

Title:

Accelerator Transmutation of Nuclear Waste: Towards the Elimination of Long-Lived Radioactive Waste

Author(s):

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For presentation at the Pyrochemical Workshop to be held in Albuquerque, NM on October 21, 1993

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September 29, 1993  
13th Pyrochemical Workshop  
October 18-21, 1993  
Albuquerque, NM

**Accelerator Transmutation of Nuclear Waste:  
Towards the Elimination of Long-Lived Radioactive Waste**

**Harry J. Dewey  
Chemical Science and Technology Division  
Los Alamos National Laboratory**

**Abstract:**

Researchers at Los Alamos have been developing transmutation concepts involving accelerator-driven nuclear systems. A medium energy, high current proton beam strikes a heavy metal target, producing a high flux of spallation neutrons. These neutrons are moderated to near-thermal energies in a blanket surrounding the target. Materials to be transmuted flow through the blanket region where they are fissioned or transmuted to stable nuclides. Stable or short-lived nuclides are separated while the long-lived radioactive species are returned to the blanket. For most applications the fission energy produced is much greater than that required to power the accelerator and can be directed to the commercial power grid.

A number of possible applications are envisioned for accelerator-driven nuclear systems. These include destruction of surplus weapons-grade plutonium, production of tritium, transmutation of commercial spent fuel, and even commercial power generation in next-generation nuclear power plants. Some of these applications will be discussed with particular emphasis on the required chemical separations for such systems.

# **Accelerator Transmutation of Nuclear Waste: Towards the Elimination of Long-lived Radioactive Waste**

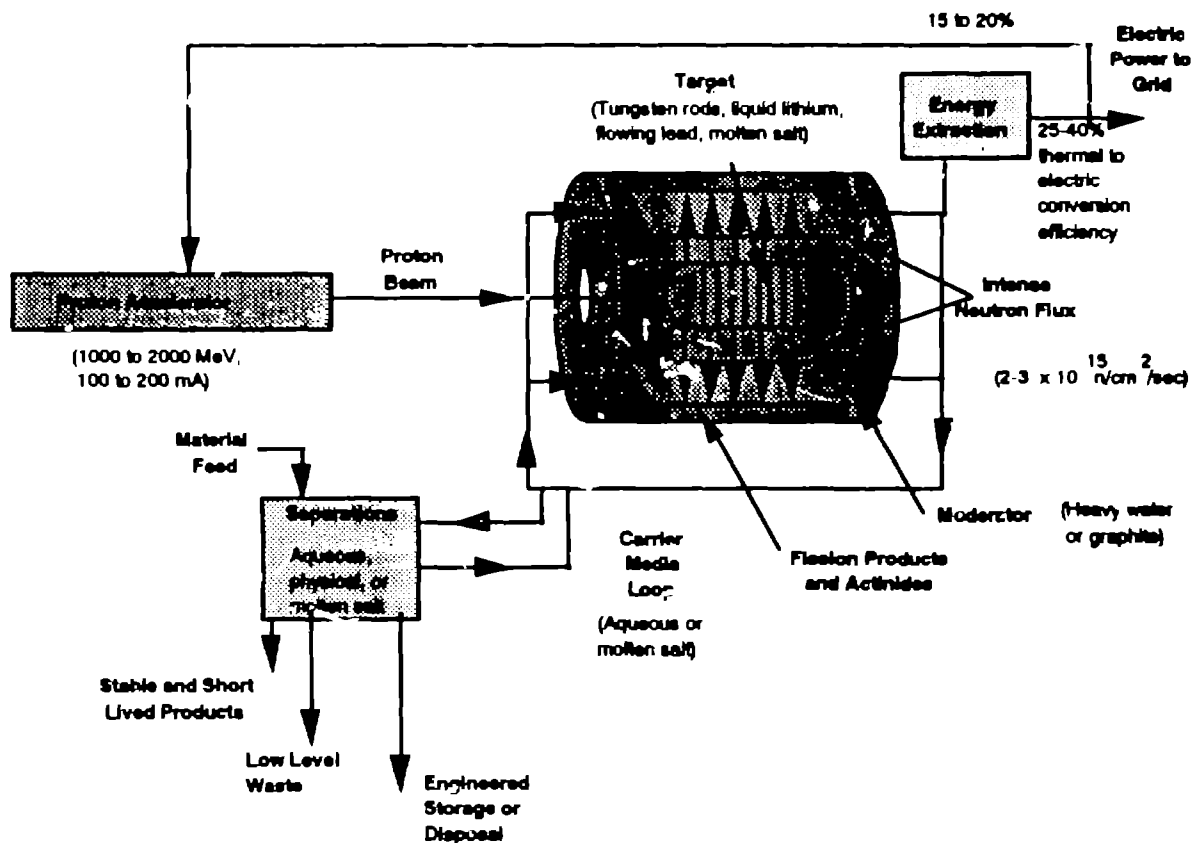
**Harry J. Dewey**

**Los Alamos National Laboratory**

**13th Pyrochemical Workshop  
Albuquerque, NM  
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# General Features ATW System

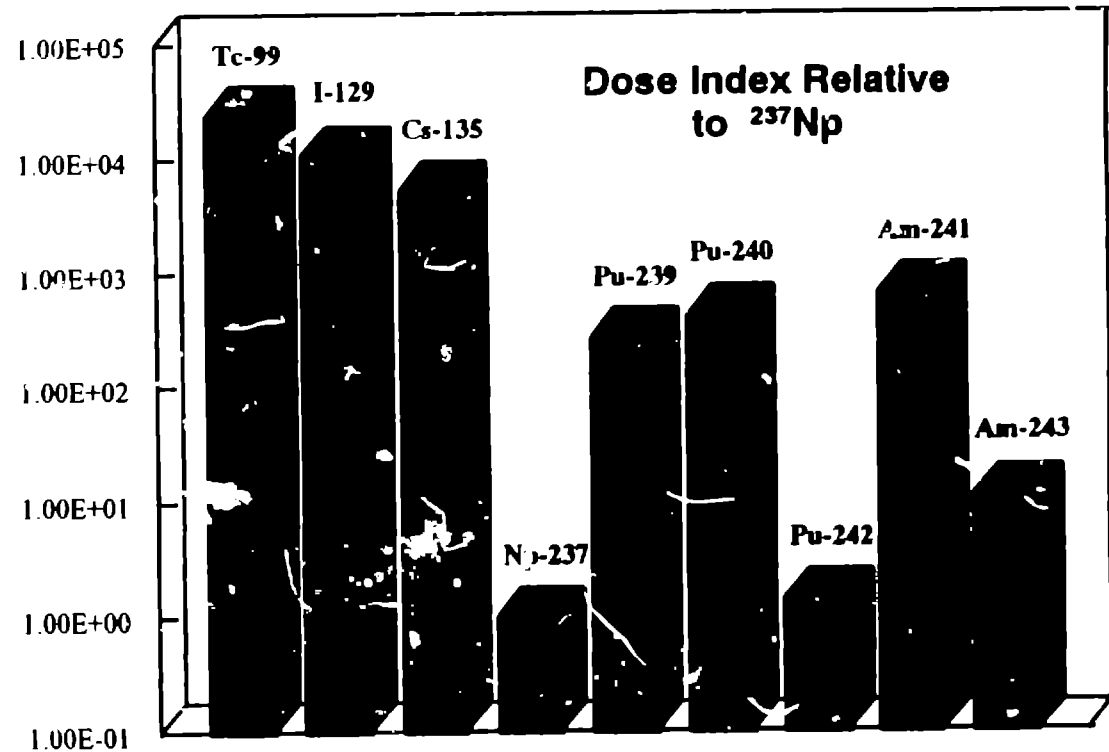
- Driven, sub critical system
- Intense thermal neutron fluxes
- High transmutation cross sections
- Minimal material inventories
- Continuous material feed
- Advanced separations



<b>Nuclide</b>	<b>Half-Life (years)</b>	<b>Isotopic Abundance</b>	<b>ATW Production Rate (g/kg fissioned)</b>	<b>Capture Cross Section (CANDU) (barns)</b>
<sup>79</sup> Se	6.50x10 <sup>4</sup>	11.24%	0.13	1.188
<sup>93</sup> Zr	1.50x10 <sup>6</sup>	19.30%	13.75	2.123
<sup>99</sup> Tc	2.13x10 <sup>5</sup>	100%	19.94	16.620
<sup>107</sup> Pd	6.50x10 <sup>6</sup>	21.21%	15.02	6.760
<sup>126</sup> Sn	1.00x10 <sup>5</sup>	40.41%	0.88	0.167
<sup>129</sup> I	1.57x10 <sup>7</sup>	72.88%	5.27	15.370
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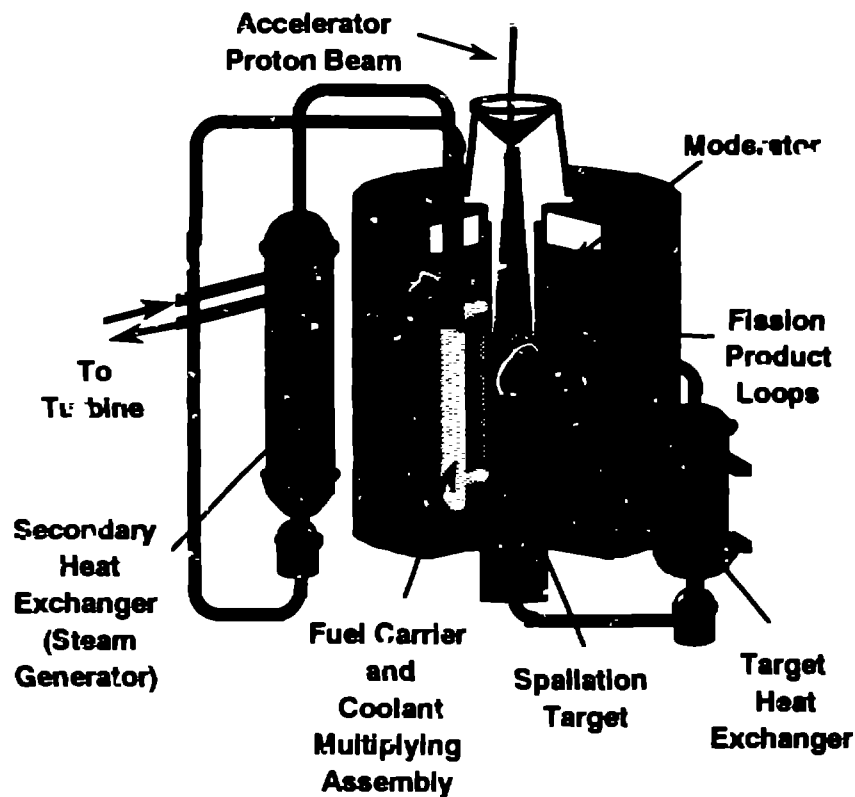
# Radiation Dose from Contaminated Water from Proposed U.S. Repository is Dominated by Fission Products

<u>Species</u>	<u>Halflife (yrs)</u>
<sup>99</sup> Tc	213,000
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Dose Index = (Repository Inventory)(Fractional Dissolution Rate)(Dose Conversion Factor)

# Target and Blanket Approaches

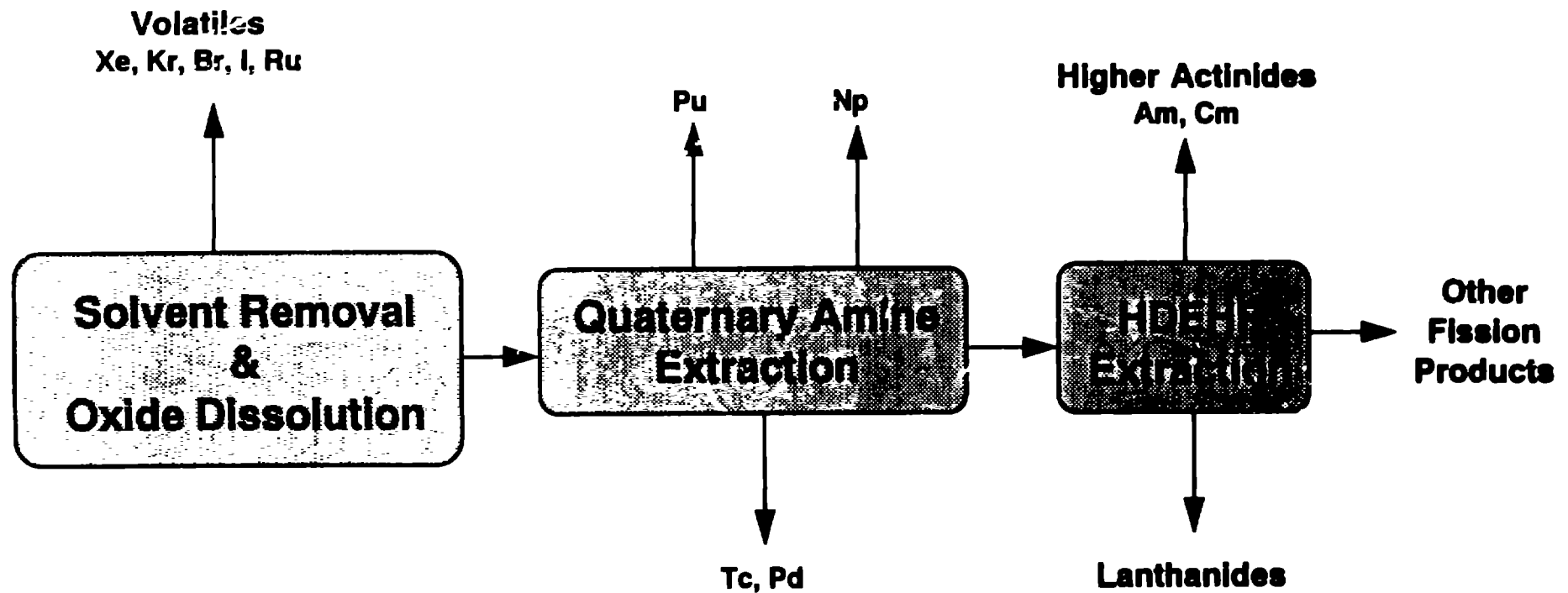


<u>Technical Approach</u>	<u>Aqueous (Reference)</u>	<u>Non Aqueous (Advanced)</u>
<u>Target</u>	Solid Tungsten/ Lead	Flowing Metal
<u>Multiplying Blanket</u>		
<u>Moderator Fluid Fuel</u>	D <sub>2</sub> O Oxide Slurry	Graphite Molten Fluoride Salt
<u>Features</u>	Allows concept "existence proof"	Superior neutronics, economics
<u>Separations</u>	Demonstrated	Advanced

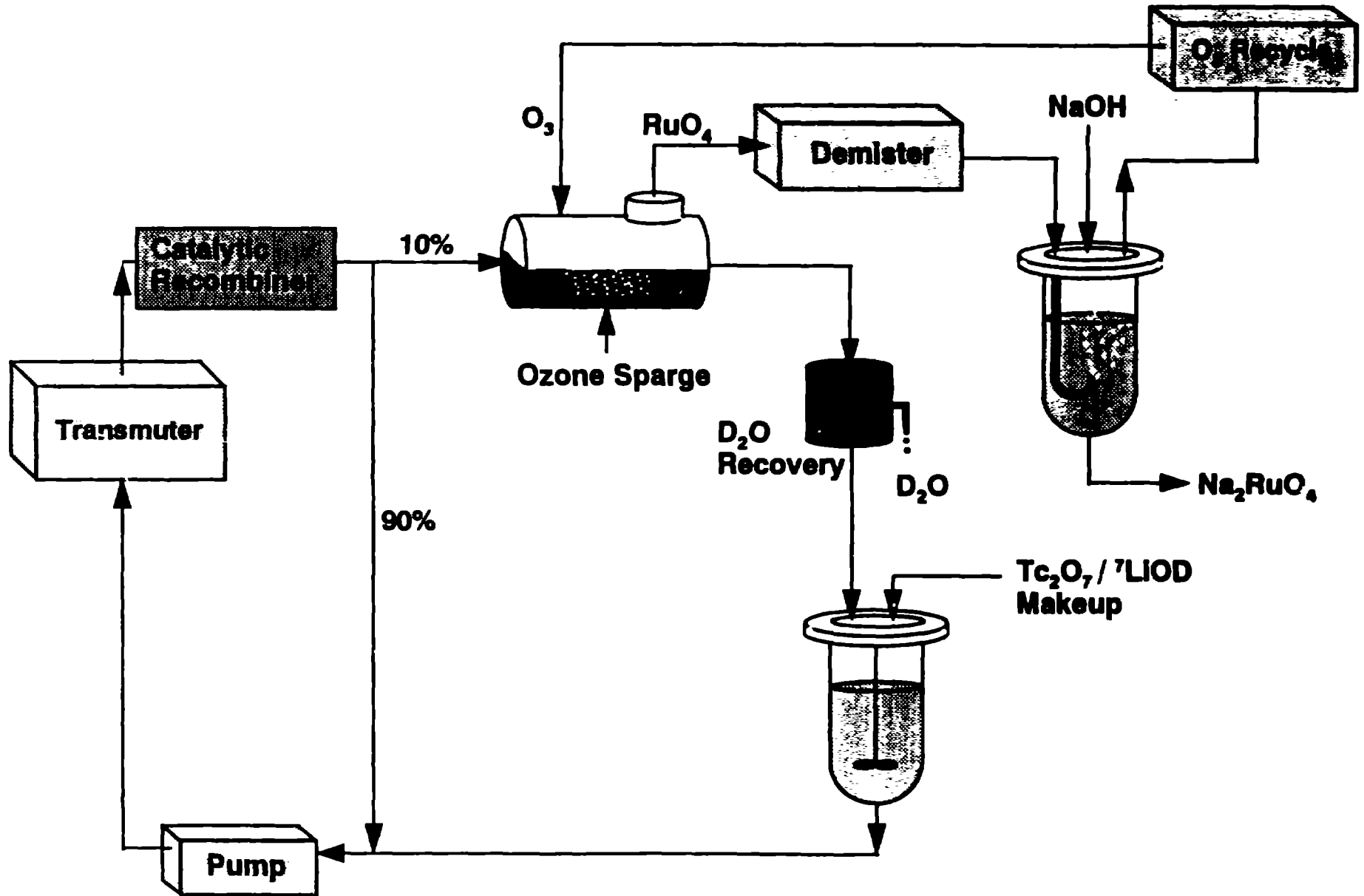




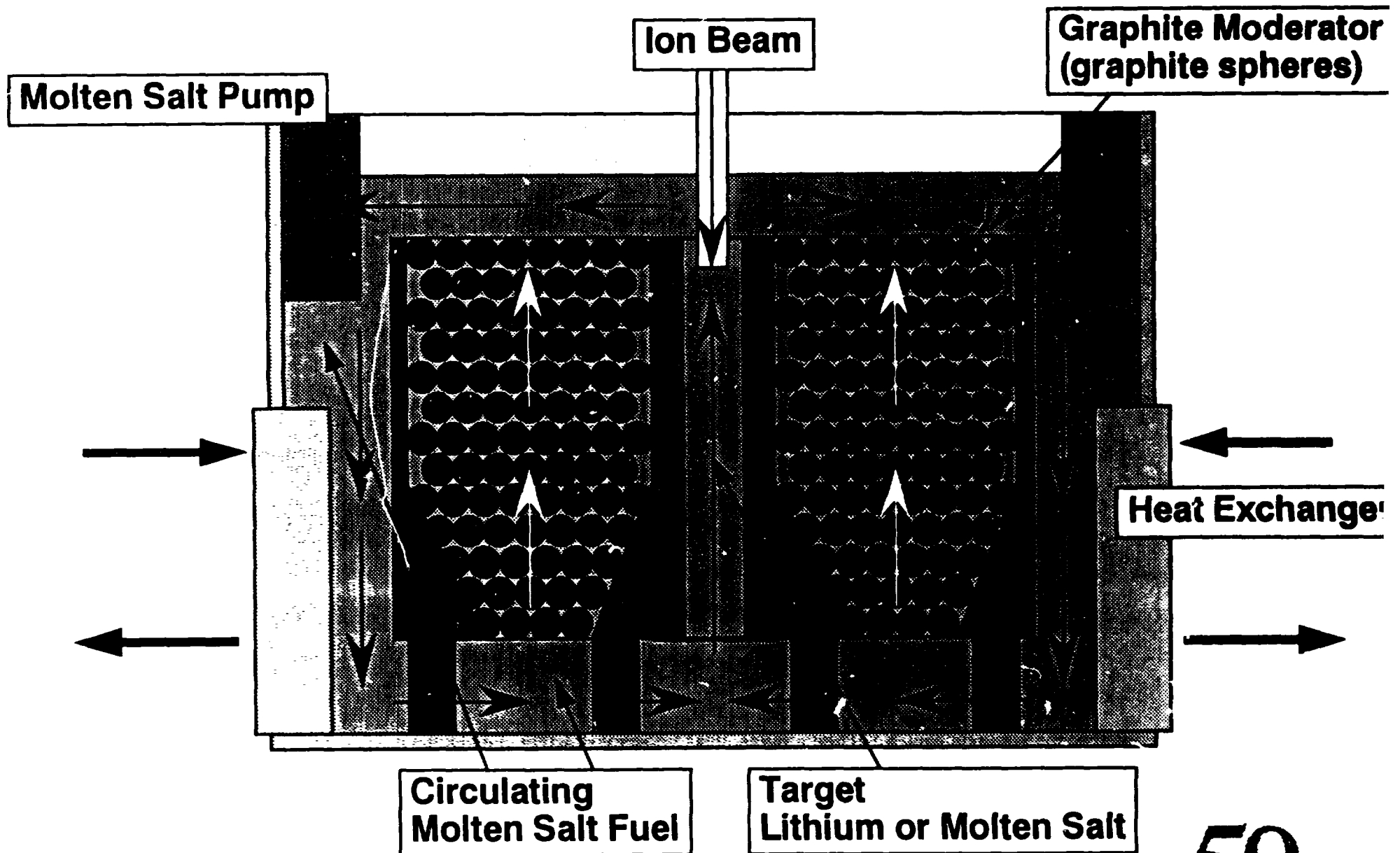
# Example of an Aqueous Approach to ATW Separations



# Ozonolysis Option for Tc/Ru Separation



# Schematic layout of the non-aqueous target/blanket assembly



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# General Features ATW System

Driven subcritical system

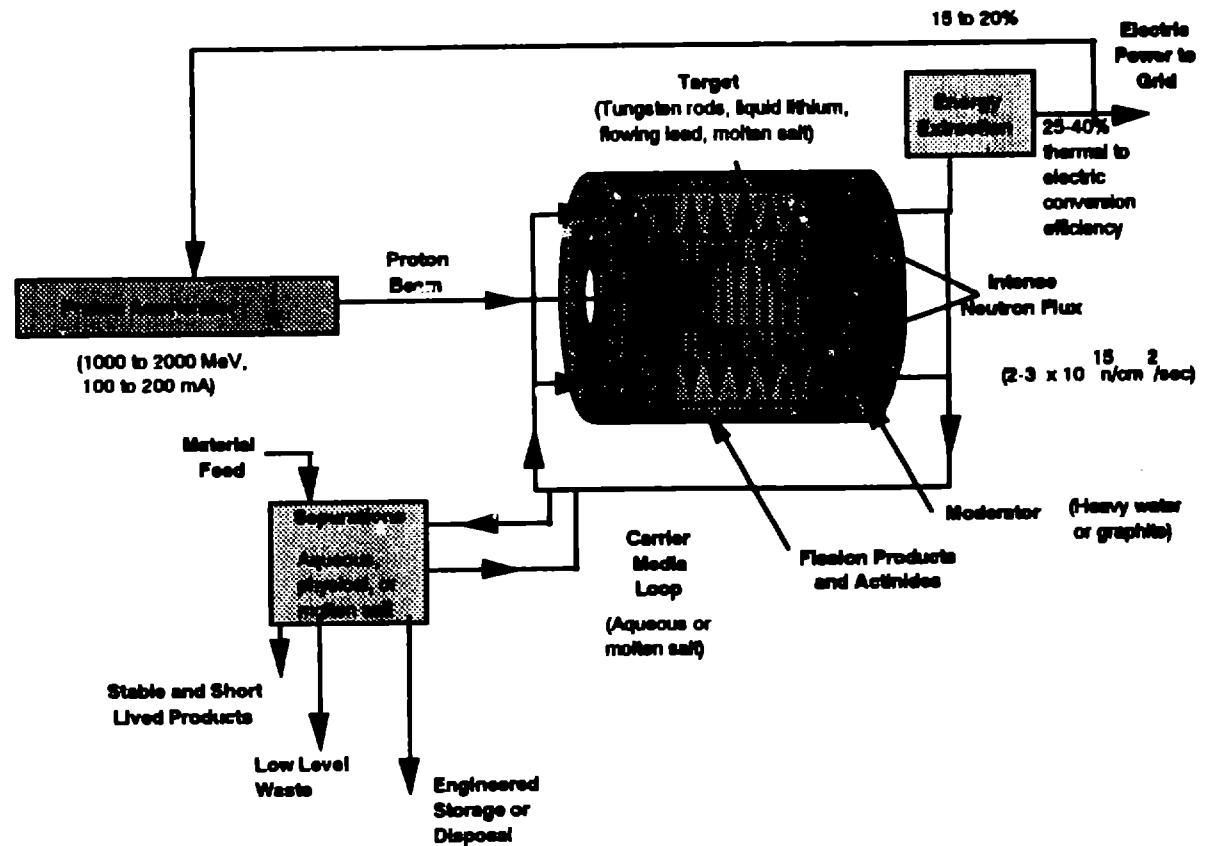
Intense thermal neutron fluxes

High transmutation cross sections

Minimal material inventories

Continuous material feed

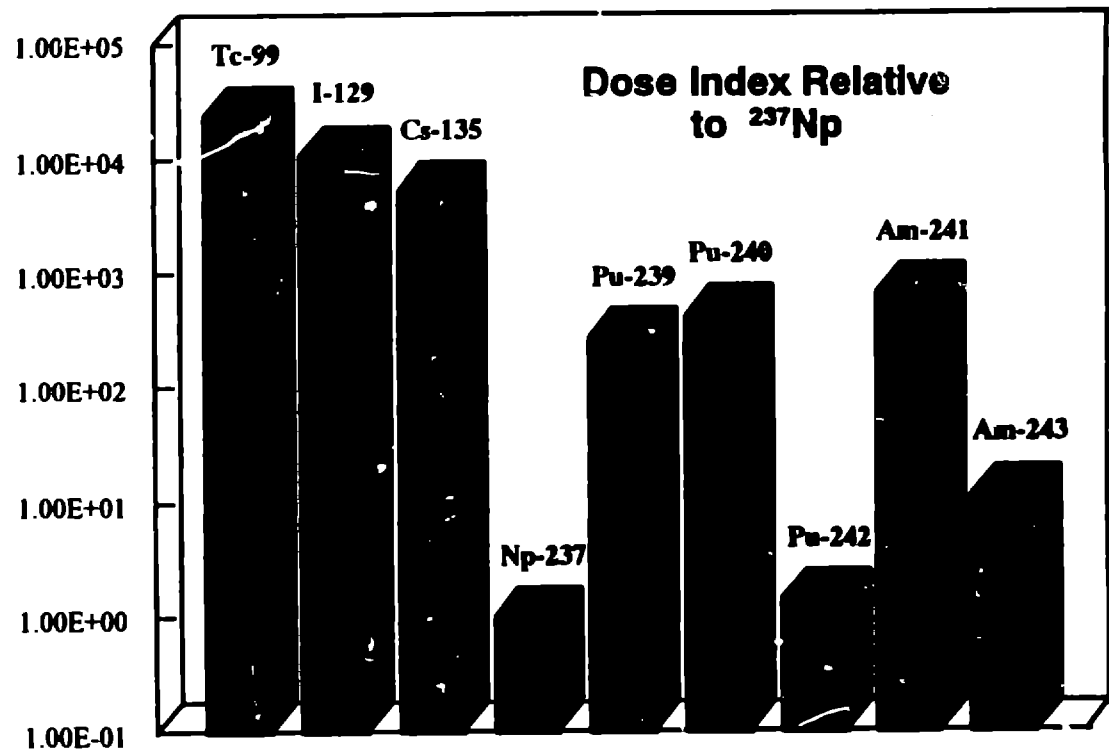
Advanced separations



<b>Nuclide</b>	<b>Half-Life (years)</b>	<b>Isotopic Abundance</b>	<b>ATW Production Rate (g/kg fissioned)</b>	<b>Capture Cross Section (CANDU) (barns)</b>
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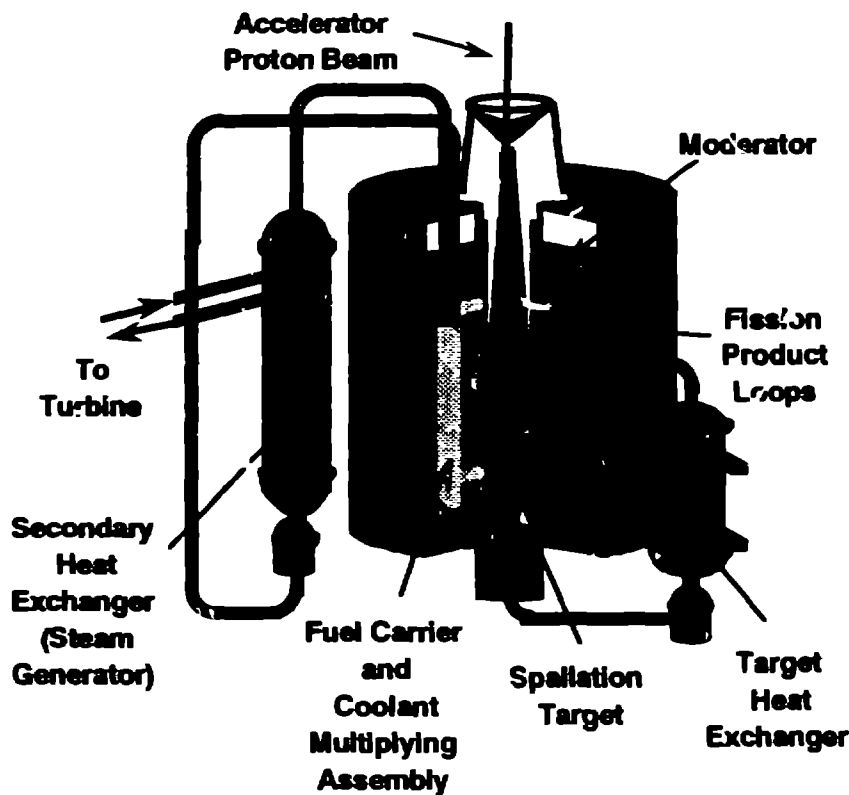
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# Target and Blanket Approaches

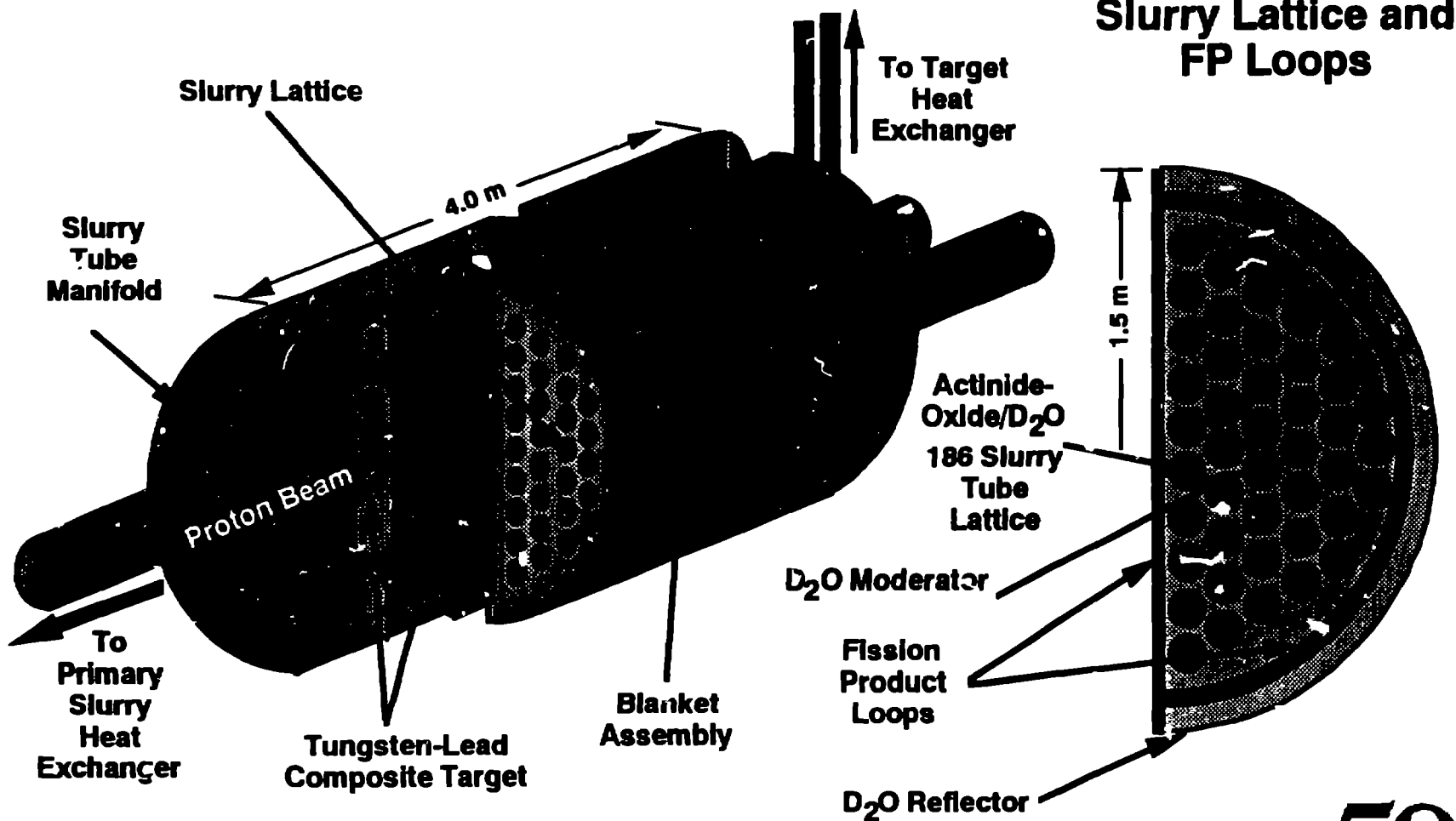


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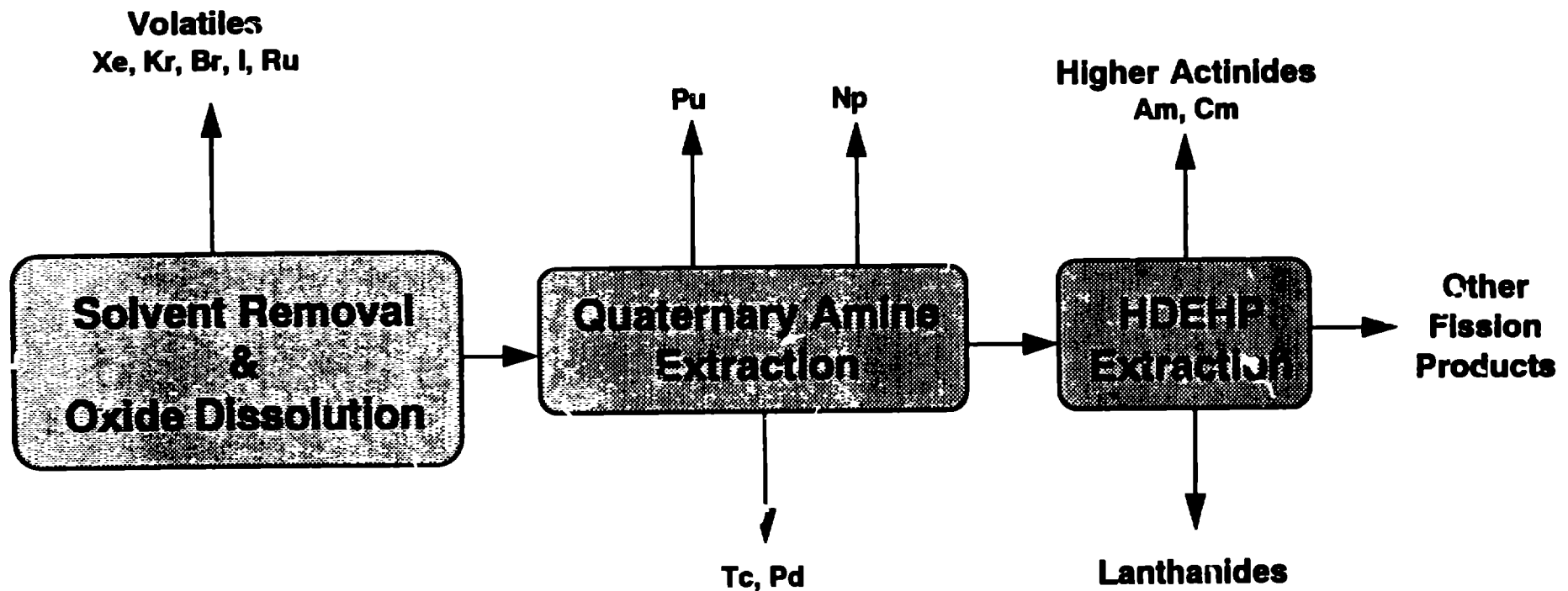


# AQUEOUS-BASED ATW /ABC TARGET-BLANKET CONCEPT

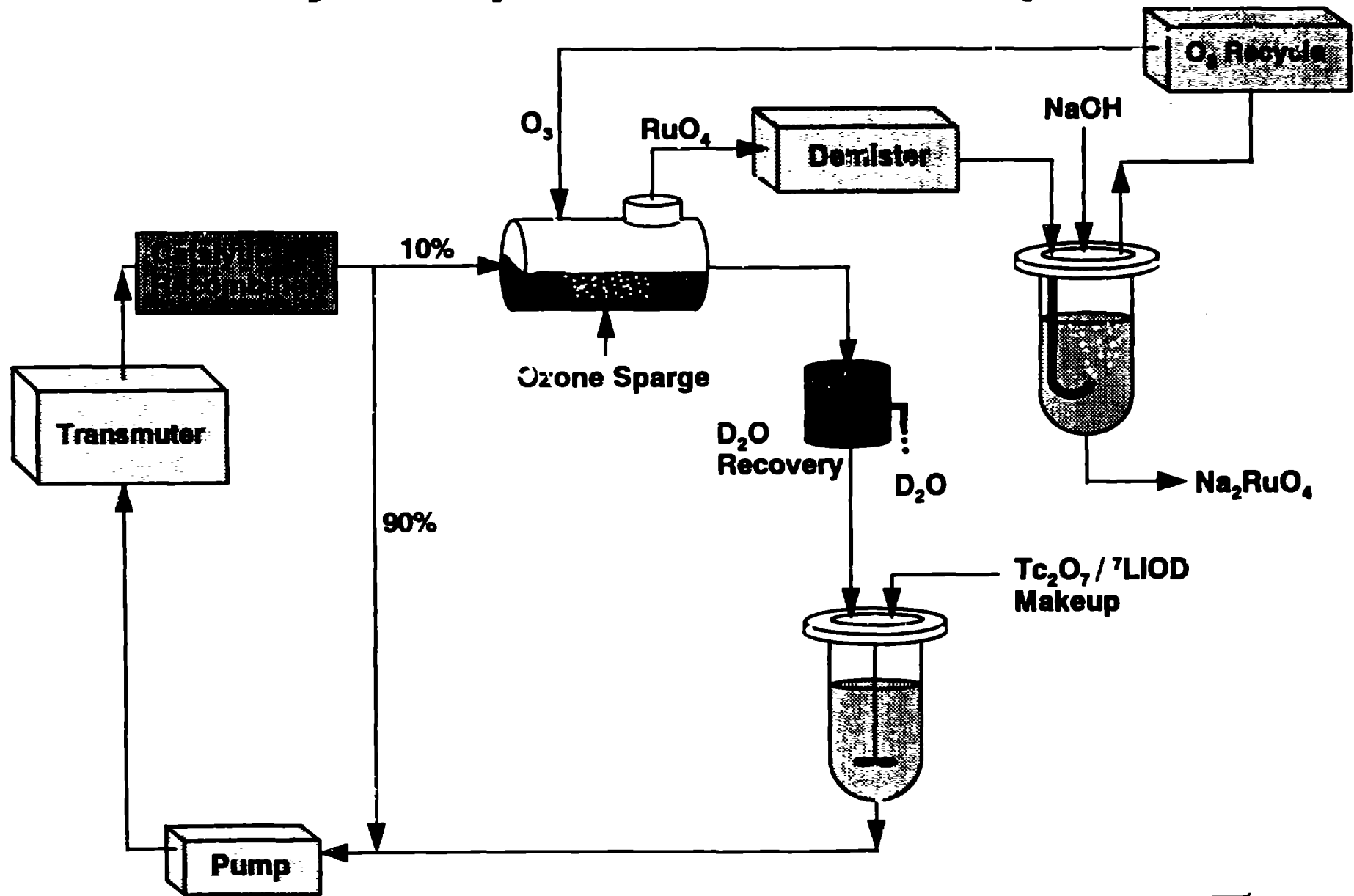
## Target-Blanket Configuration



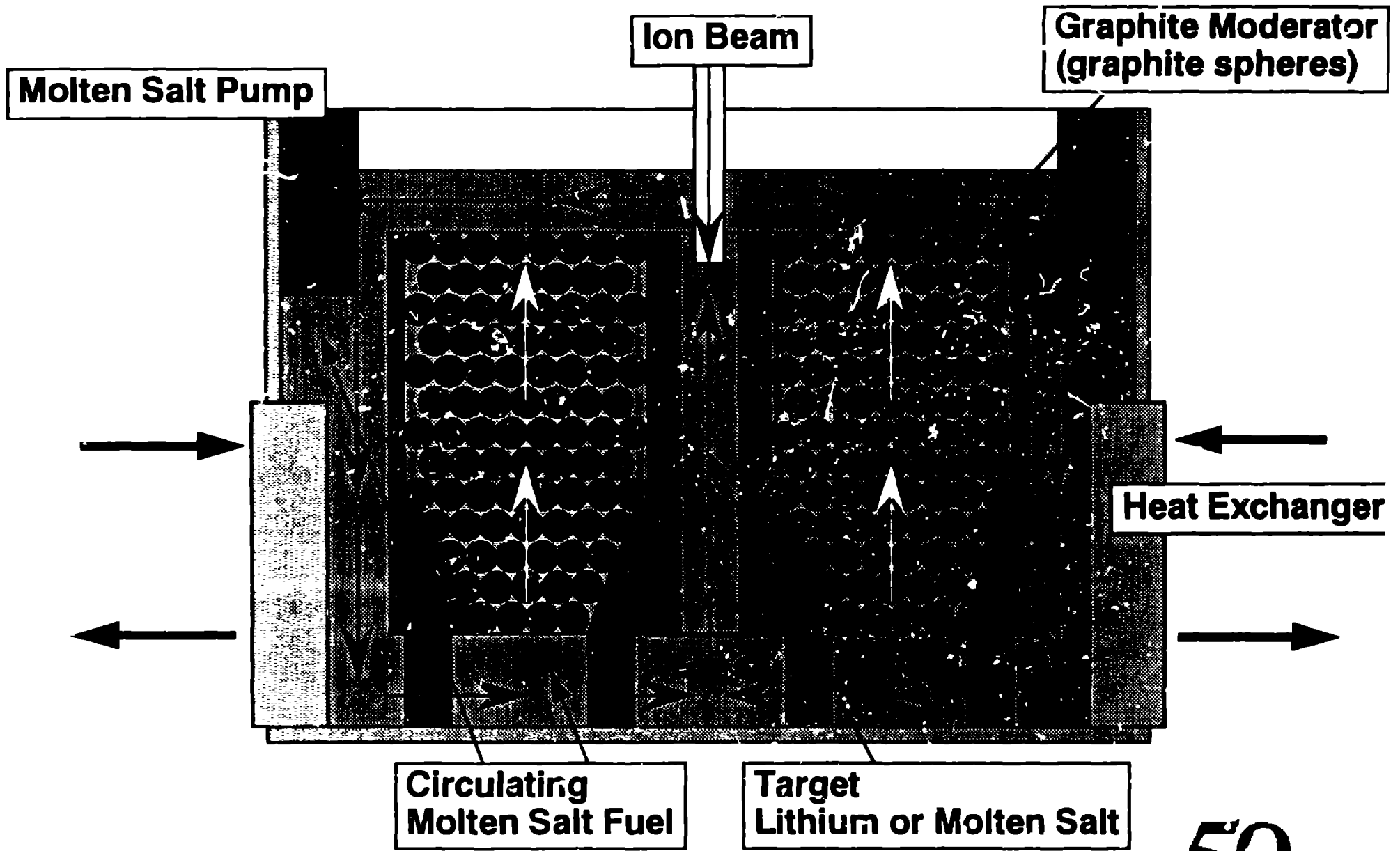
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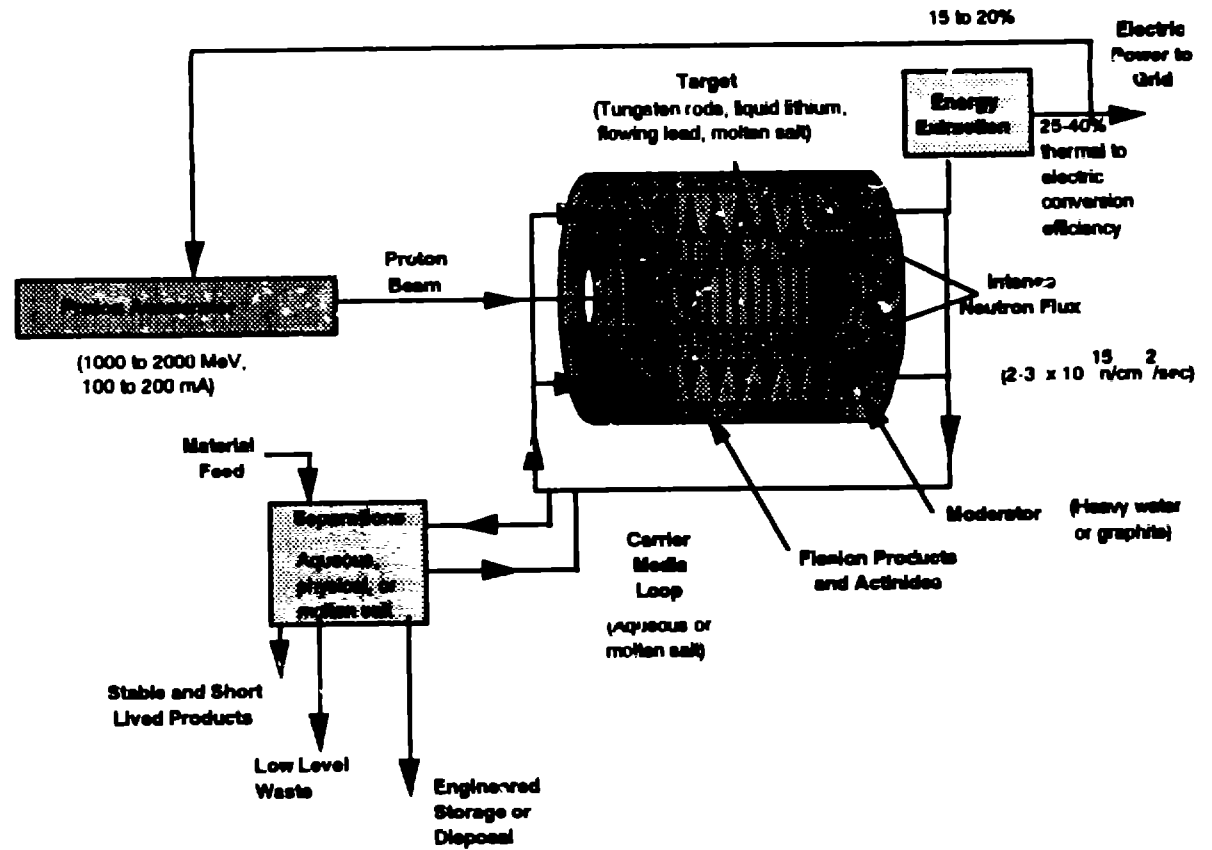
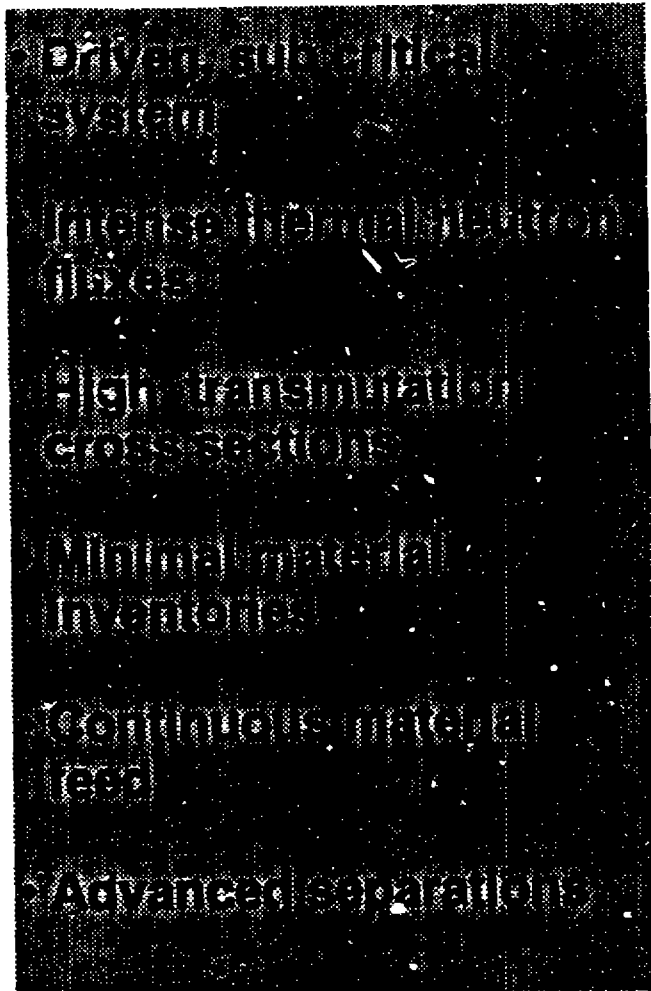
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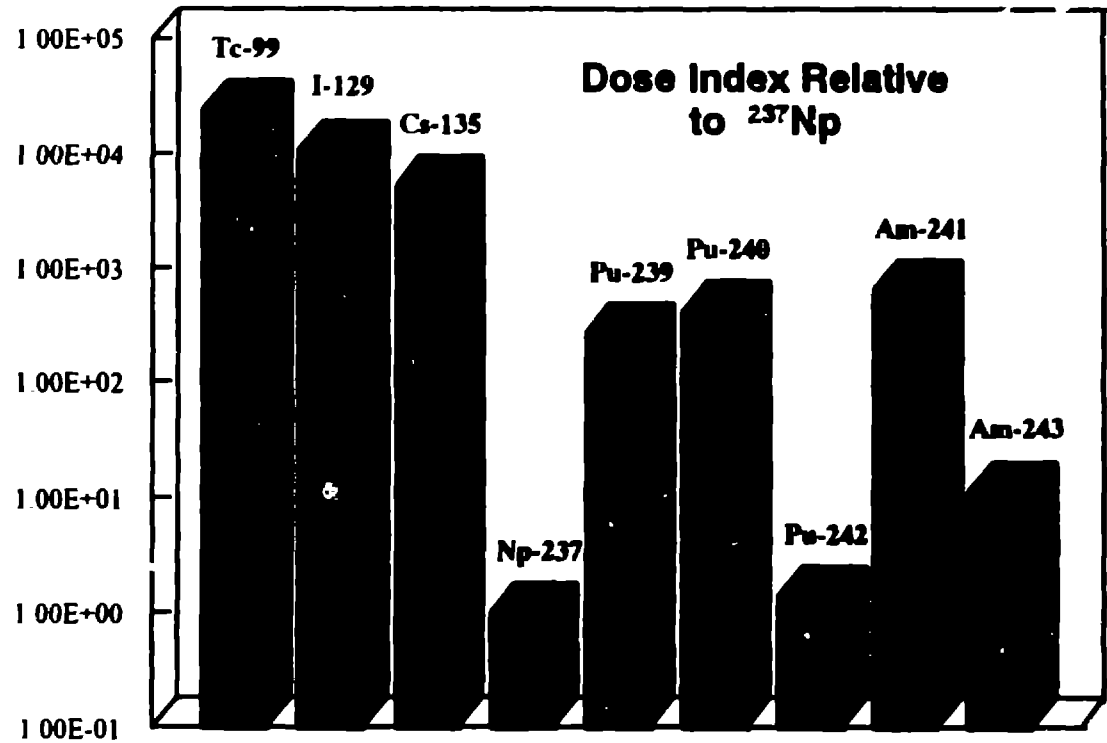
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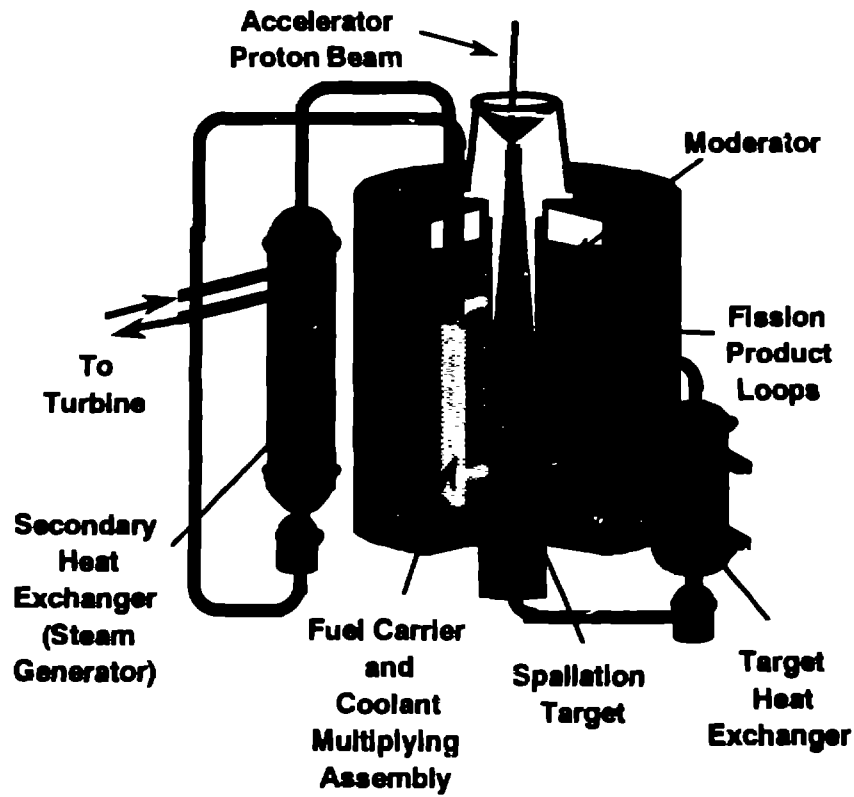
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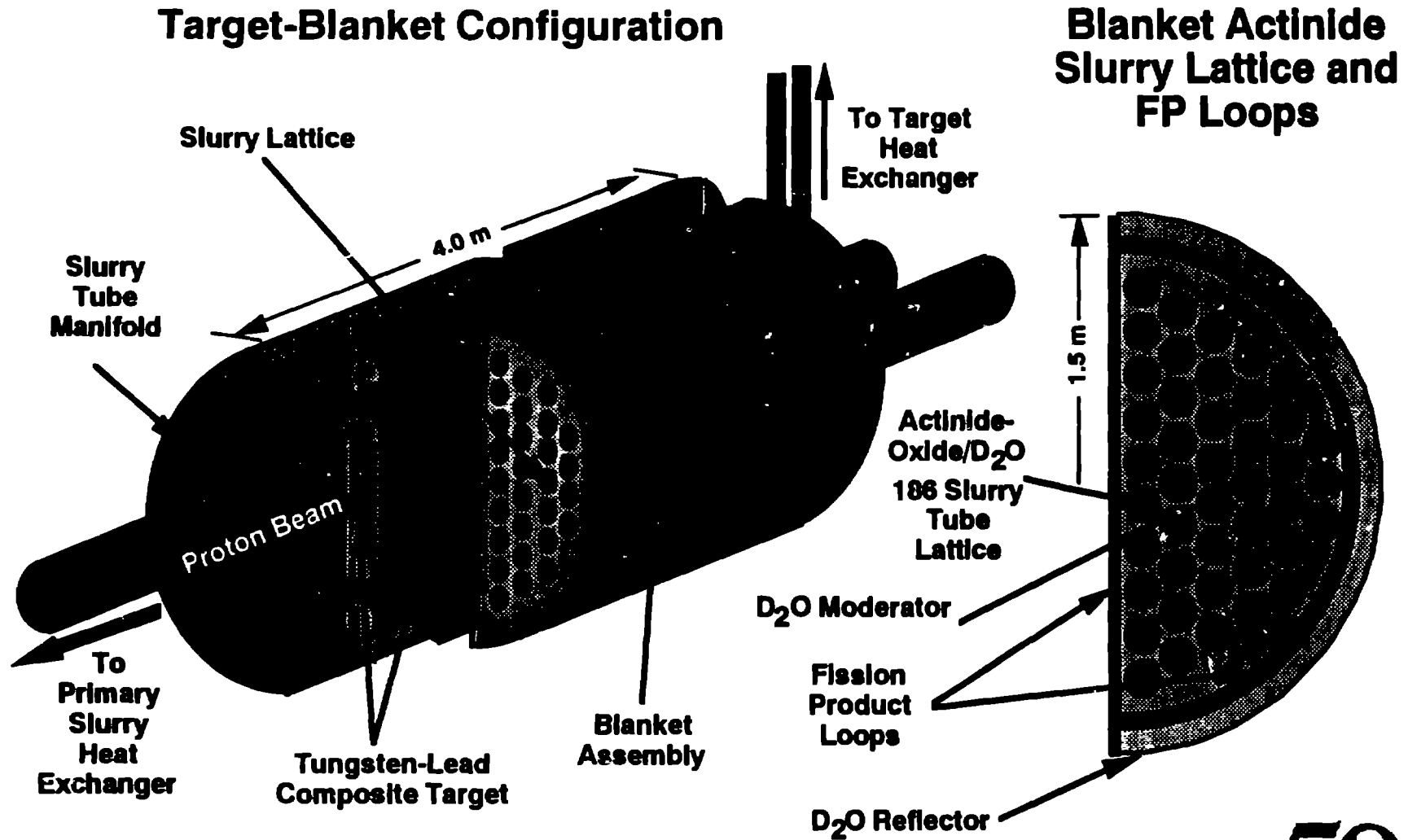


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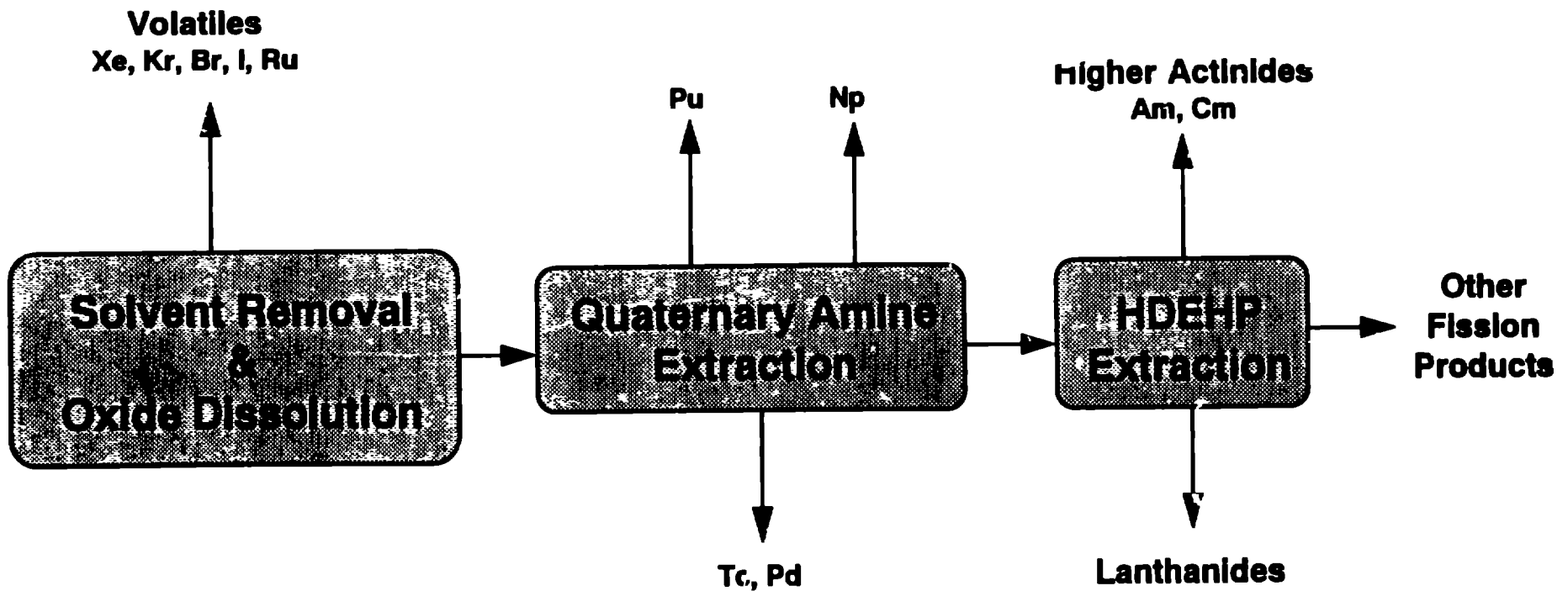


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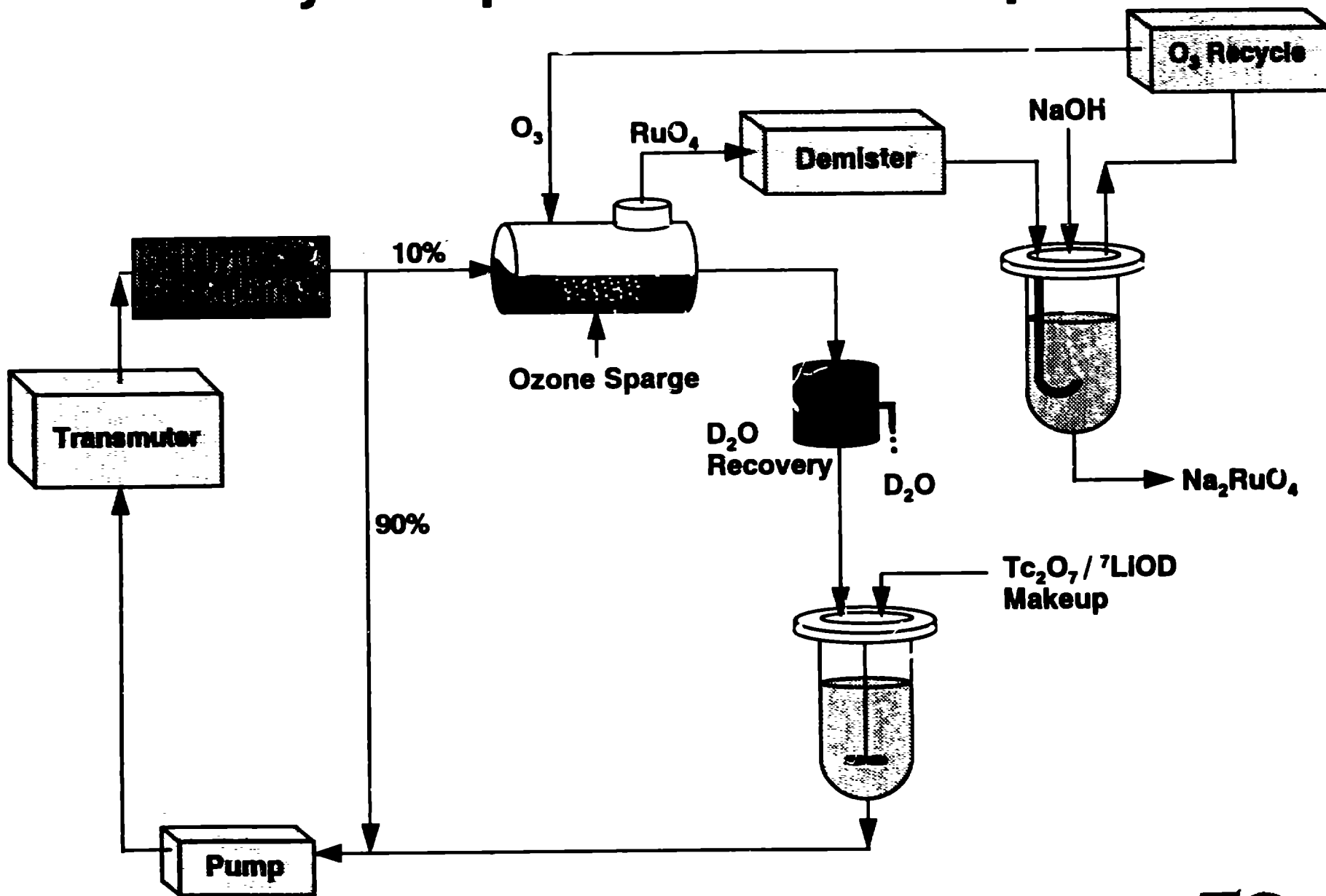
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