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# International Perspective on non-HEU Mo-99 Production

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Major facilities in the global supply chain of Mo-99

# Mo-99/Tc-99m Supply Chain

**Fuel and Target Supply**

**Reactors**

**Reactors produce Mo-99 raw material using Uranium-235 targets**

**Mo-99 Processing Facilities**

**Processors purify the Mo-99 raw material to produce processed Mo-99**

**Tc-99m Generator Facilities**

**Generator manufacturers produce Tc-99m generators from processed Mo-99**

**Hospitals and Pharmacies**

**Use Tc-99m generators to perform nuclear medicine procedures**

**Waste management**

# Current Supply Chain and its Challenges

- Clarity of current challenges:
  - NEA High Level Group has done excellent work on security of supply
  - IAEA technical programs have given insights into manufacturing issues
- The significant challenges which have been identified include:
  - An aging reactor fleet
  - Distortions in the elements of cost recovery
  - Future options for improved economics in the supply chain
- Challenges that need more focus and effort
  - Distortions embedded in “reimbursement” in some jurisdictions – need advice for governments
  - A road-map for the future of Tc-99m imaging aimed at users
  - Single points of failure: fuel, targets, waste

# Production Methodology

- Mo-99 dominantly produced from the fission of uranium
- Interesting and innovative work undertaken on alternate methodologies
  - Accelerator based systems
  - Solution reactor
  - New and improved techniques for neutron activation of Mo-98
- Estimates of technological maturity and the costs of alternatives to Mo-99 production in reactors now available

# Looking Forward

- Reactor based production is likely to remain the mainstay for the planning horizon of the medical community
- Manufacturing capability based on complete elimination of HEU from fuel and target plates remains a challenge
- The challenge is exacerbated by continued distortions and a lack of transparent full cost recovery in major marketplaces
- Sustainability requires that waste is eliminated or mitigated

# Australia's Position

- Significant national investment in the Open Pool Australian Light Water multipurpose reactor (LEU/LEU)
- Mo-99 production facility
- OPAL first went critical in 2006
- Mo-99 plant commissioned in 2008
- Commitment to waste processing

OPAL research reactor

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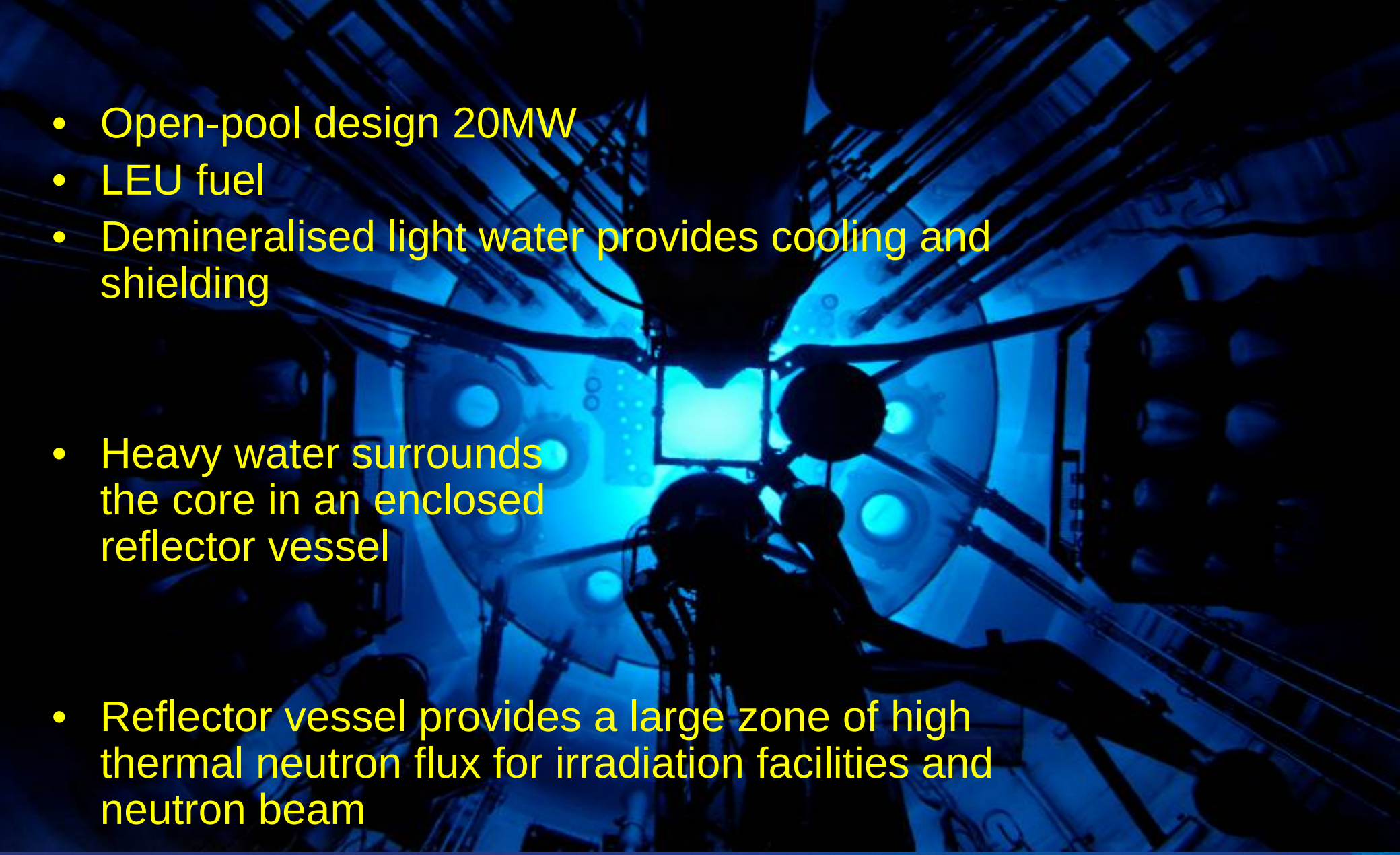

- Open-pool design 20MW
- LEU fuel
- Demineralised light water provides cooling and shielding

- Heavy water surrounds the core in an enclosed reflector vessel

- Reflector vessel provides a large zone of high thermal neutron flux for irradiation facilities and neutron beam

# Mo-99 Plant

- Utilises LEU targets
- Initial mission to supply Australia and small regional markets
- Following supply crisis capacity increased to **1000 Ci** per week
- Able to export significant quantities

# The Use of LEU

- The use of LEU fuel and LEU target plates by Australia is in conformance with, and in support of, our commitment to the full removal of highly enriched uranium from all research reactors and the elimination of HEU in target plates for Mo-99 production

- We have demonstrated that high quality, compliant Mo-99 can be reliably produced using techniques based upon LEU

# Economics of LEU use

In-house analyses demonstrate (independently verified):

- Economically produce Mo-99
- Full disposition of waste from Mo-99 production
- Within range of the market prices for Mo-99
- Fully achievable within the framework of the HLG-MR proposals

# Market Challenges

- Current market prices not yet subject to the discipline of proper cost recovery at all stages of production
- No agreed mechanism to charge for waste management
- Responsible and sustainable nuclear medicine production should include a costing approach that includes the disposition of wastes from the processing of Mo-99.

# Future Production Distribution

- Market has both global and local dynamics
- Local and national issues should not be underestimated
- Investments in LEU-based reactor technology and scale-up of Mo-99 processing technology to provide robustness in the global supply has been under constant review by stakeholders globally over the last few years
- Regional distribution of production will do more to mitigate fears of supply constraints when new investments are considered

# Future Investment Requirements

- New investments require a predictable regulatory and non-proliferation regime especially to support full compliance
  - with the elimination of HEU
  - and provision for waste management in the nuclear medicine life cycle

- Two essential pre-conditions:
  - Condition of predictability
  - Condition of sufficiently distributed supply

- Nuclear medicine community: need to make confident investments in the expansion of diagnostic capabilities and the associated training development of a new generation of nuclear medicine practitioners.

# Looking Forward

- Short term actions, particularly associated with HEU/HEU ageing reactors that do not meet the criteria established in international discussions are continuing to have a distorting effect on the investment regime
- These short term actions can create conditions of supply uncertainty that negatively impact the confidence of the nuclear medicine community (and government stakeholders)
- Efforts to eliminate HEU from fuel and target plates must be intensified
- New investments must be able to rely on a predictable environment to the greatest extent possible, both in the very short term and in the future


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