Safeguards by Design considerations

ORNL annual Molten Salt Reactor workshop

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By Olivier Gregoire, Nuclear Security and Safeguards Officer

Moltex Energy | 71 Prince William Street | Unit 102 | Saint John | New Brunswick | E2L 2B2 | Canada | +1 506 214 8551 | info@moltexenergy.com | **www.moltexenergy.com**

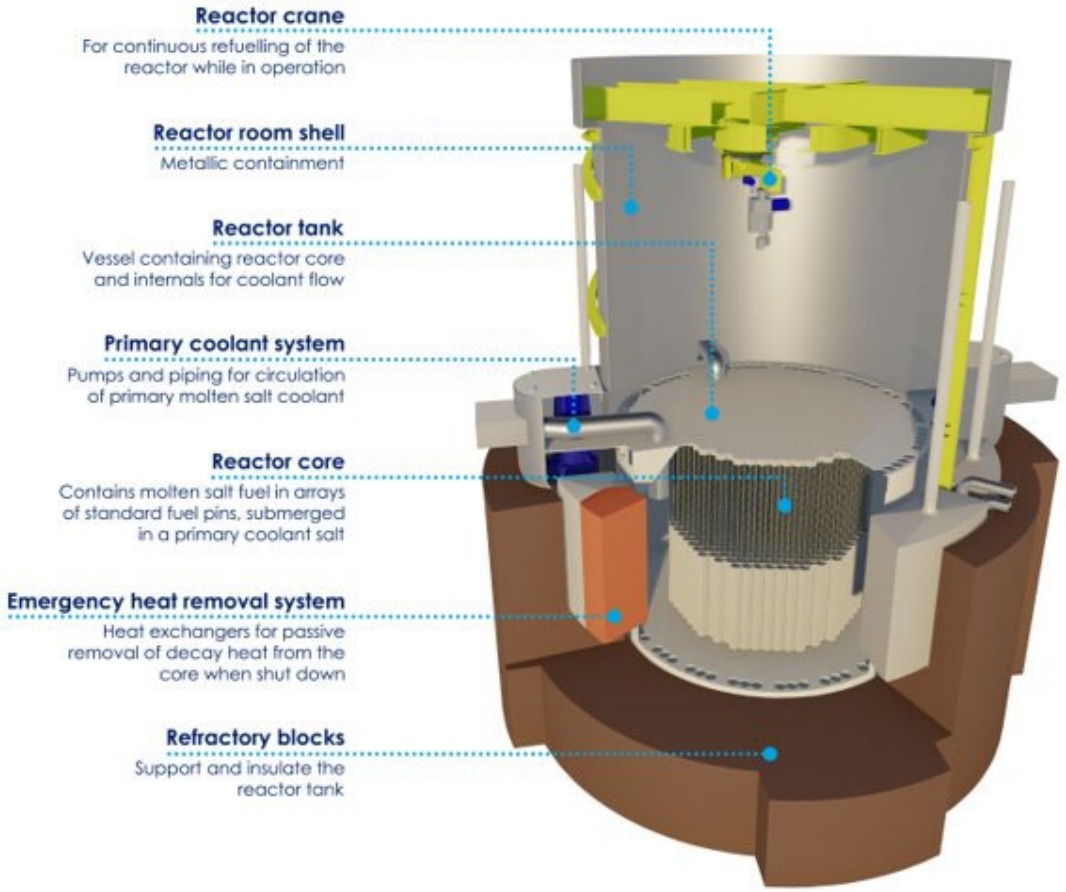
Introduction

Stable Salt Reactor – Wasteburner (SSR-W)

- High temperature, fast neutron, molten salt reactor
- 300-500 MWe per reactor
- Uses recycled nuclear waste as fuel

WAste To Stable Salt (WATSS)

- High temperature, molten salt-based separation process



Engagement with the IAEA in the framework of the Member State Support Program (MSSP)

- DIQ shared with the IAEA early 2021, first (virtual) meeting mid-2021
- Design substantially updated in this period – new engagements delayed because of IP issues
- Future engagements to focus of overall SG approach

Early engagement with IAEA is of paramount importance to implement SBD.

DIQ-based engagement format may not be ideal at such early stage in design process

Inherent aspects of SSR-W in terms of Safeguards

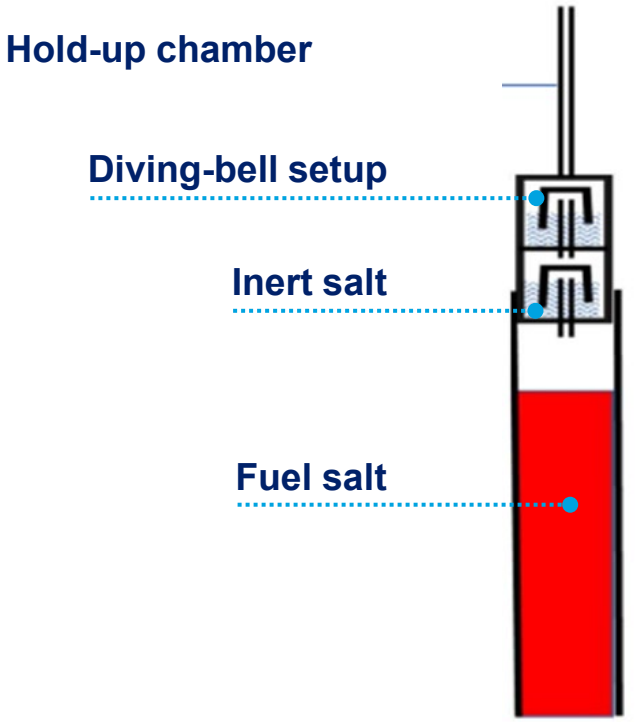
	Potential for Safeguards-by-Design provisions
Nuclear material (NM) attractiveness	• Low purity Pu / No separation of minor actinides & lanthanides * • No need for imported nuclear material / no need for U enrichment
Containment and surveillance measures	• Fuel difficult to extract from fuel elements unnoticed • Fuel elements assembled, used and disassembled in the same building complex – difficult to take out
NM accountancy / verification of declared inventory	• Individual fuel elements – potential management as ITEMS

* See "*Application of a graded approach to the concept of fuel recycling*", O. Gregoire, to be released in the Proceedings of the IAEA Technical meeting on back-end of the fuel cycle considerations for SMRs – Sep 2022

End-cap of fuel tubes

Fuel assemblies design requirements

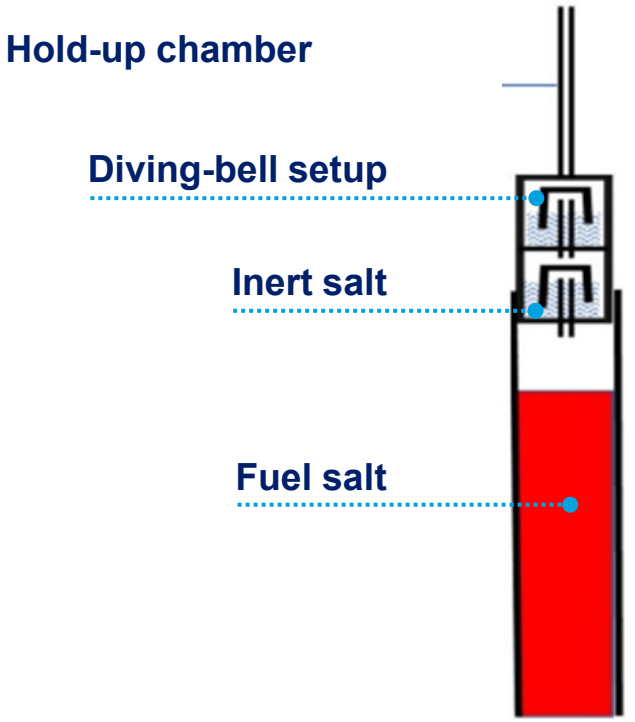
- Assemblies will be sealed in a way that prevents unplugging of the fuel pins after filling
- End caps will be filled with salt that would be frozen while the assemblies are out of the reactor core
- Assemblies will be designed so that it will not be possible to remove fuel salt from the pins without causing a visible and irreversible modification of the assembly structure



End-cap of fuel tubes

Prevention of NM removal

- Fuel pins cannot be removed from the assembly without breaking seal
- Physically impossible to dip an extracting tube into the individual pins from the top of the assembly
- Fuel cannot be extracted by tipping the entire assembly (even if heated to above melting point)



Concluding remarks

- Early engagement with IAEA – Focus on potential Safeguard-by-Design provisions and overall approach to Safeguards rather than DIQ-based declaration.

- Nuclear material accountancy – SSR-W can be treated as **Item Facility**, therefore removing the major Safeguard issue associated with molten salt reactors.

Thank you

Olivier Gregoire, Nuclear Security and Safeguards Officer

oliviergregoire@moltexenergy.com

+1 506 647 0301