REDUCING THE USE OF HIGHLY ENRICHED URANIUM IN CIVILIAN RESEARCH REACTORS

SUMMARY OF RECOMMENDATIONS FROM A STUDY BY THE NATIONAL ACADEMIES

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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)

- Russia: 32
- Japan: 4
- China: 4
- France: 6
- USA: 8
- Others: 20

Approximate annual HEU consumption (490 kg)

- ATR: 120
- MIR-M1: 62
- MURR: 24
- HFIR: 80
- FRM-II: 38
- RHF: 55
- BR-2: 29
- Others: 82

# 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 M³ 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
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## Enrichment Requirements for High-Performance Reactors

<table>
<thead>
<tr>
<th>Reactor</th>
<th>Years to LEU Conversion</th>
<th>Monolithic 16 g(U)/cc</th>
<th>UMo(8 wt%) 8.0 g(U)/cc</th>
<th>U₃Si₂ 5.8 g(U)/cc</th>
<th>U₃Si₂ 4.8 g(U)/cc</th>
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</thead>
<tbody>
<tr>
<td>ATR</td>
<td>14 years</td>
<td>LEU</td>
<td>25–30%</td>
<td>~ 30%</td>
<td>35–40%</td>
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<tr>
<td>HFIR</td>
<td>17 years</td>
<td>LEU</td>
<td>25–30%</td>
<td>~ 30%</td>
<td>35–40%</td>
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<tr>
<td>NBSR</td>
<td>12 years</td>
<td>LEU</td>
<td>LEU</td>
<td>LEU</td>
<td>~ 25%</td>
</tr>
<tr>
<td>MURR</td>
<td>12 years</td>
<td>LEU</td>
<td>~ 35%</td>
<td>~ 40%</td>
<td>~ 45%</td>
</tr>
<tr>
<td>MITR-II</td>
<td>12 years</td>
<td>LEU</td>
<td>20–25%</td>
<td>~ 30%</td>
<td>~ 35%</td>
</tr>
<tr>
<td>FRM-II</td>
<td>n/a</td>
<td>&gt; 20%</td>
<td>30–35%</td>
<td>~ 40%</td>
<td>50–60%</td>
</tr>
<tr>
<td>BR-2</td>
<td>&lt; 10 years</td>
<td>LEU</td>
<td>LEU</td>
<td>~ 22%</td>
<td>~ 27%</td>
</tr>
<tr>
<td>JHR</td>
<td>&lt; 10 years</td>
<td>LEU</td>
<td>LEU</td>
<td>~ 22%</td>
<td>~ 27%</td>
</tr>
<tr>
<td>RHF</td>
<td>&lt; 10 years</td>
<td>LEU</td>
<td>LEU</td>
<td>~ 22%</td>
<td>~ 27%</td>
</tr>
</tbody>
</table>
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