Moltex technology

A business/technology overview, and then R&D interests

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By Andrew Ballard, Head of R&D

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Brief company introduction

Moltex progress

2014

- Company founded and master patent granted

2018

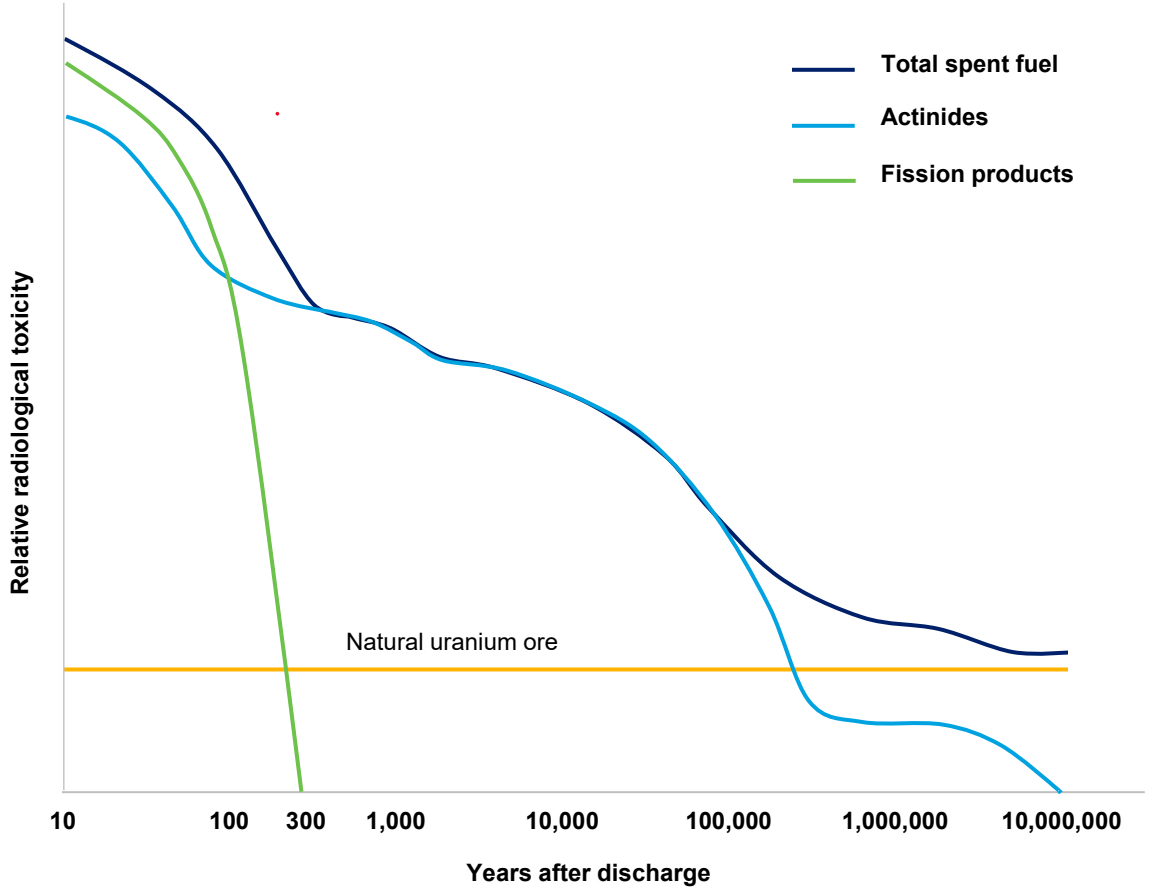
- Established office in Saint John, New Brunswick
  - Opportunity to build first reactor with NB Power at Point Lepreau
  - Supportive environment: regulations, federal and provincial policies
  - Other potential customers


WATSS
(WAste To Stable Salt)
A facility in which nuclear waste is recycled to produce fuel suitable for a fast reactor.
GridReserve
A series of tanks used to store thermal energy from the reactor and dispatch it to the grid when needed.
SSR-W
(Stable Salt Reactor - Wasteburner)
A fast reactor that uses recycled nuclear waste as fuel.

WATSS recycling process

Fuel and waste strategy

- SSR-W primarily fueled by transuranic elements made from CANDU or other LWR oxide fuel into a fuel salt
- Because SSR-W can tolerate impurities, recycling process is simpler, and fulfils non-proliferation criteria for no pure-Pu streams



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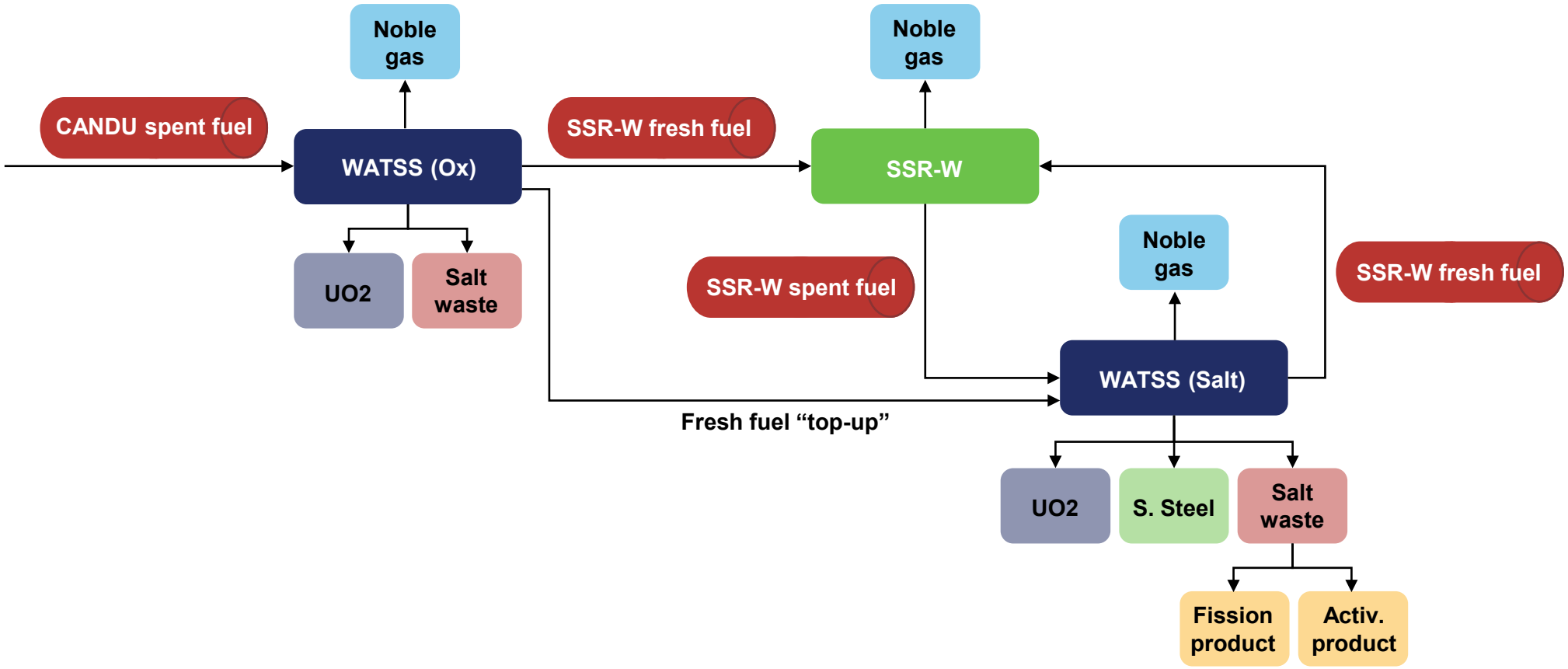
Operational radioactive waste streams



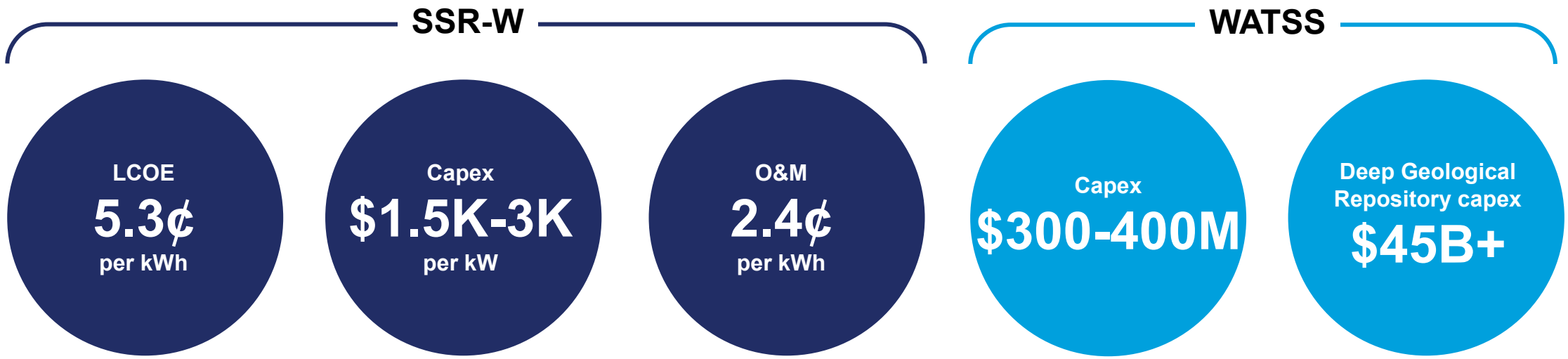
SSR-W and WATSS business drivers

Stakeholder buy-in

- Combined ~U$50M (C$63M) from NB Power, Ontario Power Generation, Canadian Nuclear Laboratories and Canadian federal government
- U$6.7M from the US Department of Energy Advanced Research Projects Agency – Energy COST (MEITNER) and APPLIED (GEMINA)*
- More from private companies, strategic investors and crowdfunding campaign

This presentation includes work sponsored by the DOE under the following ARPA-E projects:
DE-AR0001296: SSR APPLIED - Automated Power Plants: Intelligent, Efficient, and Digitised
DE-AR0000989: SSR COST – COmposite Structural Technologies for advanced reactor deployment

Ultra-competitive economics*



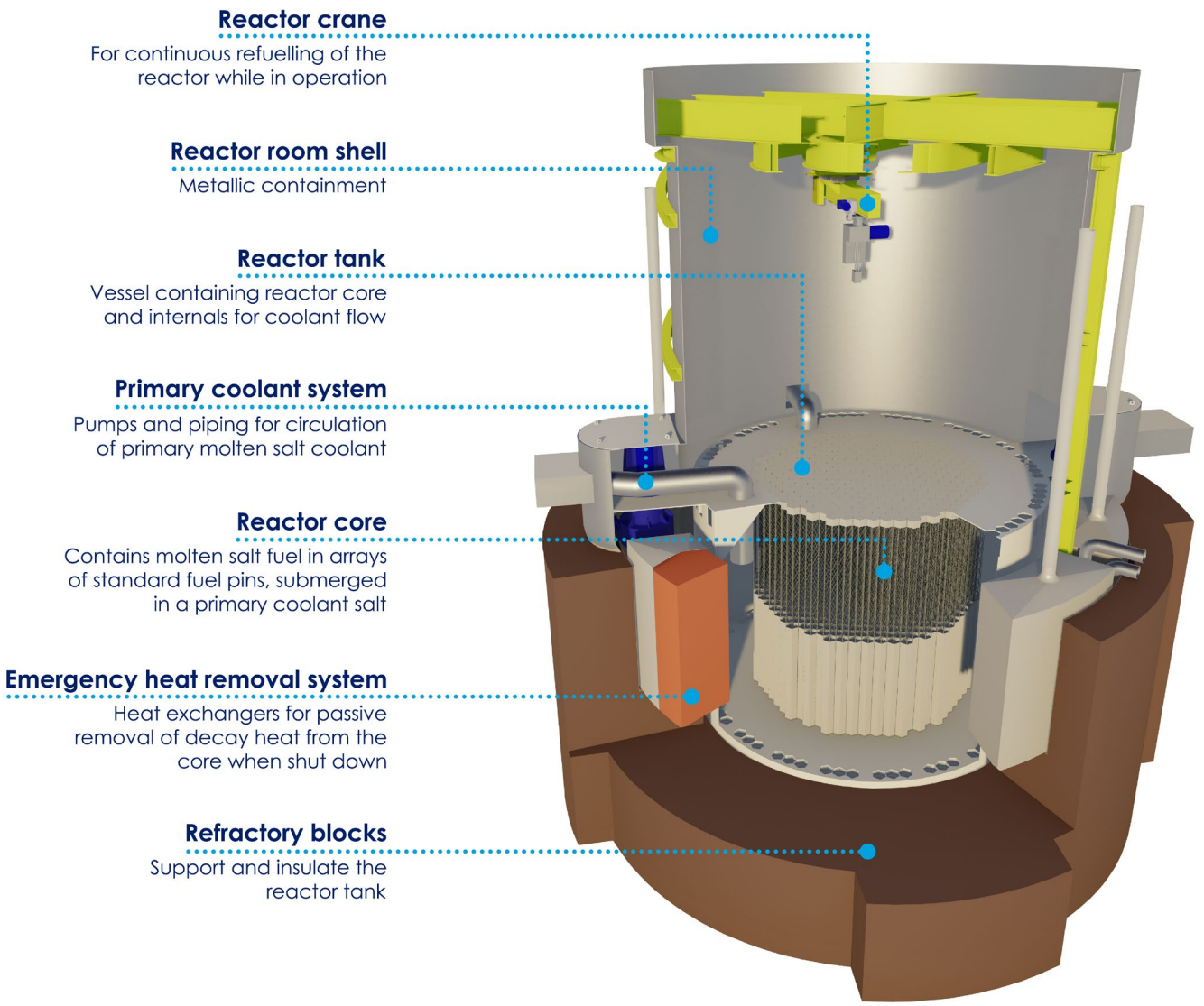
- Business case for waste reduction and low-cost electricity are distinct and compelling
- WATSS economics varies with capacity and location but has big margins

*All figures in USD.

SSR-W special interests

Reactor overview

- Fast spectrum chloride reactor
- 300MWe (FOAK), 500MWe (NOAK)
- Small, simple and cheap
- Non-proliferation characteristics considered early in design



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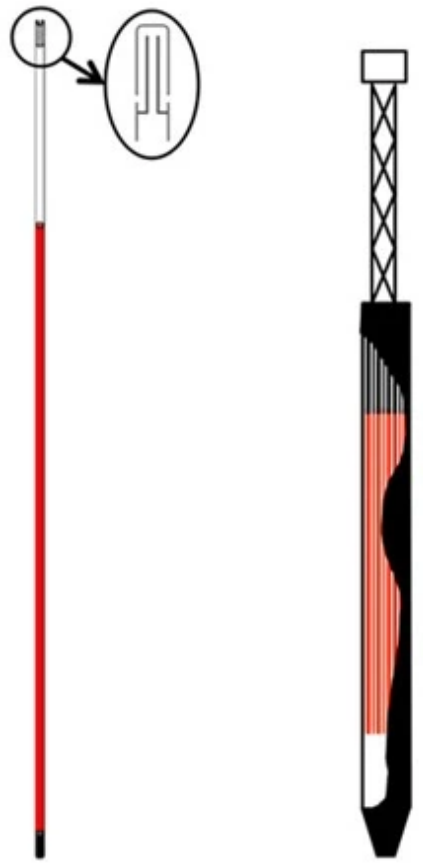
Specific design and phenomena
Conjugate heat transfer

Unique Design feature: Self heating fuel salt transfers heat to the clad, which transfers heat to the coolant.

Need: Substantiate the heat removal characteristics in the reactor safety analysis

Current tests/data: CFD modelling including [1], phenomenon study with small scale rig (Moltex UK), heat transfer validation with Separate Effects Loop (ANL)

Remaining sources of uncertainty: Heat transfer coefficients variation with thermo-physical property perturbations from soluble fission products, noble gas FPs, activation products temperature, fresh fuel composition), radiation field, code validation



Single fuel tube and assembly

T. Hua et al, Transient Modeling and Simulation of a Stable Salt Reactor, NURETH 20, August 2023 (draft submitted)

Specific design and phenomena

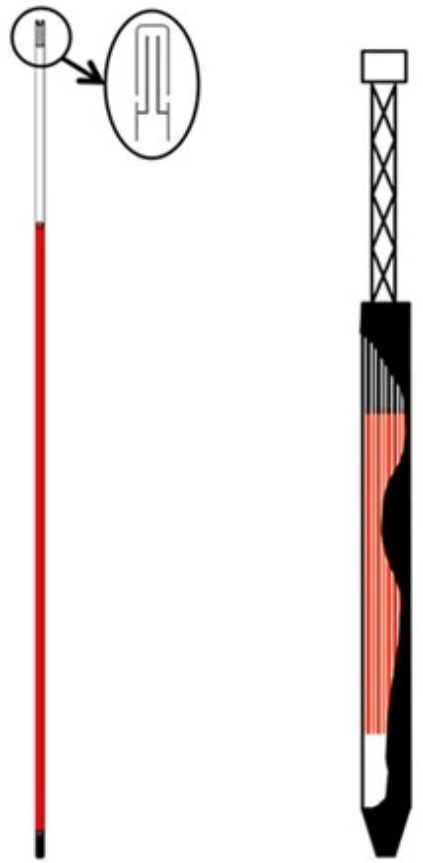
Fission gas solubility

Unique Design feature: Noble gases are soluble in fuel salt up to free surface, where they can offgas and slowly leave the assembly. Temperature profile up the fuel assembly maintains this solubility.

Need: Determine the solubility wrt temp of noble gases in fuel salt

Current tests/data: Using Henry's law, verification at small volumes of Pu bearing salt at ORNL.

Sources of uncertainty: Effect of soluble fission products, radiation, composition evolution



Single fuel tube and assembly

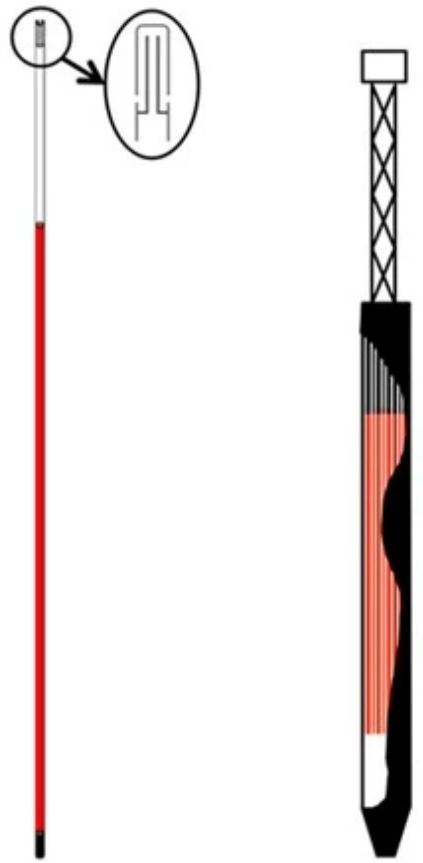
Specific design and phenomena
Material structural integrity

Unique Design feature: Fuel salt is constrained within a pin. Therefore, pin clad experiences relatively high flux (including FP/ions), relatively high FP build up in fuel salt. Each pin has a simple redox system.

Need: Identify and quantify the damage mechanisms to the material

Current tests/data: Sufficient n irradiation data for material bulk, unirradiated corrosion experiments in coolant salt ongoing

Sources of uncertainty: (irradiation induced) non-equilibrium redox chemistry, heavy ion salt/surface interactions, irradiation induced salt penetration, transmutation of fuel/coolant to form unpredicted compounds on surface, thermodynamic or irradiation driven intermetallic formation



Single fuel tube and assembly

Bottom line

Developers dependency on the expert community

The exact conditions of operation will not be perfectly replicated in tests.

Moltex will claim during licensing that the phenomena not occurring within the tests shall be understood, quantified with conservatism, and their impact considered within the design margins.

The regulator must have access to **sufficient and independent** expert knowledge to judge this claim by Moltex.

Developers have a dependency on the expert community outside of their direct supply chain.

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Thank you

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