Save the World with Nuclear Waste: Design, Simulation, and New Approaches

26 July 2016
Leslie Dewan
- Background and Motivation
- Reactor Technology
- Turning it into a Company
- Current Status and Path Forward
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Spent fuel pool in Oskarshamn, Sweden

How to address the actinide waste problem?
With computer simulations!
What’s the best way to solve the underlying problems?
Motivation and Background

Reactor Technology

Turning it into a Company

Current Status and Path Forward
<table>
<thead>
<tr>
<th>SCWR Supercritical</th>
<th>VHTR Pebble-gas</th>
<th>MSR Molten salt</th>
<th>SFR Sodium fast</th>
<th>LFR Lead fast</th>
<th>GFR Gas fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Burnup</td>
<td></td>
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<tr>
<td>Low Pressure</td>
<td></td>
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<tr>
<td>Thermal Spectrum</td>
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</tbody>
</table>

MSRE Demonstration at Oak Ridge National Lab (1965-1969)
<table>
<thead>
<tr>
<th>Feature</th>
<th>1960’s Design</th>
<th>Transatomic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MODERATOR</strong></td>
<td>GRAPHITE</td>
<td>Zirconium Hydride</td>
</tr>
<tr>
<td><strong>SALT</strong></td>
<td>FLiBe+UF₄</td>
<td>LiF+UF₄</td>
</tr>
<tr>
<td><strong>FUEL ENRICHMENT</strong></td>
<td>33%-93%</td>
<td>1.8% or spent Fuel</td>
</tr>
<tr>
<td><strong>POWER DENSITY</strong> (MWₜₜ/m³)</td>
<td>4</td>
<td>66</td>
</tr>
</tbody>
</table>
Neutron Spectrum (n/cm²-s-dU)

Energy (MeV)

- Thermal
- Epithermal
- Fast

Graphite

ZrH1.6

Unmoderated
Neutron Spectrum (n/cm²-s-dU)

- **ZrH1.6**
- **Graphite**
- **Unmoderated**

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**Energy (MeV)**

- **Thermal**
- **Epithermal**
- **Fast**

**Fissions all Actinides**
Neutron Spectrum (n/cm²s-τ₁₂₃)

- **ZrH₁.₆**
- **Graphite**
- **Unmoderated**

**Ensemble:**
- Thermal
- Epithermal
- Fast

**Fissions:**
- Fissions Only
- Fissile
- Fissions all Actinides

**Energy (MeV):**
- 1E⁻⁸
- 1E⁻⁷
- 1E⁻⁶
- 1E⁻⁵
- 1E⁻⁴
- 1E⁻³
- 1E⁻²
- 1E⁻¹
- 1E⁰
- 1E¹
Neutron Spectrum (n/cm²-s-dU)

- **ZrH1.6**
- **Graphite**
- **Unmoderated**

**Energy (MeV):**
- Thermal
- Epithermal
- Fast

**Regions:**
- Fissions Only
- Fissile
- Avoid! Resonances!
- Fissions all Actinides
Higher burnup and greatly reduced waste

- More than 4 times the burnup of current light water reactors, depending on the fuel cycle
  \[\rightarrow 215 \text{ vs } 45 \text{ GWD/MTHM}\]
- **83% waste reduction** compared to light water reactors (normalized to 1250 MWth), depending on the fuel cycle
  \[\rightarrow 1.6 \text{ vs } 9.6 \text{ tons/year}\]

**Figure 4.** Burnup (left, blue) and normalized waste production (right, red) for the examined fuel cycles, normalized to a 1250 MWth power level.
So, what do we do next with this?
ADVISORS AND BOARD MEMBERS

Dr. Regis Matzie
Former Westinghouse CTO

Dr. George Apostolakis
Former Commissioner
Nuclear Regulatory Commission ('10-'14)

Ray Rothrock
Former Chairman
National Venture Capital Assoc.

Dr. Richard Lester
Former Department Head
MIT Nuclear Science & Engineering

Dr. Michael Corradini
Prof. Wisconsin Nuclear Dept.
President of the ANS ('12-'13)

Russ Wilcox
Founder and CEO of E Ink Corp.

NOTE: advisors serve in an individual capacity and do not represent their institutions
THE CORE TEAM

Dr. Leslie Dewan
- PhD MIT Nuclear Science & Engineering
- SB MIT Nuclear Science & Engineering
- SB MIT Mechanical Engineering
- MIT Presidential Fellow
- DOE Computational Science Graduate Fellow
- World Economic Forum Young Global Leader

Mark Massie
- MS MIT Nuclear Engineering
- SB Tennessee Nuclear Engineering
- DOE Nuclear Engineering University Program Fellow
- DOE Advanced Fuel Cycle Initiative Fellow
- Forbes 30 Under 30

Sean Robertson
- MSc, INSTN-CEA/Université de Paris-Sud

Wendolyn Holland
- Yale University
- Kellogg MBA
- Previous Director of Strategic Development at Savannah River National Lab

Steve Smith
- US Nuclear Navy Veteran
- MS, Old Dominion University
- Oxford University

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A 520 MWe REACTOR FOR GRID-SCALE POWER GENERATION
Motivation and Background

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Current Status and Path Forward
Regulatory Considerations

- How will the regulatory process affect the timeline?
- How can we improve the situation?
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• How will the regulatory process affect the timeline?
• How can we improve the situation?

House Unanimously Passes Bipartisan Nuclear Energy Bill

Feb 29, 2016  |  Press Release

Washington, D.C. — The House of Representatives today approved the Nuclear Energy Innovation Capabilities Act (H.R. 4084), a bipartisan bill to support federal research and