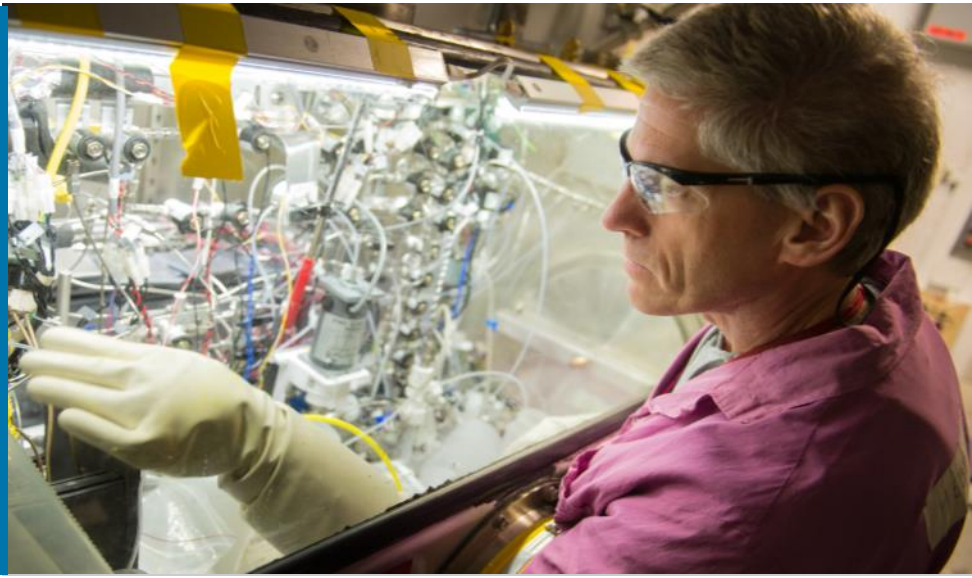
FORGING GOVERNMENT & INDUSTRY PARTNERSHIPS



AL SATTELBERGER
Deputy Laboratory Director for Programs & Chief Research Officer

Advanced Reactors Technical Summit IV
February 8, 2017
Argonne National Laboratory

ASSESSMENT OF USER NEEDS FOR IRRADIATION TESTING

PRESENTATION TO THE NUCLEAR ENERGY ADVISORY COMMITTEE

Dick Meserve and Joy Rempe, NEAC Co-Chairs
John I. Sackett, Facilities Subcommittee
Regis Matzie, International Subcommittee
Al Sattelberger and Michael Corradini, Ad-hoc Subcommittee

Washington, DC
December 9, 2016

CHARGE FROM NE-1 (JULY 29, 2016)

"… form a team" … "to assess the need and determine the requirements for an irradiation test reactor which would augment existing domestic capabilities to support the development and deployment of advanced non-light water reactors as well as to accommodate the future needs of light water reactor technologies."

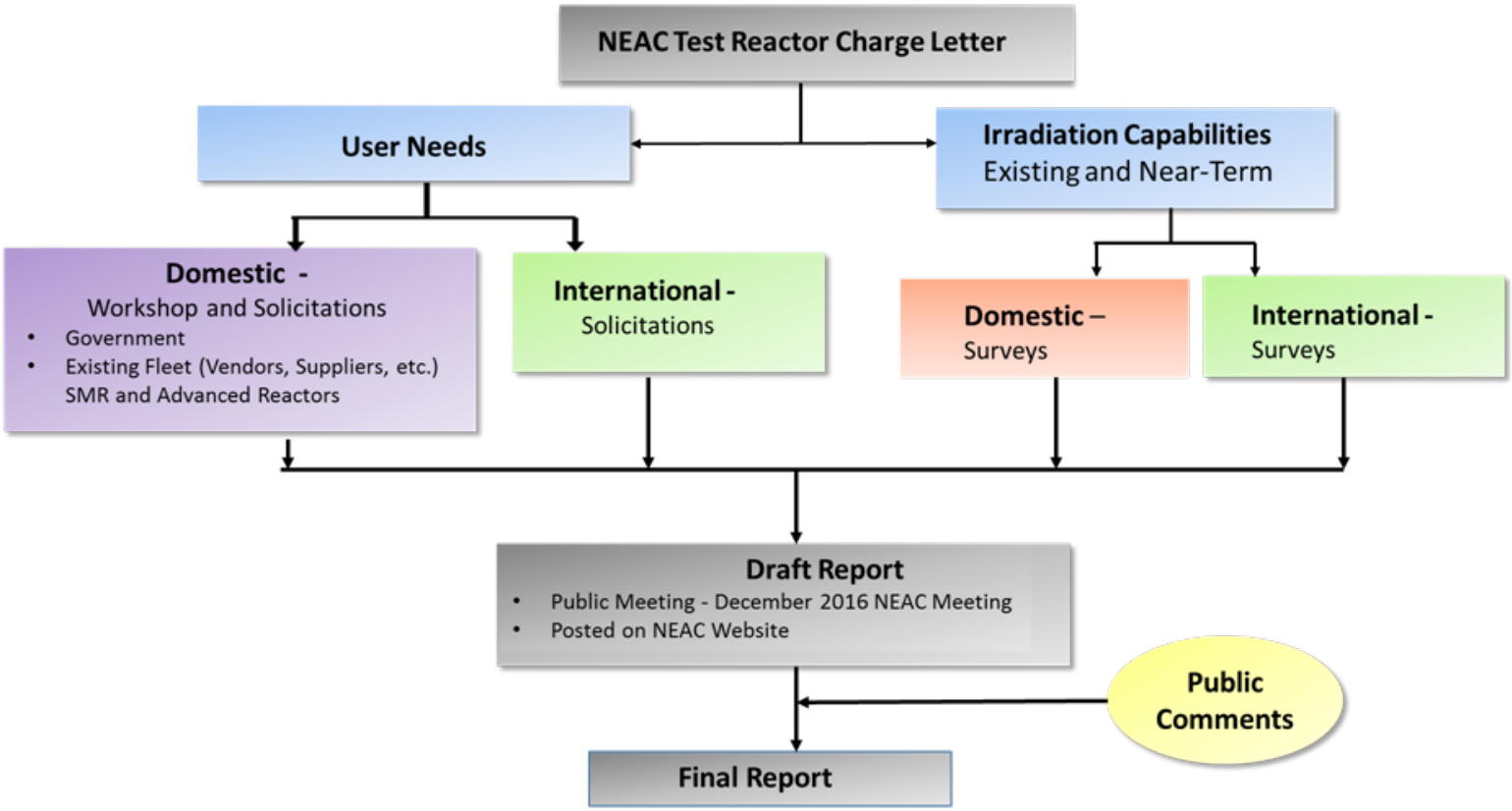
" … independently determine the requirements and overall capabilities (e.g., neutron spectrum/spectra, testing environments, etc.) for a new irradiation test reactor and compare these requirements with alternate existing facilities, methodologies, and approaches for meeting these needs…"

"The requirements review team should consider the needs of the entire community…as well as the time frame, if needed, that an irradiation test reactor capability would be required."

MOTIVATION

- Nuclear power is an important carbon-free power source.
- Starting in 2030, a significant number of operating U.S. nuclear reactors will reach 60 years of age.
- Some operating reactors will not seek subsequent license renewal.
- DOE-NE draft vision and strategy indicates that replacement nuclear power options will include a combination of advanced LWRs, SMRs, and advanced reactor technologies employing fast spectrum reactors and non-LWR coolants.
- Deployment of new fuels and materials for advanced reactor technologies and evolutionary fuels and materials for existing LWR technologies requires irradiation data to demonstrate and document their performance.
- U.S. materials and test reactors are aging (typically over 50 years old).

APPROACH


NEAC Test Reactor Charge Letter
User Needs
Irradiation Capabilities
Existing and Near-Term
Domestic -
Workshop and Solicitations
• Government
• Existing Fleet (Vendors, Suppliers, etc.)
SMR and Advanced Reactors
International -
Solicitations
Domestic –
Surveys
International -
Surveys
Draft Report
• Public Meeting - December 2016 NEAC Meeting
• Posted on NEAC Website
Public Comments
Final Report

U.S. IRRADIATION FACILITY ASSESSMENT FINDINGS

- Existing U.S. facilities provide significant capability for testing fuels and materials in a thermal neutron spectrum, but provide limited capacity for testing in a fast neutron spectrum (e.g., > $5x10^{14}$ $n/cm^2/s$, E > 0.1 MeV or 6 dpa per year).
- Existing U.S. facilities are not currently capable of irradiating fuels and materials in environments (thermal, hydraulic, mechanical, and chemical) representative of advanced liquid-metal or molten-salt reactors.
- Existing U.S. facilities are approximately 50 years old. Appropriate investments are required for their continued operation.
- Limited instrumentation and experimental support capabilities are available at existing U.S. facilities. Additional investment is required for U.S. facilities to offer options available at international facilities.

INTERNATIONAL IRRADIATION FACILITY ASSESSMENT FINDINGS

- Japan well positioned with their own SFR and HTGR test reactors for next 30 years
- Korea plans to build SFR by 2028 and currently uses BOR-60, but would be interested in participating in U.S. advanced test reactor (ATR) if based on sodium technology
- China already has SFR test reactor with plans to add a new one, but it would be interested in participating in a U.S. ATR
- UK does not have any test reactors; uses OECD Halden now and JHR in future; Fast flux is not adequate for advanced reactors (GFR, SFR, and LFR). Currently planned experiments all in Halden, but would be interested in U.S. ATR in 2030 if fast reactor capability of JHR does not materialize
- Euratom interested in lead-bismuth, SFR, and GFR, but planning 'not well advanced'. Interest in U.S. ATR depends on EU circumstance at that time
- Czech Republic has no plans for ATR and would utilize JHR when available. Interested in exploring collaboration with U.S. on ATR. Their LVR-15 can be utilized in non-LWR areas to complement U.S. ATR
- Argentina, Brazil, and Poland are not interested in U.S. ATR; focused on LWRs

ASSESSMENT OF U.S. IRRADIATION NEEDS

- Formed 'Ad hoc' Subcommittee composed of members from Fuel Cycle and Reactor Technology Subcommittees
- Invited over 20 organizations from industry (reactor/fuel vendors, designers, and developers) and government (NRC, NR, NNSA, DoC, DoD, etc.) to a 10/28 meeting at Argonne to discuss irradiation needs
  - Speakers: GA, Westinghouse, Terrestrial, GE-Hitachi, Lightbridge, EPRI, Oklo, Elysium Inc, Terrapower
  - Other industry/government participants: NR, ORNL, ANL, LANL, Southern Company, NEI, U.S. NRC, U.S. DOE
- Also received written input from Terrapower, Westinghouse, AREVA, and ARC

U.S. IRRADIATION NEED FINDINGS

- A new domestic fast flux test reactor could address several missions:
  - Fast reactor fuel and materials irradiations;
  - Accelerated materials damage irradiations;
  - Full-length fuel assembly/large component irradiations;
  - Provide domestic capability (avoiding export control issues, shipping and retrieval of samples and data, limited irradiation time, etc.)

- Desired traits to accomplish these missions include:
  - Fast flux (~5E14 to 1E16 n/cm^2-s, E > 0.1 MeV)/higher dpa (> 6 dpa/yr);
  - Large test volume (> 10 liters and > 1 meter length);
  - Loops with coolants used in non-LWR concepts;
  - Advanced real-time instrumentation and trained staff comparable to that in international test reactor facilities;
  - High reliability/availability;
  - Operational as soon as possible (in order to meet the schedule proposed by some advanced reactor vendors).

U.S. IRRADIATION NEED FINDINGS (CONTINUED)

- Some vendors indicate that a new test reactor is not essential for deploying their advanced reactor design. Backup plans include:
  - Relying on data from a non-U.S. test reactor
  - Obtaining data from existing U.S. facilities (e.g., ATR)

- Most participants indicated that a new domestic test reactor is still useful for longer term needs (e.g., using higher dpa to identify performance issues before they occur in a reactor, larger test volumes for fuel assemblies and large components, etc.)

U.S. IRRADIATION NEED RECOMMENDATION

The Ad Hoc NEAC Subcommittee recommends that DOE-NE proceed immediately with pre-conceptual design planning activities to support a new test reactor (including cost and schedule estimates). These activities would ultimately lead to the preparation of a mission need document. The planning activities would summarize the test reactor capability gap, describe why current facilities are not sufficient to address the gap, and discuss why a new test reactor is needed to support the DOE-NE strategic plan and its overall R&D program for advanced reactor concepts, as well as provide a pre-conceptual design of the reactor to meet stated technical objectives.

PATH FORWARD

- Update preliminary draft report findings and recommendations based on input obtained at December 2016 NEAC meeting;

- By December 31, 2016, post Draft Report, “Assessment of User Needs for Irradiation Testing” on NEAC website:

  http://www.energy.gov/ne/services/nuclear-energy-advisory-committee

- Comments on draft report due January 15, 2017. Final report will be issued mid-February