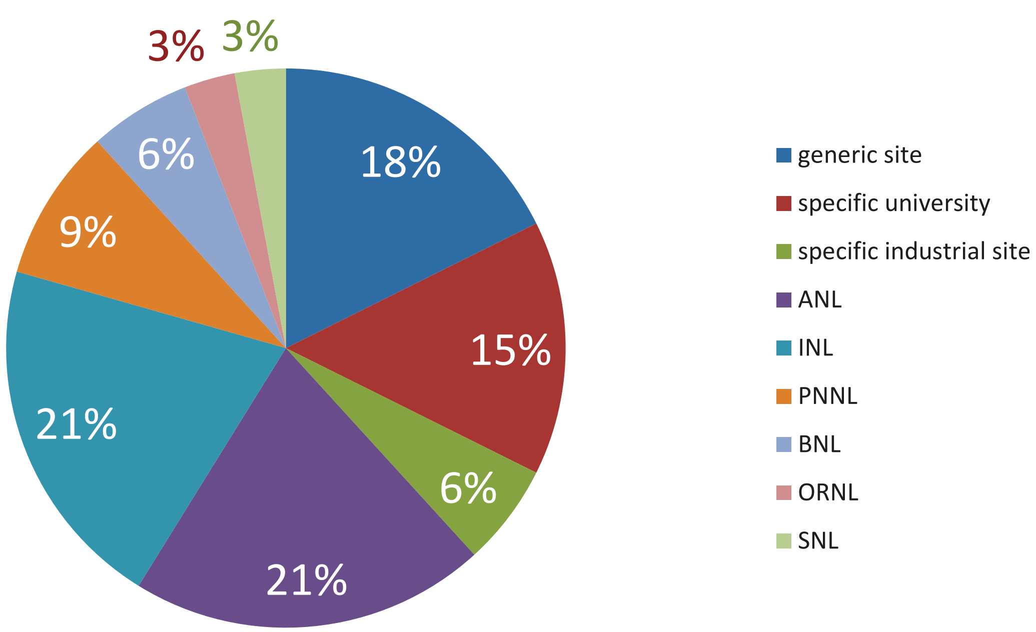

Figure 11: Specific Hosting Institutions (Q10)

Capital Costs

Question 11 asked the respondents to estimate the capital (construction) costs and schedule for the proposed capability. Since the cost of a new project may be difficult to determine without a specific study, only 28 of 34 proposals supplied estimated capital costs and construction schedules. The estimates varied over a large range, in concert with the wide variation in projects. The largest projects proposed were for a new test reactor, with the cost estimated at 2-4 billion dollars and construction estimated at 10-20 years. The lowest costs were for 'instrument only' projects at $500,000 and a 1-2 year schedule.

Questions 12 and 13 asked the respondents to propose the cost share between DOE-NE and the proposing institution. In almost all cases, DOE-NE was expected to take the entire cost of the project. Two notable exceptions were the EPRI ATLAS project and the MIT Nuclear Materials Center project. In both cases, the hosting institution would assume the cost of the building to house the capability, which was estimated at 50% of the project capital cost. The University of Houston proposes accepting 20% of the capital cost of the Impact Test Machine for their containment test facility upgrade.

Table 14 shows the summary data as well as a calculated cost to DOE-NE per year of construction. In the case where a range of values was supplied (e.g. 2-4 billion dollars and 10-20 years) the middle of the range was selected for the analysis (3 billion dollars and 15 years). Figure 12 shows the histogram of the DOE-NE share of capital costs and Figure 13 shows the histogram of the annual outlay for capital costs. The estimates for the test reactor proposals are left out of the remaining analyses.

Table 14: Summary Table of Responses for Capital Cost Estimates (Q11)

11. Capital Cost [MM$]	11. Construction Time [years]	12. DOE-NE Cost Share	Capital Intensity	Cost per Year to DOE-NE
$3,000.00	15	100%	New Construction	$200.00
$3,000.00	15	100%	New Construction	$200.00
$100.00	5	50%	New Construction	$10.00
$100.00	2	50%	New Construction	$25.00
$36.00	4	100%	New Construction	$9.00
$32.00	4	100%	New Construction	$8.00
$27.40	3	100%	New Construction	$9.13
$21.00	7	100%	New Construction	$3.00
$9.00	5	100%	Refit	$1.80
$7.50	3	100%	Refit	$2.50
$5.00	2	100%	Refit	$2.50
$2.50	2	100%	Refit	$1.25
$2.00	2	100%	Refit	$1.00
$1.20	1	100%	Refit	$1.20
$1.10	1	100%	Instrument only	$1.10
$1.00	1	100%	Instrument only	$1.00

$1.00	1	100%	Refit	$1.00
$1.00	1	100%	Refit	$1.00
$0.50	1	80%	Instrument only	$0.40
$0.50	2	100%	Instrument only	$0.25
$0.50	2	100%	Instrument only	$0.25
$0.40	1	100%	O&M only	$0.40
$0.00	0	0%	O&M only	$0.00
$0.00	0	0%	O&M only	$0.00
$0.00	0	0%	O&M only	$0.00
$0.00	0	100%	Refit	$0.00
$0.00	0	0%	Refit	$0.00
$0.00	0	0%	Refit	$0.00
unknown	unknown	100%	Instrument only	
unknown	unknown	100%	Instrument only	
unknown	unknown	100%	Instrument only	
unknown	unknown	100%	New Construction	
unknown	unknown	100%	Refit	
unknown	unknown	100%	Refit	

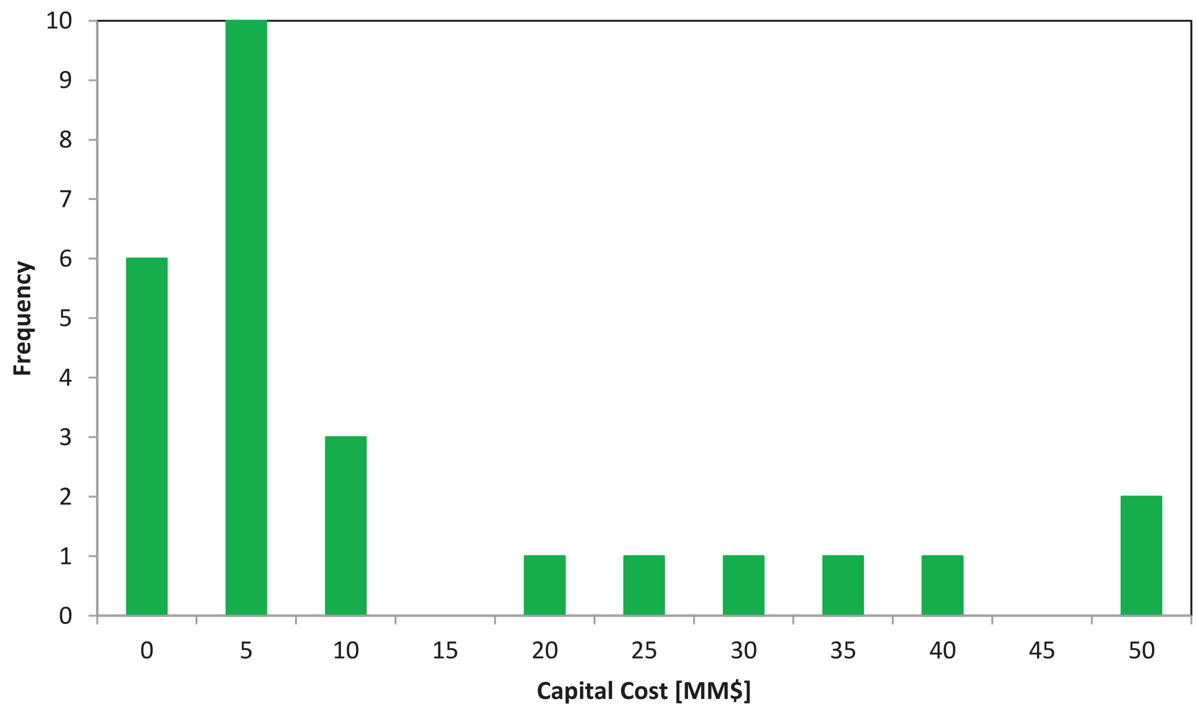

Figure 12: DOE-NE Share of Proposed Capital Costs (Q11-12)

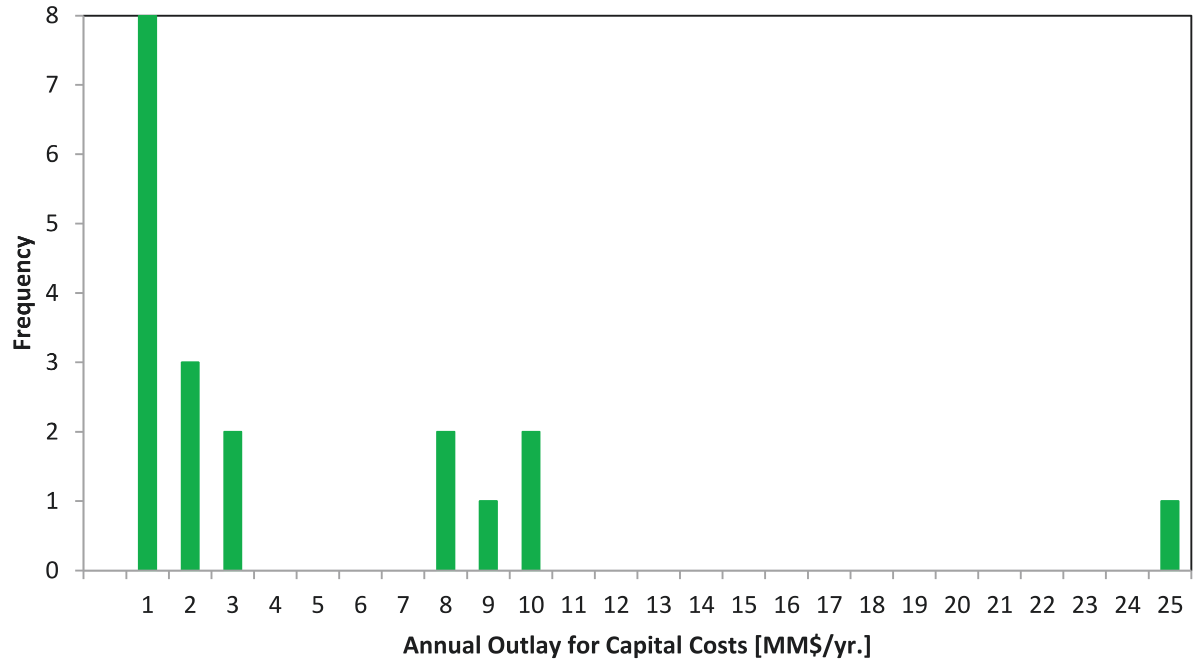

Figure 13: Annualized DOE-NE Share of Proposed Capital Costs (Q11-12)

Operating Costs

Question 14 built upon the previous three questions and asked the respondents to estimate the operating cost for the proposed capability and the proposed support structure from DOE-NE. Only 13 of 34 proposals supplied estimated operations and maintenance (O&M) costs. The estimates varied over a large range, in concert with the wide variation in projects. There is likely a high level of uncertainty in these cost estimates. Table 15 shows the distribution of the first and second funding choices proposed for the new capabilities.

Table 15: Summary Table of O&M Funding Option Choices

Option	Annual Funding Support from DOE-NE	First Choice	Second Choice
1	Operations and Maintenance Costs to support the capability	59%	9%
2	Pre-pay some amount of the usage schedule for DOE-NE programs, ensuring continued operations.	3%	15%
3	Payroll support for operations and maintenance staff for the capability.	3%	12%
4	Provide no-cost or low-cost access to the new capability for non-DOE users (similar to the current NSUF model)	18%	18%

no choice	18%	47%

Table 16 shows the distribution of alternatives suggested by respondents to cover O&M costs. While full coverage of costs is preferred by most respondents, the NSUF option (#4) is still strongly supported as an alternative.

Table 16: Distribution of Second Choice (Next Best Option) Funding Options

		Second Choice				
		1	**2**	**3**	**4**	**No Choice**
First Choice	**1**		15%	15%	30%	40%
	2	100%				
	3		100%			
	4	25%	13%	38%		25%

Annual Cost Scenarios

The combination of construction cost and schedules and O&M costs can produce an estimated set of cash-flow requirements for DOE-NE over the life of the proposed projects. Unfortunately, only nine of 34 (26%) proposed projects supplied both capital and O&M cost estimates. These estimates are likely highly uncertain in any case. Table 17 and Figures 14-16 show estimated annual costs for the 24 unique capabilities described in the responses to the RFI. Note that the two test reactor proposals and the novel neutron source proposal were omitted due to the uncertainty and very large scope. Three instrument proposals supplied no cost data of any kind. Additionally, four proposals supported capabilities described in the remaining 24, so they were redundant in terms of this analysis.

The cells in Table 17 that are brown represent capital cost annualized over the expected construction period. The costs are distributed evenly each year for simplicity. The blue cells represent an O&M cost as estimated by the respondent. Violet cells represent O&M costs that were not provided by the respondent, but were estimated as: 2.5MM$/year for large facilities, 1.0MM$/year for smaller facilities and 0.5MM$/year for instrument support. TREAT support is set at 1MM$/year since it will have many channels supplying support funding. The table and plots run for 12 years, which is five years past the longest construction time (seven years estimated for the SUNRISE facility).

Figures 14-16 plot the annualized costs over twelve years for high, medium and lower cost projects.

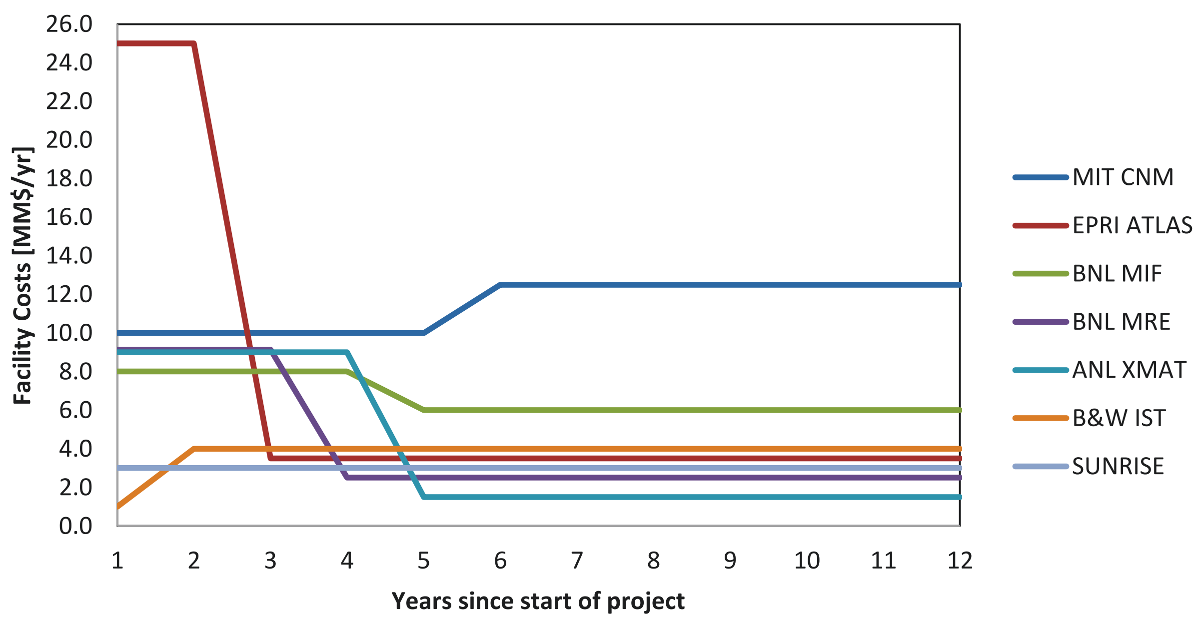

Figure 14: Annualized Facility Costs (Capital + O&M) for higher cost projects

Table 17: Annualized Total Project Costs (estimated)

Project Abbreviation	Years Since Start of Project											
	1	2	3	4	5	6	7	8	9	10	11	12
EPRI ATLAS	25.00	25.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
MIT CNM	10.00	10.00	10.00	10.00	10.00	12.50	12.50	12.50	12.50	12.50	12.50	12.50
BNL MRE	9.13	9.13	9.13	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
ANL XMAT	9.00	9.00	9.00	9.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
BNL MIF	8.00	8.00	8.00	8.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
SUNRISE	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
INL AutoClv	2.50	2.50	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
INL ARTIST	2.50	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ANL RCF	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
INL HPC	1.80	1.80	1.80	1.80	1.80	2.00	2.00	2.00	2.00	2.00	2.00	2.00
PNNL SPF	1.25	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
INL RadioL	1.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IVEM	1.10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ANL HPC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B&W IST	1.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
PNNL Cask	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PSU TREAT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ANL FIB	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
ANL IML	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SNL IBL	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PNNL Cryo	0.40	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Houston ITM	0.40	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Michigan TEM	0.25	0.25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
RPI PPA	0.25	0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50

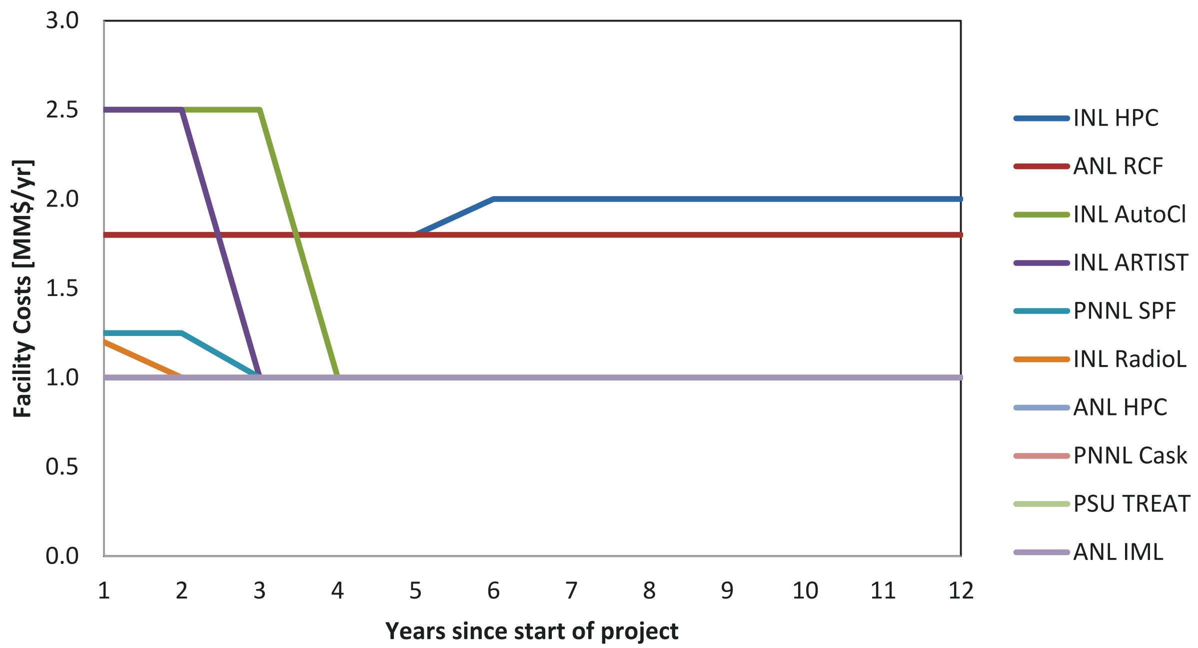

Figure 15: Annualized Facility Costs (Capital + O&M) for medium cost projects

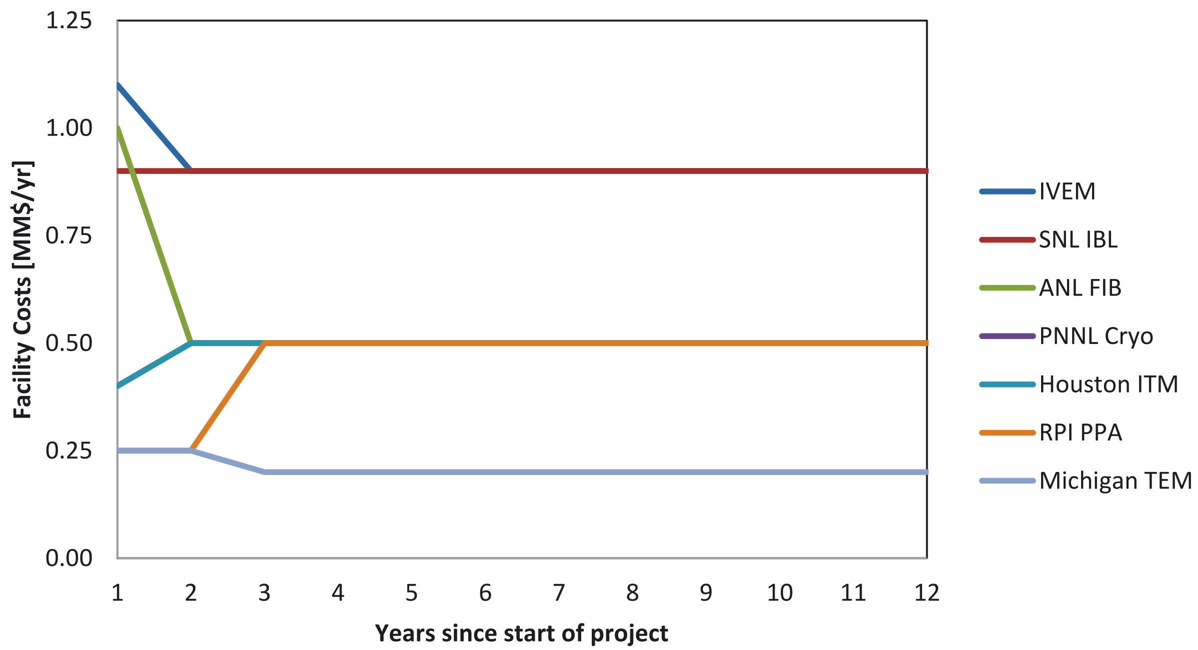

Figure 16: Annualized Facility Costs (Capital + O&M) for lower cost projects

Appendix 1: Summary data table for all proposals

University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments

Tracking ID	Institution	Capability Selection					Research Area					Capability Location		Funding Support			
		Cap.	Similar Cap. Exist	Upgrade to Existing	Utilization	Prior.	Facility	Instrue.	Primary	Second.	Research Area	Type of Instit.	Where	Cost & Schedule	O&M Costs	DOE Costs	Host Costs
RFI-IN--9614	Houston	Containment impact tester	similar at Univ. of Toronto, but less capable	this is an add-on to the existing containment tester	unknown	required for new construction IAW 10CFR50	PM	MT	ART	LWRS	ST, SF, RSK	UNIV	University of Houston	0.5MM$/1 year	unknown	80% of capital costs (0.4MM$) then full O&M costs	20% of capital costs
RFI-IN--9617	B&W	SMR Test Bed, including control room	nothing as complete in US (13 other similar)	no	3840 hrs./yr. for test loop & 1760 hrs./yr. for control room	facility is built, need to restart and support, flexible and PWR conditions	THF	INC	LWRS	ART	SY, INC, PRO	COMM	CAER, VA	1.0MM$/1 year	4MM$/year	Funds for restart and 100% of O&M for 10 years	Management costs of facility
RFI-IN--9618	BNL	Accelerator-based testing of Radioactive Materials	Few, all with non-NE missions	this is a refurbishment of an existing facility	expected to be high, tied to NSLS-II operations	Better than any existing facilities due to the higher energy ions	AF	PM	LWRS	R&D	ST, NF, SY	NL	BNL	32MM$/4 years	6MM$/year	100% of O&M permanent	share resources including proton accelerator
RFI-IN--9624	SNL	Ion Beam Lab and coupled TEM	IVEM in US, Michigan soon, JANNUS (FR) others in EU and JP	this facility is on-line already	50% of available time could go to NE	Best facility of this type. Easily accessed, already built.	AF	MS	LWRS	ART	ST, NF, PRO	NL	SNL	0	0.9MM$/year	50% of O&M costs (buys 50% of operating time)	remaining costs
RFI-IN--9628	Rensselaer	Non-contact flow measurement	nothing	this replaces an old system at RPI	300 hrs./yr.	non-contact system that doesn't affect the fluid, can handle multiple scales	AF	THF	LWRS	FCRD	SY, SF, RSK	UNIV	RPI	0.5MM$/2 years	unknown	100% of O&M permanent	Staff time to support capability
RFI-IN--9630	SUNRISE	Critical Facility	several in US	several in US that could be adapted	unknown	training of students, support for RERTR	FDF	FF	R&D	FCRD	ST, SF, RSK	NL	ORNL/HFIR	21MM$/7.5 years	3MM$/year	prepay for users for 5 years	cost recovery from users and support from ORNL
RFI-IN--9684	LANL	Test reactors, in-situ measurements and PIE facilities	existing facilities are aging	support existing facilities while investing in new builds	high	support for all NE missions, base of R&D efforts	RX	MS	LWRS	ART	ST, NF, SY	NL	any	Test Rx (3BB$/15 years)	unknown	100% of O&M permanent	as needed
RFI-IN--9687	EPRI	Large-scale Isostatic Press for Reactor Components	smaller HIP in US and Japan	nothing else is this large	1750 hrs./year	only way to make some SMR/ART components	AM	DE	R&D	5	AM, SD, NF	COMM	EPRI	100MM$/2 years	3.5MM$/year	50% of capital costs + staff salaries for 5 years	50% of capital costs + other support
RFI-IN--9695	MIT	Comprehensive Center for Nuclear Materials	several in US, but few as consolidated and with a test reactor (INL and ORNL)	this is an upgrade to the NRL at MIT, with substantial new construction	4500 hrs./year devoted to external users	combination of reactor, ion beam, neutron beams makes this unique	IGBF	NBF	LWRS	ART	ST, NF, SY	UNIV	MIT	100MM$/5 years	12.5MM$/year	50% of capital costs + 100% of O&M for 10 years	50% of capital costs + other support
RFI-IN--9698	Michigan	TEM connected to dual ion beams	IVEM in US, Michigan soon, JANNUS (FR) others in EU and JP	this is an upgrade to the MIBL	up to 50% of time (3200 hrs./year)	MIBL can perform irradiations on larger samples, already NSUF partner	AF	IB	LWRS	ART	ST, NF, UNF	UNIV	University of Michigan	0.5MM$/2 years	0.2MM$/year	100% of added O&M permanent	60% of staff support
RFI-IN--9702	PNNL	Automated Sample Prep, Cryogenic Alloy Mill and UNF Dry Cask Test Bed	nothing exists with these capabilities	sample prep will be built in existing hot cell facility	1000 hrs./year, 1500 hrs./year, unknown	all have high priority because they do not exist currently and are needed	SP	CK	LWRS	ART	ST, NF, UNF	NL	PNNL	3.9MM$/2 years (for all)	unknown	100% of O&M permanent	general support by laboratory
RFI-IN--9706	ANL	New Test Reactor	few around the world, all are aging and unreliable	support existing facilities while investing in new builds	7500 hrs./year	support for all NE missions, base of R&D efforts	RX	FDF	ART	FCRD	ST, NF, SY	NL	INL(designed by ANL)	3BB$/15 years	unknown	100% of O&M permanent	general support by laboratory

University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments

Tracking ID	Institution	Capability Selection					Research Area					Capability Location		Funding Support			
		Cap.	Similar Cap. Exist	Upgrade to Existing	Utilization	Prior.	Facility	Instrue.	Primary	Second.	Research Area	Type of Instit.	Where	Cost & Schedule	O&M Costs	DOE Costs	Host Costs
RFI-IN--9720	ANL	IVEM	There are 13 facilities around the world as of 2014, but all have strengths and weaknesses.	support existing facilities while investing in new builds	IVEM has been an Office of Science user facility for 20 years. It is ~30% overbooked, so it will have 100% utilization.	currently a unique facility that supports multiple missions	AF	IGBF	LWRS	ART	ST, NF, WS	NL	ANL	1.1MM$/1 year	0.9MM$/year	100% of O&M for 10 years	general support by laboratory (0.25MM$/year)
RFI-IN--9721	ANL	Radiochemistry Laboratory Refurbishment	Other radiochemistry and fuel facilities exist across the complex (INL). Nothing local to the central US.	this is an upgrade to building 205 at ANL			RL	CH	FCRD	R&D	REC, WS, SF	NL	ANL	improvements included in O&M costs	1.8MM$/year	100% of O&M for 10 years	general support by laboratory
RFI-IN--9722	ANL	Hot FIB/SEM	FIBs exist at other sites and are very busy. There is one FIB at ANL, but it is not radioactive.	the FIB will go into an existing facility	3680 hours/year based on HP coverage of 8 hr./day and 230 working days + another 8 hours of non-rad work.	Sample prep for large user facilities at ANL, vital for source reduction.	SP	PM	ART	R&D	ST, NF, WS	NL	ANL	1.0MM$/1 year	unknown	100% of O&M for 2 years	general support by laboratory
RFI-IN--9723	ANL	Irradiated Materials Laboratory Upgrade	INL and ORNL have facilities like this, but some are alpha-contaminated. This is also a regional asset. Can get in these cells for changes since no alpha.	this is an upgrade to the existing IML	11 months/year operations	LWRS support, good addition to the ANL RAM infrastructure.	HCF	MT	ART	R&D	ST, NF, UNF	NL	ANL	2.0MM$/2 years	unknown	set up as a user facility (NSUF)	general support by laboratory
RFI-IN--9724	ANL	XMAT Beamline for Irradiated Materials	BNL is developing a similar system (MRE), but will have lower energies and worse x-ray beam. Xe ion irradiation is only available at three other US facilities.	This builds upon existing capabilities	Similar to APS availability. 300 days per year and 24 hours per day	much higher ion energies than anything else, multiple x-ray techniques available, can add ion irradiation to already neutron irradiated samples, much thicker penetration depth	AF	IB	LWRS	R&D	ST, NF, WS	NL	ANL	36.0MM$/4 years	1.5MM$/year	100% of O&M for 10 years	none
RFI-IN--9733	BNL	Novel Neutron Source (design stage)	some in US and world, all aging, none optimized	support existing facilities while investing in new builds	likely very high, based on the final design	existing resources are all highly utilized now, but all resources are full and aging	RX	NBF	R&D	INTL	ST, NF, SY	NL	any	unknown, depends on design	unknown, depends on design	set up as a user facility (NSUF)	general support by laboratory

University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments

Tracking ID	Institution	Capability Selection					Research Area					Capability Location		Funding Support			
		Cap.	Similar Cap. Exist	Upgrade to Existing	Utilization	Prior.	Facility	Instrue.	Primary	Second.	Research Area	Type of Instit.	Where	Cost & Schedule	O&M Costs	DOE Costs	Host Costs
RFI-IN--9734	BNL	Radioactive Material Beamlines on NSLS-II	Some limited, but this will be unique (same as BNL and ANL proposals), JANNUS (FR) and another…	This builds upon existing capabilities	5000 hours per year based on NSLS-2 schedule	Builds on NEET grant for hot NSLS-2 beamline and GSI-2 award for x-ray CT of RAM in beamline.	PS	IB	R&D	LWRS	ST, NF, WS	NL	BNL	27.4MM$/ 3 years	unknown	100% of O&M permanent	new building construction to house facility
RFI-IN--9741	ANL	HPC Resources for NE	DOE-SC has huge resources, but applicant says that they are not suited to NE program needs due to the way that they are administered.	This builds upon existing HPC capabilities.	Expanded based on actual needs. Expect 100% usage of whatever resources are available.	This is a growing but underdeveloped area in NE.	HPC		R&D	LWRS	NF, SY, SA	NL	BNL	0	1.0MM$/year	100% of O&M for 5 years	share HPC resources and admin
RFI-IN--9759	PSU	IVEM support, ion-irradiation facilities, HVEM, Hot Atom Probe, TREAT support	some similar facilities exist, TREAT and IVEM are unique in important ways	support existing facilities while investing in new builds	high usage expected	Important capabilities, some (IVEM) require only support	AF	MS	LWRS	ART	ST, NF, SY	any	any	unknown, depends on design	unknown, depends on design	100% of O&M for 5 years	unknown, depends on design
RFI-IN--9780	INL	ATR Autoclave	Full-scale in Halden, smaller scale at Oregon State and Wisconsin-Madison	nothing else is this large	several times per year (before each cycle)	Better reliability for ATR experiments (non-radiation effects)	RX	THF	LWRS	ART	ST, NF, INC	NL	INL	7.5MM$/2 years	unknown	100% of O&M permanent	general support by laboratory + programs (NR)
RFI-IN--9785	INL	Additive manufacturing for instrumentation	This is an emerging area.	nothing exists at the laboratory	Expected high usage.	Support NEAMS V&V and improve ATR irradiations with better knowledge of in-experiment conditions.	AIN		LWRS	ART	INC, AM	NL	INL	unknown	unknown	set up as a user facility (NSUF)	general support by laboratory
RFI-IN--9789	INL	Radiolytic Damage Laboratory	nothing stated (look in NEID)	this would be built at an existing faculty, but the instruments would be new		supports material recovery mission	RL	CH	FCRD	R&D	REC, WS, UNF	NL	INL	1.2MM$/1 year	unknown	set up as a user facility (NSUF)	general support by laboratory
RFI-IN--9792	INL	HPC Resources for NE	Many similar facilities, including DOE-SC, but these are local and NE-focused.	builds upon existing HPC infrastructure investments at INL (FALCON)	high	Modeling and simulation are a growing area. TREAT restart support, NEAMS support.	HPC		LWRS	ART	NF, RSK, ST	NL	INL	$0.00	5.0MM$/year	set up as a user facility (NSUF)	general support by laboratory
RFI-IN--9793	INL	ARTIST - TH Test Loop for Advanced Reactors	nothing exact, separate loops elsewhere in US	this would be built at an existing facility, the design is new		Supported by INL LDRD, supports ART program, supports ATF program with cladding work, salt corrosion	THF	TT	ART	FCRD	SY, PC, DRY	NL	INL	5.0MM$/2 years	unknown	100% of O&M permanent	general support by laboratory + EERE + user fees

Appendix 2: Summaries of all proposals by functional area

Advanced Manufacturing and Processing

Applicant Institution	Electric Power Research Institute (EPRI)	**Title**	ATLAS-Large Format HIP for PM
Applicant	David Gandy	**Capital Intensity**	New Construction
Applicant Type	Industry	**Capital Cost [MM$]**	100MM$, including the facility. DOE would provide funds for the HIP at 50MM$.
Capability Location	EPRI Site (TBD) + Ohio State University and University of Tennessee-Knoxville	**Construction Time [years]**	2
Tracking ID	RFI-9687	**O&M Costs [MM$/yr.]**	3.5
Summary	Construct a 3.1m (10ft) hot isostatic press (HIP) machine to study the use of PM techniques to manufacture small modular reactor (SMR) and other nuclear power plant (NPP) components. Also develop centers of excellence in the study of powder metallurgy at the Ohio State University and University of Tennessee, Knoxville.		
Existing Capabilities	The largest HIP in US is 60" in diameter; the largest in world is 72" (JP).		
Expected Utilization	1750 hours per year		
NE Priority	Some components for advanced reactors cannot be manufactured using conventional techniques. This technique offers much faster fabrication times from design of a new component to the actual production.		
Functional Areas	AM	DE	
NE Missions	RD&D	INTL	ARC
R&D Areas	AM	SD	SM

Applicant Institution	Pacific Northwest NL	**Title**	Cryogenic Mechanical Milling Facility for High Radiation Resistant Materials
Applicant	T.S. Brun	**Capital Intensity**	Instrument Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	0.4
Capability Location	@PNNL	**Construction Time [years]**	1
Tracking ID	RFI-9702-2	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	The capability proposed is a cryogenic mechanical alloying (MA) facility to synthesize nanostructured alloys with breakthrough performance for reactor core applications. The new cryo-milling facility will enable unprecedented control over the microstructure and chemistry of nuclear materials for both excellent radiation resistance and ease of fabrication. Such a facility is essential to make the next generation reactor designs viable.		
Existing Capabilities	Traditional mechanical milling systems, running under water-cooling, are available at ORNL and the University of California, Berkeley. The new cryogenic milling facility will be a unique capability in the Unites States.		
Expected Utilization	1500 hours/year		
NE Priority	This is a priority investment for DOE-NE, because it will advance reactor materials research by enabling production of high performance core materials with control over microstructure and properties.		
Functional Areas	AM	SP	
NE Missions	LWRS	RD&D	ARC
R&D Areas	ST		

Applicant Institution	Idaho NL	**Title**	Additive Manufacturing for Rapid Instrumentation Manufacturing
Applicant	Joshua Daw	**Capital Intensity**	Instrument Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	No estimate provided.
Capability Location	HTTL @ INL	**Construction Time [years]**	1
Tracking ID	RFI-IN-9785	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	Build or buy an AM system to prototype and build instrumentation and sensors for in-core and in-experiment use.		
Existing Capabilities	This is an emerging area, so existing capabilities are in constant flux.		
Expected Utilization	Expected high usage, based on funding levels for reactor experimentation. The capability would support ATR and TREAT at INL and possibly HFIR and MITR (NSUF partners).		
NE Priority	The capability would support NEAMS V&V and improve ATR and TREAT irradiations with better knowledge of in-experiment conditions.		
Functional Areas	AIN	AM	INC
NE Missions	LWRS	ARC	RD&D
R&D Areas	INC	AM	

High Performance Computing

Applicant Institution	Idaho National Laboratory	**Title**	HPC Capabilities at NSUF
Applicant	Denise Stephens	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	10
Capability Location	@ INL	**Construction Time [years]**	5 (incremental spending each year to add HPC capacity)
Tracking ID	RFI-IN-9792	**O&M Costs [MM$/yr]**	2

Summary	Build upon existing HPC infrastructure at INL and expand NSUF access to HPC facilities and resources.
Existing Capabilities	Many similar facilities, including DOE-SC, but these are local and not NE-focused.
Expected Utilization	Expected utilization is high, based on support for V&V for NEAMS and CASL as well as experimental design for ATR and TREAT and other simulation needs.
NE Priority	Modeling and simulation are a growing area. The capability will support the TREAT restart, as well as CASL and NEAMS programs.

Functional Areas	HPC		
NE Missions	LWRS	ARC	RD&D
R&D Areas	NF	RSK	ST

Applicant Institution	Argonne National Laboratory	**Title**	Nuclear Engineering High Performance Computing Resource
Applicant	Hubert Ley	**Capital Intensity**	O&M Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	0
Capability Location	@ ANL	**Construction Time [years]**	0
Tracking ID	RFI-IN-9741	**O&M Costs [MM$/yr]**	1.0 (includes O&M support funding as well as capability expansion)
Summary	The project would expand the existing DOT HPC laboratory (TRACC) for use by NE programs. It is run like a business, not a research facility, so it has high reliability and redundancy.		
Existing Capabilities	DOE-SC has huge HPC resources, but they are not suited to NE program needs due to the way that they are administered. This resource (TRACC) is situated near the big ANL supercomputers and can share knowledge among system administrators.		
Expected Utilization	The capability can be expanded based on actual needs. Expect 100% usage of whatever resources are available.		
NE Priority	This is a growing but underdeveloped area in NE. Modeling and simulation are growing areas and support a wide variety of programs.		
Functional Areas	HPC		
NE Missions	RD&D	LWRS	ARC
R&D Areas	NF	SY	SA

Ion Irradiation Facilities with TEM for In-situ Monitoring

Applicant Institution	Argonne National Laboratory	**Title**	The IVEM – Tandem Facility Transmission Electron Microscopy with in situ Ion Beam Irradiation
Applicant	Meimei Li	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	1.1
Capability Location	@ ANL	**Construction Time [years]**	1
Tracking ID	RFI-IN-9720	**O&M Costs [MM$/yr]**	0.9
Summary	The IVEM-Tandem Facility consists of an intermediate voltage electron microscope (IVEM), an ion implanter, and an ancillary vacuum system for specimen holder storage. The IVEM is a Hitachi H-9000NAR (100-300kV electron energy) microscope with specially designed objective lens area for interfacing to a 500 keV NEC Implanter with a 911 Danfysik ion source. The ion implanter allows the acceleration of a wide range of ion species including proton, inert gases, and many elements from Al to Au, with ion energies as low as 50 keV and as high as 1 MeV double-charged. Ion flux ranges from 1E+10 to 1E+12 ions/cm2/sec (corresponding to 10-5 to 10-3 dpa/sec for 1 MeV Kr ions incident on Mo). Also looking at 1.1MM$ in instrumentation improvements.		
Existing Capabilities	There are 13 facilities around the world as of 2014, but all have strengths and weaknesses. The beams at Sandia National Laboratory's Ion Beam Laboratory and the University of Michigan's Ion Beam Laboratory hit the target at 90 degrees, so irradiation and imaging cannot be done at the same time.		
Expected Utilization	IVEM has been an Office of Science user facility for 20 years. It is ~30% overbooked, so it will have 100% utilization.		
NE Priority	The IVEM facility provides unique data for validating multiscale materials models under development within the DOE NE Light Water Reactor Sustainability (LWRS), Nuclear Energy Advanced Modeling and Simulation (NEAMS) and Consortium for Advanced Simulation of Light water reactors (CASL) programs.		
Functional Areas	AF	IGBF	MS
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	WS

Applicant Institution	Sandia NL	**Title**	Transforming Sandia's IBL and I3TEM to a Partial User Facility
Applicant	Khalid Hattar	**Capital Intensity**	O&M Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	0
Capability Location	IBL @ SNL	**Construction Time [years]**	0
Tracking ID	RFI-IN-9624	**O&M Costs [MM$/yr]**	0.9
Summary	The IBL is a new (25000 ft^2, $40M) state of the art accelerator facility that opened in June 2010. Although the IBL has a broad range of experimental capabilities, the following four are thought to be of the greatest interest to the DOE-NE community: 1. In-situ ion irradiation transmission electron microscope. 2. High-energy light- or heavy-ion irradiation at elevated temperature and/or applied mechanical load 3. Deep, high-dose-rate, light-ion irradiation experiments at temperatures from 77K to 1073K 4. Calibrated neutron production through D-D or D-T reactions.		
Existing Capabilities	This lab has seven accelerators at a variety of energies. New dynamic TEM with a variety of stages. There are new international facilities being built, Fonds National de la Recherche in Luxembourg, Xiamen University in China, and MIAMI-2 at University of Huddersfield in England. IVEM is the only US facility (University of Michigan Ion Beam Laboratory will be online soon).		
Expected Utilization	50% of the available annual time could go to NE customers.		
NE Priority	It is on the Kirtland AFB, so access is easier than on SNL proper. The facility is already built and operating, adding NE customers just needs operating cost support.		
Functional Areas	AF	MS	
NE Missions	LWRS	ARC	RD&D
R&D Areas	ST	NF	PRO

Applicant Institution	University of Michigan	**Title**	Dual-beam in-situ TEM Capability in the Michigan Ion Beam Laboratory
Applicant	Gary Was	**Capital Intensity**	Minor Refit
Applicant Type	University	**Capital Cost [MM$]**	0.5
Capability Location	MIBL @ University of Michigan	**Construction Time [years]**	2
Tracking ID	RFI-IN-9698	**O&M Costs [MM$/yr]**	0.2
Summary	The project requires the connection of a TEM (already acquired) to two beam lines to perform in-situ monitoring during H and He ion irradiations. This is one beam from the 1.7MV Tandem accelerator and one from the 0.4MV ion accelerator.		
Existing Capabilities	The other choices in the world are the JANNUS facility in France and the TIARA facility in Japan. Only JANNUS has the beams meet in a TEM. It also only operates a few hours per day and both are at national laboratories, so difficult for users to access. In the US, there is IVEM at ANL and one at Sandia. Only the Sandia facility has the capability to have dual beams in the TEM.		
Expected Utilization	Perhaps 3200 hours per year for external users. (50%)		
NE Priority	MIBL can perform irradiations on larger (than TEM disks) samples that can be used for other tests. The cost to bring this online is low compared to other facilities. MIBL is already an NSUF partner and one of the busiest.		
Functional Areas	AF	IBI	MS
NE Missions	LWRS	ARC	RD&D
R&D Areas	ST	NF	UNF

Applicant Institution	Pennsylvania State University	**Title**	IVEM Support & MIBL Support
Applicant	Arthur Motta	**Capital Intensity**	O&M Only
Applicant Type	University	**Capital Cost [MM$]**	0
Capability Location	Any	**Construction Time [years]**	0
Tracking ID	RFI-IN-9759-1	**O&M Costs [MM$/yr]**	1
Summary	The IVEM facility combines a high resolution transmission electron microscope with an ion beam attachment, allows researchers to observe the damage as it occurs, thus allowing to discern damage accumulation mechanisms, interaction of defect clusters with the pre-existing microstructure and to study the detailed kinetics of the process of radiation damage accumulation in the material as a function of temperature. The MIBL is an NSUF partner and deserves continued support. They are planning to connect a TEM to two ion beam lines, to combine observation with irradiation.		
Existing Capabilities	JANNUS (FR) and a new facility at SNL.		
Expected Utilization	The expected (and current) usage by NE researchers is high.		
NE Priority	The IVEM the low cost leader for any similar facility as it is already in operation and needs only operational funds to continue operation.		
Functional Areas	AF	MS	
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	

Applicant Institution	Los Alamos National Laboratory	**Title**	In-situ measurement of ion irradiation (TEM or x-ray)
Applicant	Stu Maloy	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	No estimate provided.
Capability Location	National Laboratory	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9684-2 (IVEM and XRD areas)	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	Support the IVEM as a tool for NE researchers. Additionally, develop better in-situ irradiation monitoring at ions or at reactors.		
Existing Capabilities	None provided.		
Expected Utilization	No estimate provided.		
NE Priority	Some defects immediately diffuse to the surface at high temperatures, so they must be observed in real-time or missed.		
Functional Areas	AF	MS	
NE Missions	ARC	FC	LWRS
R&D Areas	ST	NF	

Ion Irradiation Facilities with XRD for In-situ Monitoring

Applicant Institution	Los Alamos National Laboratory	**Title**	In-situ measurement of ion irradiation (TEM or x-ray)	
Applicant	Stu Maloy	**Capital Intensity**	Minor Refit	
Applicant Type	National Laboratory	**Capital Cost [MM$]**	No estimate provided.	
Capability Location	National Laboratory	**Construction Time [years]**	No estimate provided.	
Tracking ID	RFI-IN-9684-2 (IVEM and XRD areas)	**O&M Costs [MM$/yr]**	No estimate provided.	
Summary	Support the IVEM as a tool for NE researchers. Additionally, develop better in-situ irradiation monitoring at ions or at reactors.			
Existing Capabilities	None provided.			
Expected Utilization	No estimate provided.			
NE Priority	Some defects immediately diffuse to the surface at high temperatures, so they must be observed in real-time or missed.			
Functional Areas	AF	MS		
NE Missions	ARC	FC	LWRS	
R&D Areas	ST	NF		

Applicant Institution	Massachusetts Institute of Technology	**Title**	A New Center for Nuclear Materials
Applicant	David Moncton	**Capital Intensity**	New Construction
Applicant Type	University	**Capital Cost [MM$]**	100MM$, including a new building, NE would provide 50MM$ for equipment
Capability Location	NRL @ MIT	**Construction Time [years]**	5
Tracking ID	RFI-IN-9695 (Ions-XRD & SP-PIE)	**O&M Costs [MM$/yr]**	10-15
Summary	Expand the capabilities of the NRL at MIT to create a comprehensive center for the study of nuclear materials. Additions include: the development of advanced instrumentation for in-core experiments and for post irradiation examination, new proton accelerator facilities, a sub-critical test facility, a high-brightness x-ray source and an improved neutron beam system.		
Existing Capabilities	The MITR is a rare commodity, with the ATR being the only other real 'test' reactor in the US. Most of the other facilities are new and reflect capabilities that exist elsewhere. The combination of these capabilities at one site makes them rarer.		
Expected Utilization	Expect 5000 hours per year, with 10% (500 hours) devoted to MIT faculty and students and the rest for the NSUF.		
NE Priority	The combination of proton irradiation and modeling and simulation can replace strict neutron irradiation for high-dose needs. This will also allow the in-situ characterization of the sample using x-ray and neutron beams.		
Functional Areas	IGBF	NBF	PM
NE Missions	LWRS	ARC	RD&D
R&D Areas	ST	NF	SY

Applicant Institution	Brookhaven National Laboratory	**Title**	Accelerator Based Facility for Materials Irradiation Testing
Applicant	Nikolaos Simos	**Capital Intensity**	Extensive Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	32
Capability Location	@ BNL	**Construction Time [years]**	4
Tracking ID	RFI-IN-9618	**O&M Costs [MM$/yr]**	6
Summary	The project would refurbish an old accelerator complex for irradiation testing of reactor materials. This would be integrated with an existing PIE facility including hot cells, x-ray PIE analysis and electron microscopy. The existing proton, ion and x-ray beams will be used for minimal investment. The new facility will also provide fast and thermal neutrons.		
Existing Capabilities	Few similar facilities exist and all are at institutions that have different missions than NE. This will also have spallation neutrons and high energy heavy ions (more like fission fragments).		
Expected Utilization	The expected utilization should be high, like the NSLS-2 beamlines.		
NE Priority	This is better than existing facilities due to the higher energy ions and the ability to examine the sample in-situ during irradiation.		
Functional Areas	AF	PM	
NE Missions	LWRS	RD&D	INTL
R&D Areas	ST	NF	SY

Applicant Institution	Brookhaven National Laboratory	**Title**	Materials in a Radiation Environment (MRE) – A Synchrotron Beamline for Studying Radioactive Materials and Radiation Damage
Applicant	Lynne Ecker	**Capital Intensity**	New Construction
Applicant Type	National Laboratory	**Capital Cost [MM$]**	27.4
Capability Location	@ BNL	**Construction Time [years]**	3
Tracking ID	RFI-IN-9734	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The project would build two new end stations at the NSLS-2 for radioactive material use. It would support multi-mission use (also NNSA and SC missions). In addition, the new capability will add ion beams to the x-ray as well, for in-situ monitoring of radiation damage progression.		
Existing Capabilities	There are some limited facilities available, but this will be unique. Internationally, there is JANNUS (FR) and a few others.		
Expected Utilization	5000 hours per year based on NSLS-2 schedule		
NE Priority	This project builds on a previous NEET grant for examining radioactive materials in the NSLS-2 beamline and a current infrastructure (GSI-2) award for construction of an x-ray CT for radioactive materials in the beamline.		
Functional Areas	PSI	IBI	
NE Missions	RD&D	LWRS	ARC
R&D Areas	NF	ST	WS

Applicant Institution	Pennsylvania State University	**Title**	Other Bulk and in-situ ion irradiation facilities
Applicant	Arthur Motta	**Capital Intensity**	Minor Refit
Applicant Type	University	**Capital Cost [MM$]**	No estimate provided.
Capability Location	Any	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9759-2	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	New capabilities should be developed for other applications, such as when deep ion penetration is needed, or when the effect of thin foil surfaces is not wanted, bulk ion irradiation, in which one irradiates a sample and examines the results post-facto, is extremely useful.		
Existing Capabilities	There are a few existing capabilities, such as the MIBL.		
Expected Utilization	None provided.		
NE Priority	No estimate provided.		
Functional Areas	AF	IGBF	
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	

Applicant Institution	Argonne National Laboratory	**Title**	Extreme Materials (XMAT) Beam Line for In Situ Examination of Radiation Damage at the Advanced Photon Source
Applicant	Abdellatif Yacout	**Capital Intensity**	New Construction
Applicant Type	National Laboratory	**Capital Cost [MM$]**	36
Capability Location	@ ANL	**Construction Time [years]**	4
Tracking ID	RFI-IN-9724	**O&M Costs [MM$/yr]**	1.5
Summary	The project would build an ion source next to an APS beamline so that samples could be ion-damaged and viewed using x-ray techniques at the same time. High-energy heavy ions like fission fragments will do damage to fuels unlike other facilities at lower energies. Thicker samples can be irradiated. Can do thermal and mechanical stresses in situ. Can be built using technology leveraged from other work.		
Existing Capabilities	BNL is developing a similar system (MRE), but will have lower energies and a lower-quality x-ray beam. Xenon ion irradiation is only available at three other US facilities.		
Expected Utilization	Similar to APS availability. 300 days per year and 24 hours per day		
NE Priority	This facility will have much higher ion energies than anything else. Multiple x-ray techniques will available for in situ measurement. Experimenters can add ion irradiation to already neutron irradiated samples. The higher energy ions will reach a much thicker penetration depth.		
Functional Areas	AF	IGBF	IBI
NE Missions	LWRS	RD&D	ARC
R&D Areas	ST	NF	WS

Radiochemistry Facilities

Applicant Institution	Argonne National Laboratory	**Title**	Radiochemistry Facility Refurbishment
Applicant	Mark Williamson	**Capital Intensity**	Extensive Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	18
Capability Location	@ ANL	**Construction Time [years]**	10 (or 3 years as desired)
Tracking ID	RFI-IN-9721	**O&M Costs [MM$/yr]**	O&M funding included in the cost.

Summary	This project would refurbish the existing Building 205 laboratories to bring them up to modern standards. There is already good infrastructure in place (glove boxes (air and inert), hoods, test beds, etc.).		
Existing Capabilities	Other radiochemistry and fuel facilities exist across the complex (e.g. MFC @ INL). There is nothing local to the central US.		
Expected Utilization	No estimate provided.		
NE Priority	Loss of the existing capability will result in additional, increased costs and potentially lead to programmatic delays to DOE-NE while a new radiochemistry facility is established.		
Functional Areas	RL	CH	
NE Missions	FC	RD&D	
R&D Areas	REC	WS	SF

Applicant Institution	Idaho National Laboratory	**Title**	Radiolytic Damage Laboratory
Applicant	Jack Law	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	1.2
Capability Location	@ INL	**Construction Time [years]**	1
Tracking ID	RFI-IN-9789	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The project would create a new laboratory to investigate the damage caused by radioactive decay in liquids. Will have 20kCi Co-60 source, Electron Spin Resonance spectrometer and Laser Flash Photolysis spectrometer.		
Existing Capabilities	No similar coherent set of capabilities exist.		
Expected Utilization	No estimate provided.		
NE Priority	This new capability will support the material recovery mission as well as other NE priorities.		
Functional Areas	CH	RL	
NE Missions	FC	RD&D	INTL
R&D Areas	REC	WS	UNF

Reactors and Neutron Sources

Applicant Institution	AREVA NP	**Title**	**SUNRISE**
Applicant	Thomas Coleman	**Capital Intensity**	New Construction
Applicant Type	Industry (+ University)	**Capital Cost [MM$]**	17-24
Capability Location	HFIR @ ORNL	**Construction Time [years]**	5-10
Tracking ID	RFI-IN-9630	**O&M Costs [MM$/yr]**	2-4
Summary	Low-power critical facility (LPCF) for R&D, education, technology demonstration. Supports LEU conversions (RERTR). The LPCF will provide a safe, flexible, highly instrumented, multi-use and easy-to-operate design similar to the pool critical assembly (PCA) operated at ORNL from 1958 to 1987. It will be a light water moderated, reflected and cooled design with the ability to modify fuel lattices via changeable core grid plates for flexible fuel element placement.		
Existing Capabilities	There is some similar capacity domestically and internationally. In the U.S., facilities exist at SNL and NCERC in the western part of the country. Sandia is a defense mission lab and it is very difficult for students to go there and gain access. Likewise, access to NCERC is limited and costly due to the nature of the materials that are used there. These facilities lack capabilities (power, instrumentation, power, flexibility) and their processes for assigning priorities are impediments to potential users. International facilities are too expensive to use. The Sandia Lab facility could possibly be upgraded to perform the same functions. However, it is unlikely the access to a defense mission lab could be modified to grant access to all potential SUNRISE users and students. This doesn't solve the location issue, i.e. west versus southeast and proximity. *Applicants claim that these facilities are too hard to access and do not meet their (unspecified) criteria.*		
Expected Utilization	It is challenging to project the utilization of a facility that doesn't exist. One anticipated need is for the development of low-enriched fuel to replace highly-enriched fuel. Qualification of such a new fuel type could take hundreds of hours of operation. Development of such fuels has been problematic and characterized by many failures with little success. *Unspecified, but applicants list possible uses in addition to RERTR support. No user facility claims.*		
NE Priority	This facility is a priority for the nuclear energy community because it will help resolve technical issues associated with low-enriched fuel and improve proliferation resistance. Training new nuclear engineers, support of RERTR.		
Functional Areas	FDF	FF	
NE Missions	RD&D	FC	INTL
R&D Areas	NF	SF	RSK

Applicant Institution	Los Alamos NL	**Title**	**Thermal and Fast Test Reactors (generic proposal)**
Applicant	Stu Maloy	**Capital Intensity**	New Construction
Applicant Type	National Laboratory	**Capital Cost [MM$]**	2-4,000
Capability Location	National Laboratory	**Construction Time [years]**	10-20
Tracking ID	RFI-IN-9684-1	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	R&D community needs both thermal test reactors (2-4dpa/year) and fast test reactors (20-40dpa/year) available to irradiate samples at a constant temperature.		
Existing Capabilities	ATR, HFIR, BOR-60, Joyo, etc. All facilities are either aging or have other problems.		
Expected Utilization	Expected utilization would be high.		
NE Priority	Broad program support		
Functional Areas	RX		
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	SY

Applicant Institution	Argonne NL	**Title**	**New Fast Test Reactor (generic proposal)**
Applicant	Chris Grandy	**Capital Intensity**	New Construction
Applicant Type	National Laboratory	**Capital Cost [MM$]**	2-4,000
Capability Location	@ INL, designed by ANL	**Construction Time [years]**	10-20
Tracking ID	RFI-IN-9706	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The U.S. requires an advanced fast test reactor (AFTR) for the development of high-performance nuclear fuel, cladding and structural materials. An adequate fast-neutron irradiation capability is required to test candidate fuels and materials samples in a prototypic environment and to provide irradiated fuels and materials for transient testing. Testing is necessary to verify the performance and safe utilization of the fuels and materials prior to their implementation in a prototype or demonstration reactor. New test reactor and prototype for Gen IV NPP. Flexible in design so that it can be adjusted to new missions.		
Existing Capabilities	Russia and Japan have respectively the BOR-60 and JOYO test reactors that could provide fast-neutron irradiation services for the U.S. However, BOR-60 is nearing its end-of-life and its future availability is highly uncertain, and JOYO has been shut down for many years following a fuel handling incident that damaged internal reactor structures. Possible to reactivate FFTF (Hanford Site, WA, US) (*applicant's statement*).		
Expected Utilization	7450 hours/year at 80% capacity factor *(this does not reflect on the current operation schedule of US test reactors which is more like 50%)*		
NE Priority	Supports many programs (FCRD, LWRS, NRC licensing, NSUF access), teaching.		
Functional Areas	RX	FDF	
NE Missions	ARC	RC	RD&D
R&D Areas	ST	NF	SY

Applicant Institution	Brookhaven NL	**Title**	**Novel Neutron Source (Rx or Spallation) (generic proposal)**
Applicant	Albert Hanson	**Capital Intensity**	New Construction
Applicant Type	National Laboratory	**Capital Cost [MM$]**	No estimate provided.
Capability Location	National Laboratory/led by BNL	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9733	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	Design study for a new high-intensity neutron source (cold or thermal neutrons, continuous, not pulsed) for research, could be reactor-based or could be a spallation source. Mostly for neutron beam applications. *Applicant has specific design plan.*		
Existing Capabilities	Several facilities exist in US and world, all aging, none are optimized.		
Expected Utilization	Likely very high, based on the final design		
NE Priority	Existing resources are highly utilized now, but all resources are full and aging		
Functional Areas	RX	NBF	AF
NE Missions	RD&D	INTL	
R&D Areas	ST	NF	

Applicant Institution	Pennsylvania State University	**Title**	Support for the TREAT facility
Applicant	Arthur Motta	**Capital Intensity**	O&M only
Applicant Type	University	**Capital Cost [MM$]**	0
Capability Location	Idaho National Laboratory	**Construction Time [years]**	0
Tracking ID	RFI-IN-9759-5	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The behavior of high burnup fuel in the case of a design basis accident, such as a LOCA or RIA, needs to be well understood. In particular it is essential to certify that the material retains enough ductility.		
Existing Capabilities	Few similar facilities in the world. TREAT is the best of the choices.		
Expected Utilization	No estimate provided.		
NE Priority	To understand this susceptibility it is necessary to perform integral tests, with irradiated fuel and expensive monitoring. The planned availability of the TREAT facility will allow such transient testing to be again performed in the US. The facility and its associated PIE capabilities should clearly be supported.		
Functional Areas	RX	FDF	
NE Missions	FC	ARC	RD&D
R&D Areas	NF	SY	

Sample Preparation and Post-Irradiation Examination

Applicant Institution	Massachusetts Institute of Technology	**Title**	A New Center for Nuclear Materials
Applicant	David Moncton	**Capital Intensity**	New Construction
Applicant Type	University	**Capital Cost [MM$]**	100MM$, including a new building, NE would provide 50MM$ for equipment
Capability Location	NRL @ MIT	**Construction Time [years]**	5
Tracking ID	RFI-IN-9695 (Ions-XRD & SP-PIE)	**O&M Costs [MM$/yr]**	10-15
Summary	Expand the capabilities of the NRL at MIT to create a comprehensive center for the study of nuclear materials. Additions include: the development of advanced instrumentation for in-core experiments and for post irradiation examination, new proton accelerator facilities, a sub-critical test facility, a high-brightness x-ray source and an improved neutron beam system.		
Existing Capabilities	The MITR is a rare commodity, with the ATR being the only other real 'test' reactor in the US. Most of the other facilities are new and reflect capabilities that exist elsewhere. The combination of these capabilities at one site makes them rarer.		
Expected Utilization	Expect 5000 hours per year, with 10% (500 hours) devoted to MIT faculty and students and the rest for the NSUF.		
NE Priority	The combination of proton irradiation and modeling and simulation can replace strict neutron irradiation for high-dose needs. This will also allow the in-situ characterization of the sample using x-ray and neutron beams.		
Functional Areas	IGBF	NBF	PM
NE Missions	LWRS	ARC	RD&D
R&D Areas	ST	NF	SY

Applicant Institution	Los Alamos National Laboratory	**Title**	Post irradiation examination facilities (generic)
Applicant	Stu Maloy	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	No estimate provided.
Capability Location	National Laboratory	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9684-3	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	DOE-NE should build or maintain hot cells and PIE facilities including multiple facilities across the complex.		
Existing Capabilities	There are several PIE and hot cells left, but all of them support and investment.		
Expected Utilization	Expected utilization is high for these unique facilities.		
NE Priority	These facilities support multiple NE missions.		
Functional Areas	PM	HCF	
NE Missions	LWRS	FC	
R&D Areas	ST	NF	WS

Applicant Institution	Pacific Northwest National Laboratory	**Title**	Automated Sample Fabrication Facility for Irradiated Materials and Spent Fuels
Applicant	T.S. Brun	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	2.5
Capability Location	@ PNNL	**Construction Time [years]**	2
Tracking ID	RFI-IN-9702-1	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	This project would design and build an integrated machining capability, including small and large CNC milling machines and electrical discharge machining (EDM) systems, to advance the testing of irradiated materials and the production of property data from a given amount of material as well as to provide convenient handling at reduced radiation exposure. For high resolution transmission electron microscopy and atom probe tomography, samples taken by these CNC machines will need to be further fabricated into micron size specimens using equipment such as a focused ion beam (FIB) system.		
Existing Capabilities	Several sample preparation facilities exist, but none with automated capabilities.		
Expected Utilization	1000 hours/year		
NE Priority	This is a priority investment for DOE-NE, because the demand for obtaining small samples from highly irradiated materials or core components, including tested specimens, has substantially increased in the past decade. At the same time, materials characterization equipment has become increasingly sophisticated and physical and mechanical property testing methods have moved toward miniature samples.		
Functional Areas	SP	SPG	
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	UNF

Applicant Institution	Argonne National Laboratory	**Title**	Irradiated Materials Laboratory Upgrade
Applicant	Michael Billone	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	2
Capability Location	@ ANL	**Construction Time [years]**	2
Tracking ID	RFI-IN-9723	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The project would refurbish and upgrade the facilities at the Irradiated Materials Laboratory at ANL. It already has gloveboxes and four beta/gamma hot cells. This would add shipping and receiving area, dynamic testing, in-cell sample prep machining and cutting, a shielded optical microscope and an SEM and TEM. It would provide sample preparation facilities for the APS as well.		
Existing Capabilities	INL and ORNL have facilities like this, but some are alpha-contaminated. This would also be a regional asset. Since these cells are not alpha-contaminated, personnel can enter them to setup experiments.		
Expected Utilization	The facility would be available for use 11 months per year. This could not be a user facility for universities due to work with contaminated materials, but the work could be done by ANL staff.		
NE Priority	This project would provide LWRS support and be a valuable addition to the ANL radioactive material examination infrastructure.		
Functional Areas	HCF	MT	
NE Missions	ARC	RD&D	INTL
R&D Areas	ST	NF	UNF

Applicant Institution	Argonne National Laboratory	Title	FIB/SEM for Radioactive Sample Preparation
Applicant	Abdellatif Yacout	**Capital Intensity**	Instrument Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	1
Capability Location	@ ANL	**Construction Time [years]**	1
Tracking ID	RFI-IN-9722	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	This project would purchase a new Focused Ion Beam Scanning Electron Microscope (FIB/SEM) for radioactive sample preparation at ANL, supporting NE work at the APS, ATLAS and IVEM.
Existing Capabilities	FIBs exist at other sites and are very busy. There is one FIB at ANL, but it does not handle radioactive materials.
Expected Utilization	3680 hours/year based on rad-con coverage of 8 hrs./day and 230 working days + another 8 hours of non-rad work.
NE Priority	This instrument would provide sample preparation capability for three large user facilities at ANL, vital for source reduction and ALARA.

Functional Areas	SP	PIE	SPG
NE Missions	ARC	RD&D	
R&D Areas	ST	NF	WS

Applicant Institution	Pennsylvania State University	**Title**	High Voltage Electron Microscopes
Applicant	Arthur Motta	**Capital Intensity**	Instrument Only
Applicant Type	University	**Capital Cost [MM$]**	No estimate provided.
Capability Location	any	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9759-3	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	At one point (1970s, 80s) high voltage electron microscopes were the preferred route to achieve high resolution and several machines were available in the country, thus allowing researchers to perform electron irradiation of materials. Because the HVEM creates only isolated point defects as opposed to displacement cascades, is possible to understand the specific role of point defects in the processes of in damage development, void or precipitate nucleation or precipitate dissolution, etc.		
Existing Capabilities	These microscopes now only exist in Japan and Europe.		
Expected Utilization	No estimate provided.		
NE Priority	A new HVEM would be a very welcome addition to our arsenal of radiation damage tools.		
Functional Areas	AF	MS	
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	

Applicant Institution	Pennsylvania State University	**Title**	Active Atom Probe (with accompanying FIB/SEM)
Applicant	Arthur Motta	**Capital Intensity**	Instrument Only
Applicant Type	University	**Capital Cost [MM$]**	No estimate provided.
Capability Location	any	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9759-4	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	Atom Probe Tomography has given us many insights that would not be available with any other technique. Under irradiation many processes such as irradiation induced segregation, dissolution and precipitation change the microchemistry of the material leading to changes in mechanical properties such as pressure vessel embrittlement.		
Existing Capabilities	The use of APT is expanding in the United States, but APTs that can study irradiated material are still few.		
Expected Utilization	No estimate provided.		
NE Priority	To understand such processes in irradiated materials it is necessary to study the distribution of atoms in the material. The support of one such facility that would also be open to outside users along with the accompanying FIB would be warranted.		
Functional Areas	MS	SP	
NE Missions	LWRS	ARC	FC
R&D Areas	ST	NF	

Thermal Hydraulics Test Facilities

Applicant Institution	Rensselaer Polytechnic Institute	**Title**	Pulsed Photon Activation (PPA) Flow Measurement Facility
Applicant	Li (Emily) Liu	**Capital Intensity**	Minor Refit
Applicant Type	University	**Capital Cost [MM$]**	0.5
Capability Location	Accelerator Facility at RPI	**Construction Time [years]**	2
Tracking ID	RFI-IN-9628	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	PPA technique is one kind of radioactive tagging techniques that have been developed for the non-intrusive measurement of fluid velocity in a flow channel by the transit-time method. It uses an external, pulsed high-intensity gamma rays and/or high-energy neutron source to induce radioactivity in the fluid. The activated nuclei are observed at a known distance downstream from the activation site by a detector that measures the passage of activated fluid as a function of time. By analysis of the time profile of irradiated fluid, important flow properties can be obtained without introducing any perturbation into the flow.		
Existing Capabilities	Nothing similar exists for these studies.		
Expected Utilization	300 hours/year		
NE Priority	The PPA technique is unique and it acquires information of multi-phase flow (oxygen will be tagged and traced through its radioactive decay) inside tubes, nano-materials, etc. It provides special micro-level experimental insight of two-phase and multi-phase flow.		
Functional Areas	AF	THF	
NE Missions	LWRS	FC	
R&D Areas	SY	SF	RSK

Applicant Institution	Idaho National Laboratory	**Title**	Multi-Purpose Thermal Hydraulic Test Facility for Support of Advanced Reactor Technologies (ARTIST)
Applicant	James O'Brien	**Capital Intensity**	Extensive Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	5
Capability Location	Energy Sciences Building at INL	**Construction Time [years]**	2
Tracking ID	RFI-IN-9793	**O&M Costs [MM$/yr]**	No estimate provided.

Summary	The project would build a three-loop heat transfer system to simulate an advanced reactor. It would contain a helium loop, a salt loop and a water loop. The loops are connected by heat exchangers, but each of them can be run independently to support individual tests and each includes flexible test sections.
Existing Capabilities	There is nothing existing that has all of the capabilities of the proposed system. There are separate loops elsewhere in US that provide part of the capability of the ARTIST design.
Expected Utilization	No estimate provided.
NE Priority	Design of this project has been supported by INL Laboratory Directed Research and Development (LDRD) funding. The proposed capability directly supports the ARC program as well as the ATF program with cladding work and salt corrosion studies.

Functional Areas	THF	TT	
NE Missions	ARC	FC	RD&D
R&D Areas	NF	SY	PC

Applicant Institution	Babcock & Wilcox	**Title**	Integrated System Test and Control Room and Operator Performance Laboratory
Applicant	Joe Miller	**Capital Intensity**	Minor Refit
Applicant Type	Industry	**Capital Cost [MM$]**	1.0
Capability Location	CAER, Lynchburg, VA	**Construction Time [years]**	1
Tracking ID	RFI-IN-9617	**O&M Costs [MM$/yr]**	4
Summary	The facility is a pilot-scale thermodynamic power system (IST) with a common LWR/SMR reactor design attributes; full-scale height, pressure, temperature, and flow and a Control room (INCONTROL) with full-scope simulators for current power plant and generic design platforms and a control room mock-up consistent with the conceptual approach of current state-of-the-art designs. It is a test bed for the B&W mPower SMR design used for licensing studies with the NRC.		
Existing Capabilities	Currently, a capability similar to that described above does not exist domestically outside of private sector. No existing public-supported facility matches the PWR conditions as closely as IST and none has the integrated control room environment.		
Expected Utilization	3840 hours per year (IST) and 1760 hours per year (INCONTROL)		
NE Priority	The initial investment in the Center for Advanced Engineering and Research (CAER) is complete and the IST has been operated for over two years. Up-front costs, first-of-a-kind facility commissioning, operation and maintenance experience, and facility modification expertise allows the investment for DOE-NE to be focused on research, development and demonstration at a location with proven capabilities and documented attributes. The CAER is equipped to fulfill multiple missions.		
Functional Areas	THF	INC	
NE Missions	LWRS	ARC	RD&D
R&D Areas	SY	INC	PRO

Other Capabilities

Applicant Institution	University of Houston	**Title**	Impact Test Machine (ITM) for Nuclear Containment Research
Applicant	Yi-Lung Mo	**Capital Intensity**	Instrument Only
Applicant Type	University	**Capital Cost [MM$]**	0.5MM$ (NE would pay 80% or 0.4MM$)
Capability Location	University of Houston	**Construction Time [years]**	1
Tracking ID	RFI-IN-9614	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The project would install an "impact ram" attachment for the existing universal element tester to simulate aircraft impact on NPP containment structures for nuclear power plants.		
Existing Capabilities	There is a similar base tester at the University of Toronto, Canada. The University of Houston rig is more versatile. The combined system will be unique in the world.		
Expected Utilization	No estimate provided.		
NE Priority	This type of testing (aircraft impact) is required for new nuclear power plant construction IAW 10CFR50.		
Functional Areas	MT	PM	
NE Missions	ARC	LWRS	RD&D
R&D Areas	ST	SF	RSK

Applicant Institution	Pacific Northwest NL	**Title**	Used Nuclear Fuel Dry Cask Test Bed
Applicant	R.M. Meyer	**Capital Intensity**	Instrument Only
Applicant Type	National Laboratory	**Capital Cost [MM$]**	1
Capability Location	PNNL	**Construction Time [years]**	1
Tracking ID	RFI-IN-9702-3	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	The proposed capability is a mock-up of a canister-based dry cask system that initially will support development, verification and validation of sensors and instrumentation for assessing the structural integrity of dry storage system components, and to assess technologies for monitoring dry cask internal conditions.		
Existing Capabilities	There are no facilities with these capabilities currently.		
Expected Utilization	No estimate provided.		
NE Priority	Approximately 25% of discharged nuclear fuel from commercial power plants is in dry storage casks, and this number is continuously increasing. The failure of these systems to perform their safety functions and release of radiological materials into the environment present significant negative consequences, particularly in terms of eroded public perception and confidence that could strain the viability of the nuclear industry. Ready access to dry storage system mock-ups in the United States is currently limited and could present a significant barrier to successful sensor and instrumentation development for dry storage systems.		
Functional Areas	CK		
NE Missions	LWRD	FC	ARC
R&D Areas	UNF	WS	RSK

Applicant Institution	Idaho NL	**Title**	Full-scale autoclave for ATR Qualification
Applicant	Joshua Daw	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost [MM$]**	5-10
Capability Location	TRA @ INL	**Construction Time [years]**	No estimate provided.
Tracking ID	RFI-IN-9780	**O&M Costs [MM$/yr]**	No estimate provided.
Summary	This project would build a large autoclave that can accept a full ATR test train so that it can be tested at temperature, pressure and flow prior to insertion in the reactor.		
Existing Capabilities	There is a full-scale system in Halden and a smaller scale version at Oregon State University and the University of Wisconsin-Madison. None of these are useful for qualifying ATR experiments.		
Expected Utilization	The new capability would be utilized several times per year in concert with the ATR experiment schedule.		
NE Priority	The new capability would provide enhanced reliability for ATR experiments by testing the train against non-radiation effects.		
Functional Areas	RX	THF	
NE Missions	LWRS	ARC	RD&D
R&D Areas	ST	NF	INC

Appendix 3: Request for Information DE-SOL-0008318

REQUEST FOR INFORMATION

DE-SOL-0008318

University, National Laboratory, Industry and International Input on Potential Office of Nuclear Energy Infrastructure Investments

April 13, 2015

Office of Nuclear Energy

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1 Introduction

The mission of the U.S. Department of Energy (DOE) Office of Nuclear Energy (NE) is to advance nuclear power as a resource capable of meeting the Nation's energy, environmental and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development and demonstration (RD&D). NE's RD&D activities help resolve technical challenges thus enabling the deployment of new reactor and fuel cycle technologies that will support the current fleet of reactors and facilitate the construction of new plants.

Developing and maintaining a national RD&D framework to achieve NE's mission requires an integrated approach involving people, tools, facilities, and knowledge tied to strategic partnerships. Experimental infrastructure (i.e. tools and facilities) is a critical piece of this framework. However, these capabilities, especially radiological and nuclear facilities required to handle nuclear material, are expensive to build and maintain. Therefore, thoughtful management of new capability procurement is required, while also providing researchers an effective mechanism to obtain access to unique nuclear energy research facilities.

DOE currently solicits and awards general scientific infrastructure enhancements to universities and national laboratories, as well as university research reactor upgrades through an annual Scientific Infrastructure Support for Consolidated Innovative Nuclear Research Funding Opportunity Announcement. The awards made through this mechanism primarily focus on localized research and training needs; providing a single investment to procure the necessary infrastructure. Complementary to these efforts, there remains a need to identify, develop and maintain high priority national infrastructure supporting nuclear energy-related RD&D.

There is interest within the nuclear energy community in a number of potential national infrastructure areas with varying funding models. Example capabilities that have been brought to NE's attention include, **but are not limited to** (in no priority order):

- Dedicated High Performance Computing Capability;
- Powder Metallurgy coupled with Hot Isostatic Processing Scale-up Demonstration Facility;
- In-situ transmission electron microscopy with integrated ion beam irradiation;
- Low Power Critical Facility;
- Thermal Hydraulic Test Facility, and;
- Other high priority regional or national nuclear infrastructure capabilities.

2 Requested Information

DOE is seeking information, comments, feedback, and recommendations from interested parties to determine what capabilities supporting research, training and technology

demonstration are of highest interest to the nuclear energy research community. In addition to receiving feedback on the aforementioned capabilities, DOE seeks input on other high priority nuclear energy-related infrastructure needs including information on the potential benefit, location, funding model, and feasibility of establishing, maintaining, and operating such facilities. It is currently envisioned that, in general, supported facilities would become part of the Nuclear Science User Facilities, which provides access to national nuclear energy infrastructure through a competitive process or through full cost recovery mechanisms.

Replies to this request should follow the general organization of Section 2 of this RFI and information should be as succinct as possible. Respondents are encouraged to provide information on all parts of this RFI; however, not every part of the RFI need be answered in order to submit a response to the RFI.

2.1 Cover Page

Responses shall include a cover page containing the following information:

- RFI title and reference number
- Names, phone numbers, and e-mail addresses for the principal points of contact
- Company or affiliate name and address
- Date of submittal

2.2 Capability Selection

Clearly define your proposed capability and specifically identify why it is a priority for the nuclear energy community. Responses to this section of the RFI should address, but are not limited to:

1. What is the necessary capability and its essential features? If applicable, include manufacturer and model numbers.
2. Does a similar capability exist domestically (or internationally, if appropriate for consideration) and if so, why is additional investment required?
3. If there is an existing capability but it is currently inadequate, could it be refurbished or upgraded to meet the identified need?
4. What is the anticipated utilization of this capability by the host organization and as a user facility? Please specify in hours per year.
5. Why should the proposed capability be a priority investment for DOE-NE?

2.3 Research Areas

6. The new capability could be a facility or a specific instrument. Please use the following lists to determine the most appropriate category. If the capability does not fit with any of the identified categories, please specify its benefit to nuclear energy research.

Facility Categories	Instrumentation Categories
1. Accelerator Facilities	12. Chemical Testing
2. Fuel Development Facilities	13. Containment (Glove Boxes)
3. Hot Cell Facilities	14. Dimensional Examination
4. Neutron Beam Facilities	15. Electromagnetic Testing
5. Ion/Gamma Beam Facilities	16. Fuel Fabrication
6. PIE/Materials Characterization	17. Ion Beam Instruments
7. Radiochemistry Laboratories	18. Mechanical Testing
8. Reactor Facilities	19. Microscopes and Detectors
9. Sample Preparation Facilities	20. Neutron Beam Instruments
10. Special Laboratories	21. Photon Source Facility Instruments
11. Thermal-Hydraulic Facilities	22. Radiography/Imaging
	23. Sample Preparation Gear
	24. Shipping Containers (Casks)
	25. Spectrometry & Spectroscopy
	26. Surface Techniques
	27. Thermal Testing
	28. X-ray Diffraction Instruments

Functional Area

Primary	Secondary

7. In terms of relevance to NE's mission, please identify which of the following objectives the proposed capability would support.

Primary	Secondary	DOE-NE Mission
		1. Improve the reliability and performance, sustain the safety and security, and extend the life of current reactors by developing advanced technological solutions.
		2. Meet the Administration's energy security and climate change goals by developing technologies to support the deployment of affordable advanced reactors.

		3. Optimize energy and waste generation, safety, and nonproliferation attributes by developing sustainable fuel cycles.
		4. Enable future nuclear energy options by developing and maintaining an integrated national RD&D framework.
		5. Maintain U.S. leadership at the international level by engaging nations that pursue peaceful uses of nuclear energy.

8. In terms of overall NE-related research, identify which of the following research areas the proposed capability would support.

Priority	Research Area
	Structural Materials
	Nuclear Fuels (including cladding)
	Nuclear Systems Design Studies
	Power Conversion Systems
	Dry Heat Rejection Systems
	Process Heat Transport Systems
	Instrumentation and Controls
	Material Recovery Processes
	Waste Forms
	Safeguards and Security Technologies
	Used Fuel Disposition
	Safety and Risk Assessment
	Advanced Manufacturing Technologies
	Systems Analysis
	Space and Defense Power Systems
	Other (please specify:)

2.4 Capability Location

Some capabilities are one-of-a-kind while others are common among multiple locations and institutions. The following questions will help determine the extent of the need and the preferred location for a new capability.

9. What type of institution should host this new capability and why?
10. Where should this capability be located and why? Please specify the preferred institution or region(s) as appropriate. Preference should be given to regions with the most need or best synergy with existing capabilities.

2.5 Capability Funding Support

DOE seeks input related to potential funding models for initial and continued support of the proposed capability. While all options will be considered, those that do not result in an enduring mortgage to DOE are preferred.

The following questions are specific to the initial investment:

11. What is an estimated cost and schedule for establishing the capability?
12. What costs should DOE bear?
13. What costs should the hosting institution bear?

The following is specific to continued maintenance and operation of the capability:

14. Rank the following options in order of preference.

Preference	Annual Funding Support from DOE-NE	Duration (e.g., 5 years, 10 years, permanent)
	Operations and Maintenance Costs to support the capability	
	Pre-pay (or buy) some amount of the usage schedule for DOE-NE programs, ensuring continued operations.	
	Payroll support for operations and maintenance staff for the capability	
	Provide no-cost or low-cost access to the new capability for non-DOE users (similar to the current NSUF model)	
	Other (please specify:)	

2.5 Other Information

Provide any other relevant information you feel is important and not otherwise already covered.

3 Participant Eligibility to Respond to RFI

Information is being sought from educational institutions, National Laboratories, private-sector institutions, international research entities, and any other interested party.

4 Program Guidelines

This market research request is done under the Federal Acquisition Regulation (FAR), Parts 10 – Market Research and FAR subpart 15.201(e) – Requests for Information.

5 Intellectual Property Rights

Participants are advised that their RFI response package should be submitted without any restrictive markings. However, if restrictions are required in order to fully explain a response, the participant is responsible to mark the cover page and any and all submittal documents appropriately. Respondents are strongly discouraged from placing any restrictive markings on submissions as they may limit DOE's ability to use the submitted information.

6 Communications Protocol

Responses must be submitted through www.NEUP.gov to be considered. You must create an account to access the submission site. Submit electronic submissions through the "Applications" function at www.NEUP.gov. If you have problems completing the registration process or submitting your response, call 208-526-1507 or send an email to NEUP@inl.gov.

Participants are advised that any indication of interest, in the affirmative, is not meant to imply nor in any way impart an obligation on the part of the Government that an award will be forthcoming for the offered work or project.

7 Schedule

7.1 Submission Time and Date

The DOE will accept packages in response to this RFI No. DE-SOL-0008318 through **8:00 p.m. ET, June 19, 2015.**

This announcement does not impose any obligation on the Government nor does it signify any intent for a contract or other form of award.

8 Disclaimers

a. DOE does not plan to send individual acknowledgements or replies to respondents to the RFI. However, DOE may conduct one-on-one meetings with entities that respond to this request if clarification or additional information is required to improve the DOE's understanding of the comments provided. If DOE decides to hold one-on-one meetings, applicable interested parties will be contacted. The decision to meet with a company one-on-one has no bearing on the worthiness of its RFI submittal or on any future offerings.

b. This is a request for information only. It has no direct relation to other DOE Funding Opportunity Announcements or solicitations. DOE does not presently intend to solicit or award any kind of contract or financial assistance award; this RFI is issued only with the intent of obtaining information.

c. Any response to this RFI is voluntary and does not commit to Government to any expense or obligation. This request does not impose any obligation on the Government or signify a firm intention to enter into a contract. No costs associated with responding to this RFI or participating in any subsequent meetings will be borne by the Government.

d. DOE does not intend to publish the results of the responses to this RFI.