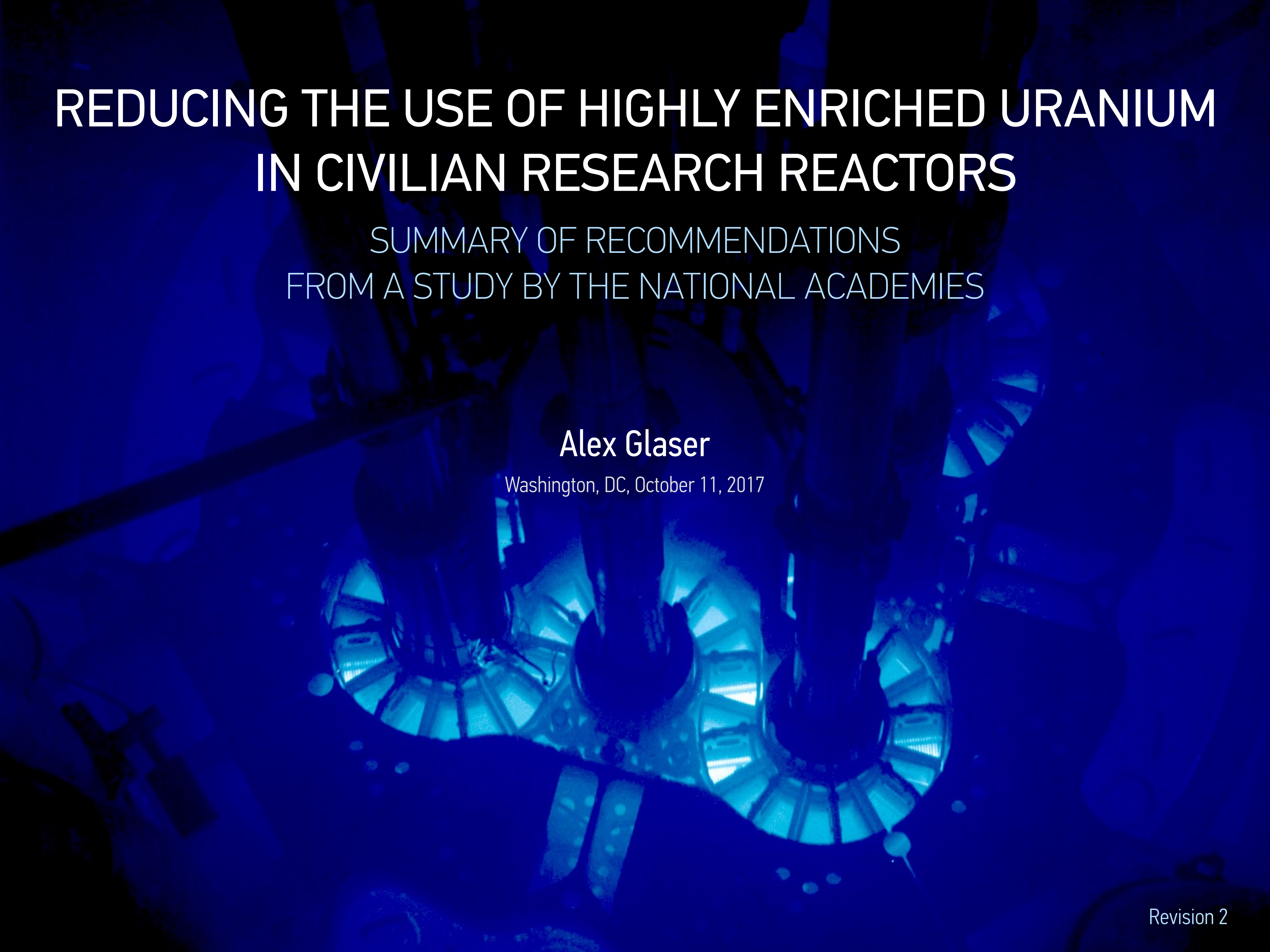


REDUCING THE USE OF HIGHLY ENRICHED URANIUM IN CIVILIAN RESEARCH REACTORS

SUMMARY OF RECOMMENDATIONS FROM A STUDY BY THE NATIONAL ACADEMIES

Alex Glaser

Washington, DC, October 11, 2017

Revision 2

COMMITTEE MEMBERS

Julia M. Phillips	Chair, Sandia National Laboratories (retired)
Pablo Adelfang	International Atomic Energy Agency (retired)
Gerald Gabrielse	Harvard University
Alexander Glaser	Princeton University
David W. Johnson	Journal of the American Ceramic Society
Patrick Lemoine	Commissariat à l'Energie Atomique (retired)
William R. Martin	University of Michigan
Roger Pynn	Indiana University-Bloomington
William H. Tobey	Harvard University
Paul Wilson	University of Wisconsin-Madison
Pavel Podvig	Technical consultant, Princeton University
Jennifer Heimberg	Study Director

Reducing *the Use of Highly Enriched Uranium in Civilian Research Reactors,* National Academies of Sciences, Engineering, and Medicine
The National Academies Press, Washington, DC, 2016, doi.org/10.17226/21818

STATEMENT OF TASK

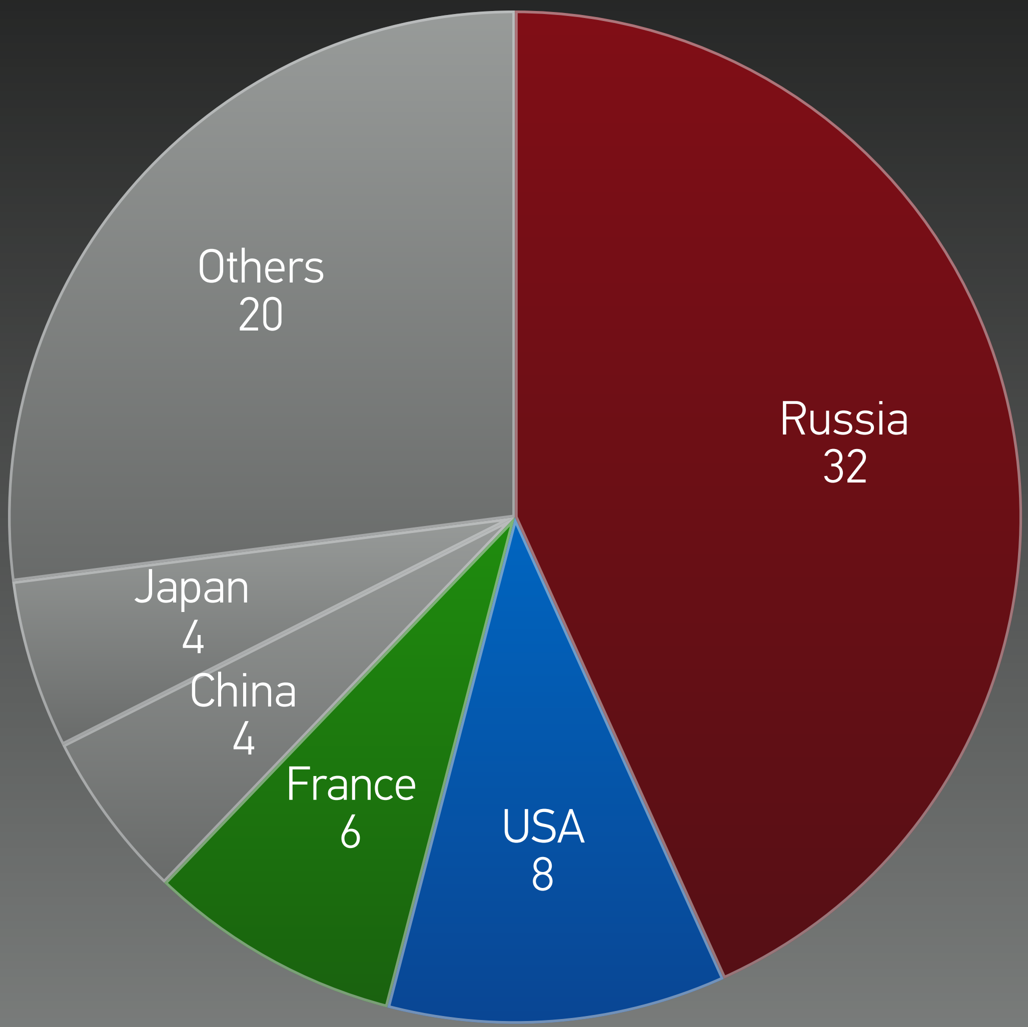
The committee will review the current status of and progress toward eliminating highly enriched uranium (HEU) use in fuel for civilian research and test reactors. This study will provide:

1. A list of civilian research and test reactors that operate using HEU fuel.

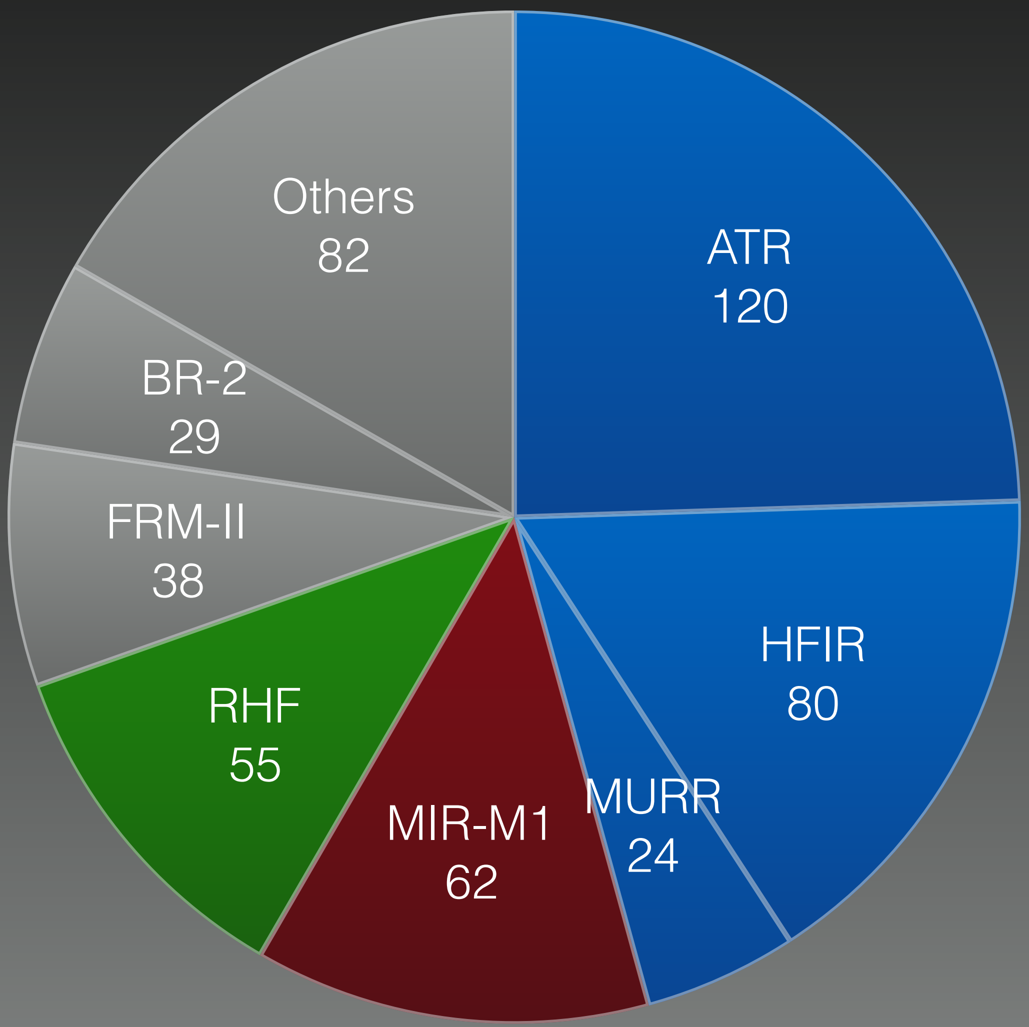
2. A review of civilian research and test reactor conversion status over the past five years.

3. An assessment of the progress being made by the Department of Energy and others to eliminate worldwide use of HEU in fuel for civilian research and test reactors. This assessment should **identify key technical and nontechnical factors and obstacles** to conversion; key obstacles to converting the remaining HEU-fueled reactors; and **steps that could be taken to overcome the identified obstacles**.

WHERE HEU IS USED TODAY



Number of HEU-fueled
civilian research reactors (74)



Approximate annual
HEU consumption (490 kg)

Data from M. K. Meyer, A Global Overview of High Density U-Mo Fuel Development Efforts, *International Symposium on Minimization of Highly Enriched Uranium (HEU) in the Civilian Nuclear Sector: The Way Ahead,* Oslo, Norway, June 17-20, 2006

SEVEN RECOMMENDATIONS

1. Develop a 50-year interagency strategy and roadmap for neutron needs
2. Continue the development of very high-density LEU fuels for research reactors
3. Monitor the development of dispersion-type fuels as a backup for U.S. research reactors
4. Pursue an interim solution for conversion of high-performance research reactors
5. Engage Russia in conversion efforts through periodic workshops and scientific exchanges
6. Augment the annual progress reports of the M^3 program
7. Conduct independent technical review for robust project and risk management

Reducing *the Use of Highly Enriched Uranium in Civilian Research Reactors,* National Academies of Sciences, Engineering, and Medicine
The National Academies Press, Washington, DC, 2016, doi.org/10.17226/21818

ENRICHMENT REQUIREMENTS FOR HIGH-PERFORMANCE REACTORS

	Years to LEU conversion	Monolithic 16 g(U)/cc	UMo(8wt%) 8.0 g(U)/cc	U_3Si_2 5.8 g(U)/cc	U_3Si_2 4.8 g(U)/cc
ATR	14 years	LEU	25–30%	~ 30%	35–40%
HFIR	17 years	LEU	25–30%	~ 30%	35–40%
NBSR	12 years	LEU	LEU	LEU	~ 25%
MURR	12 years	LEU	~ 35%	~ 40%	~ 45%
MITR-II	12 years	LEU	20–25%	~ 30%	~ 35%
FRM-II	n/a	> 20%	30–35%	~ 40%	50–60%
BR-2	< 10 years	LEU	LEU	~ 22%	~ 27%
JHR	< 10 years	LEU	LEU	~ 22%	~ 27%
RHF	< 10 years	LEU	LEU	~ 22%	~ 27%

RUSSIA STILL HAS VAST AMOUNTS OF EXCESS HEU

BUT THEY ARE CONTAMINATED WITH UNWANTED URANIUM ISOTOPES

300–400 TONS OF ADDITIONAL HEU ARE "DE FACTO" EXCESS

Russia's current military inventory is estimated at about 650 tons of HEU

No more than 100 tons would be in the weapons stockpile

Apparently, remaining Russian HEU has an elevated content of minor uranium isotopes (U-232 and U-236, in addition to U-234) and cannot easily be used as source material for reactor fuel applications

IN 2012, RUSSIA "DISCREETLY" RESTARTED HEU PRODUCTION

Ending 25-year moratorium

Zelenogorsk Enrichment Plant (EKhZ) is producing weapon-grade uranium for FRM-II (and HEU with lower enrichment levels for other international customers)

Source: www.ecp.ru/eng