Stable Salt Reactors

A new platform technology in nuclear fission

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Moltex mission

- To reduce the cost of nuclear fission energy so that it economically beats burning coal and gas and **the world** is powered with renewables and nuclear

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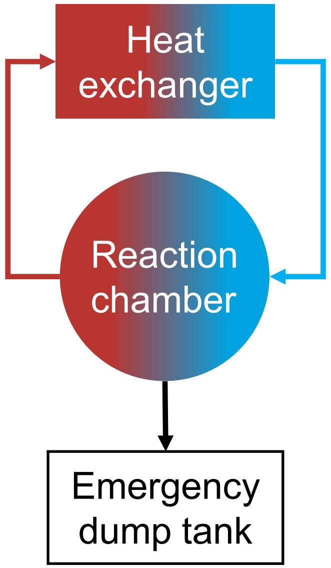
The real challenge for nuclear

- Nuclear energy with low enough capital and fixed operating costs to be profitable at 30-50% capacity factor in unsubsidised competition with fossil fuels
- Radical innovation needed to slash costs of nuclear
- SSR achieves that cost objective, comfortably, through a single minded focus on intrinsic safety and simplicity

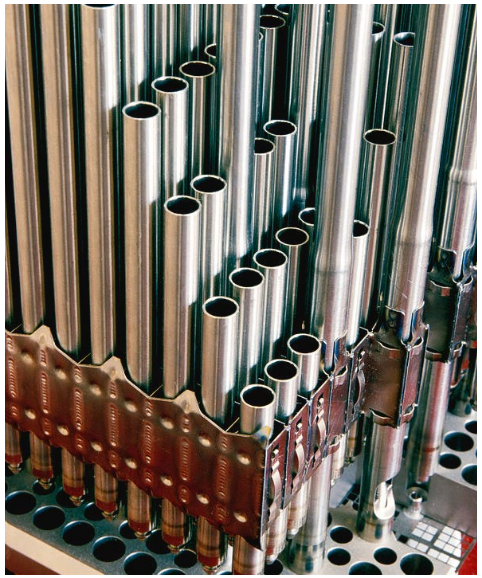
Two ways to use molten salt fuel

Conventional MSRs



- **Intensely radioactive fuel salt pumped at pressure round an engineered system which can never be approached by a human being**

Stable Salt Reactor platform

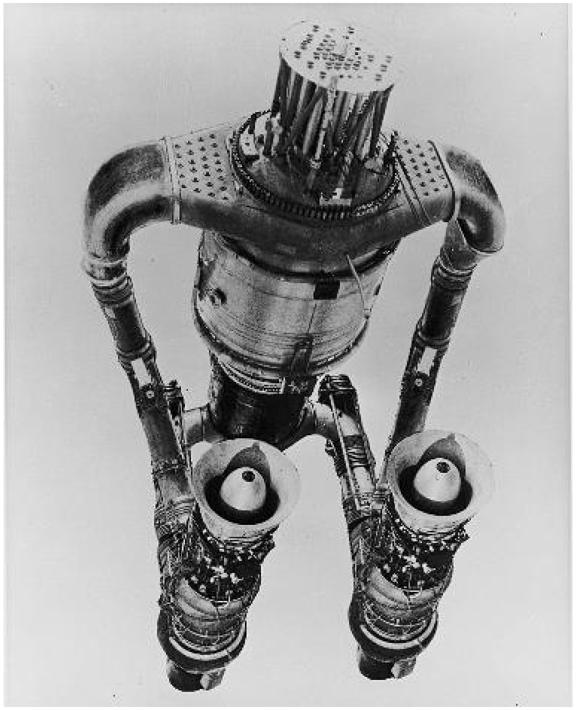


- **Fuel salt placed in fuel assemblies**
- **New concept, patent now granted worldwide**

Why is this a new idea?

- “Static” molten salts in fuel pins rejected by ORNL because convection of fluids would be unreliable in an aircraft – but convection is essential for heat transfer in unpumped fluids
- **Decision not revisited for ground-based reactors**

Aircraft reactor experiment which led to molten salt reactor experiment



Stable salt reactor platform

Fast spectrum “Wasteburner” SSR-W

- Fueled by higher actinides from conventional oxide fuel
- Chloride salt fuel
- Output temperature 600°C
- Patented exceptionally simple process (**Wa**ste **to** **S**table **S**alts) to extract Pu/Am from spent CANDU fuel with only 0.38% Pu

Thermal spectrum <5% LEU SSR-U

- Graphite moderated (graphite does not contact fuel)
- Uranium/sodium fluoride fuel salt
- Proprietary coolant salt
- Output temperature >800C
- In discussion with potential customers

SSR-W progress

2014

- Company founded and master patent granted

2018

- Moltex Energy (Canada) established and granted exclusive rights to SSR-W in North America
- $5m agreement signed with NB Power for development in Canada

2019-2020

- CNSC Vendor Design Review phase 1
- Major investments including from established nuclear companies
- Co-funded research at Canadian Nuclear Labs on spent fuel recycling
- Multi-million $ ARPA-E funded research at US labs

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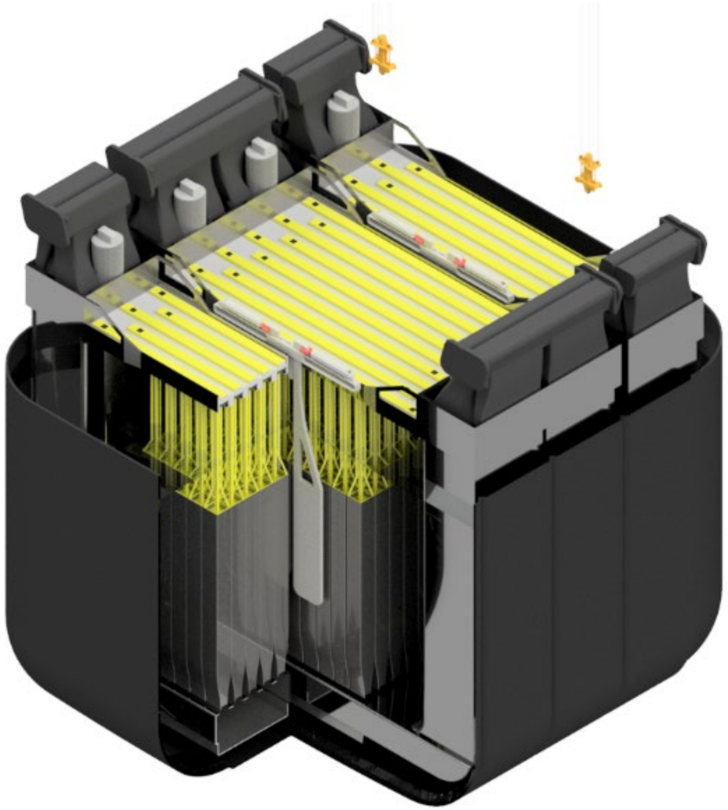
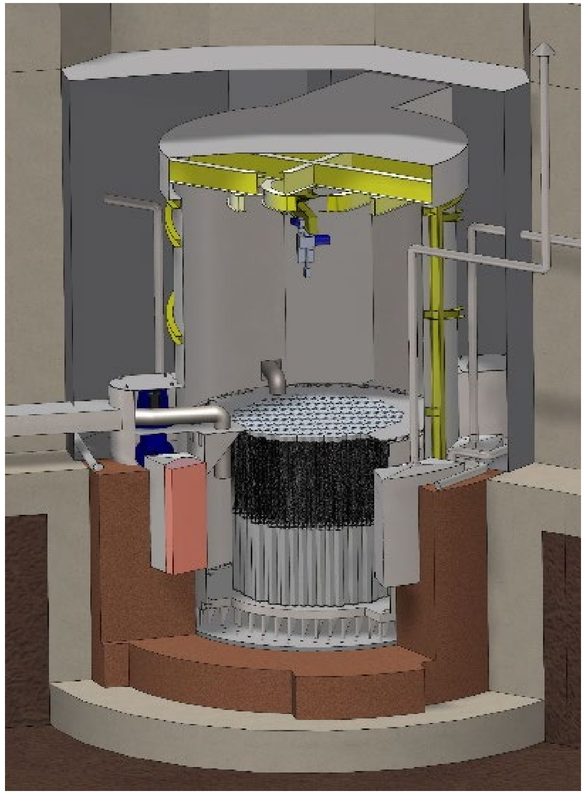
Evolution of SSR-W design since 2018 – Drivers of change

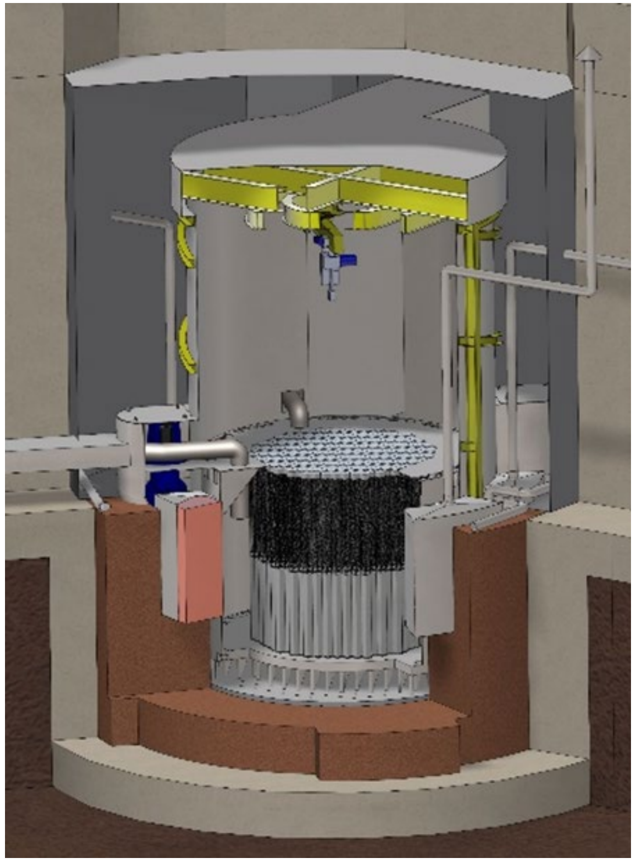
- Regulator feedback received during CNSC Vendor Design Review phase 1
- Operator feedback from New Brunswick Power as an experienced nuclear operator and licensee
- Increased understanding of the neutronic and thermal hydraulic behaviour of SSR's through ongoing R&D





SSR-W "Wasteburner" 1,250 MW thermal output at 600°C

- Fuel salt is uranium/plutonium/americium chloride
- Fuel assemblies replaced with reactor at full power using vertical lift crane that never contacts the molten salt coolant
    - No active control of reactivity with control rods – on power refuelling ensures only just sufficient reactivity at all times
    - High negative temperature coefficient gives passive shutdown without use of shutdown rods – boron rods for backup/cold shutdown
    - Fresh and spent fuel assemblies stored at peripheral locations in tank so airlock operations infrequent
- Novel, patented, heat exchangers permit elimination of intermediate coolant loop – heat passes directly from primary coolant to "solar salt" thermal storage system



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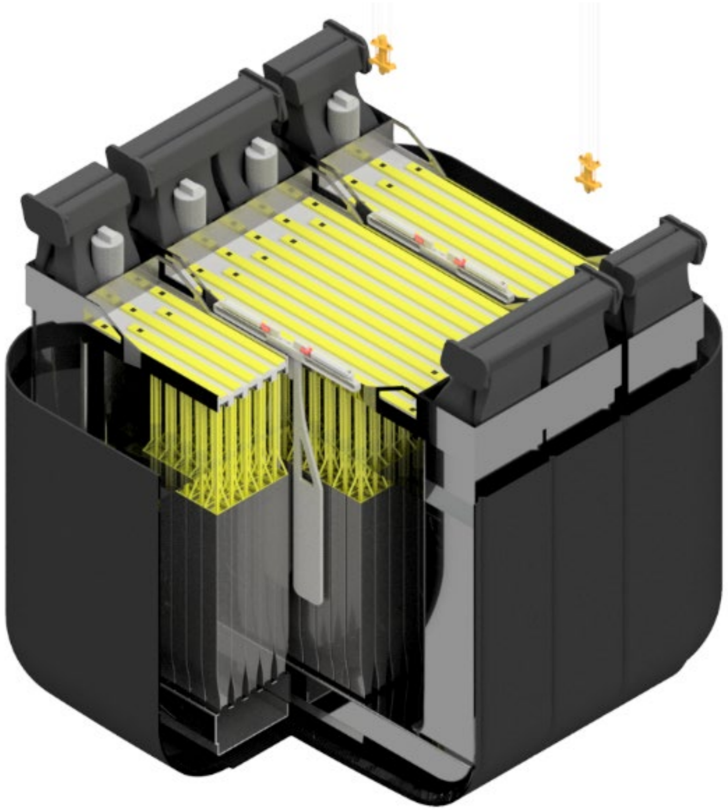
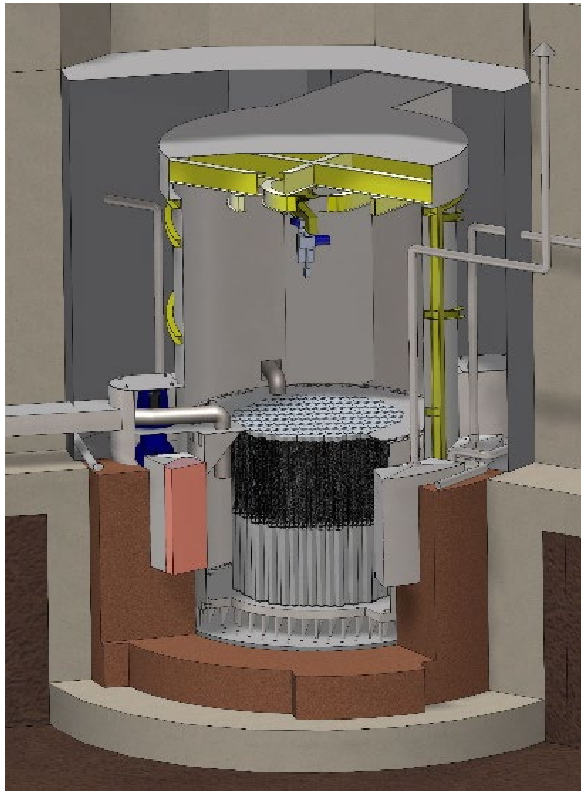
Elimination of fuel shuffling in the core

- Rectangular core design permitted counterflow shuffling of fuel assemblies across the core

- Design theoretically scalable simply by lengthening the core

- Revised design does not require, or allow, this





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Elimination of shuffling of fuel assemblies in core

Drivers of the change

- NB Power had operational concerns over moving each fuel assembly 10 times
- Design of fuel shuffling apparatus indicated significant complexity leading to reliability concerns
- Regulator input made clear that easy scaling of the rectangular core would not be possible – each size would be a new reactor

Consequences

- Significant simplification of operations and reduction in risk of an assembly being stuck
- Reduced complexity of crane system
- Single 500 MWe reactor for rollout (up to 1.5 GW power plant with thermal storage)
- Minor reduction in potential burnup achievable – but burnup actually limited by materials

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Thank you

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