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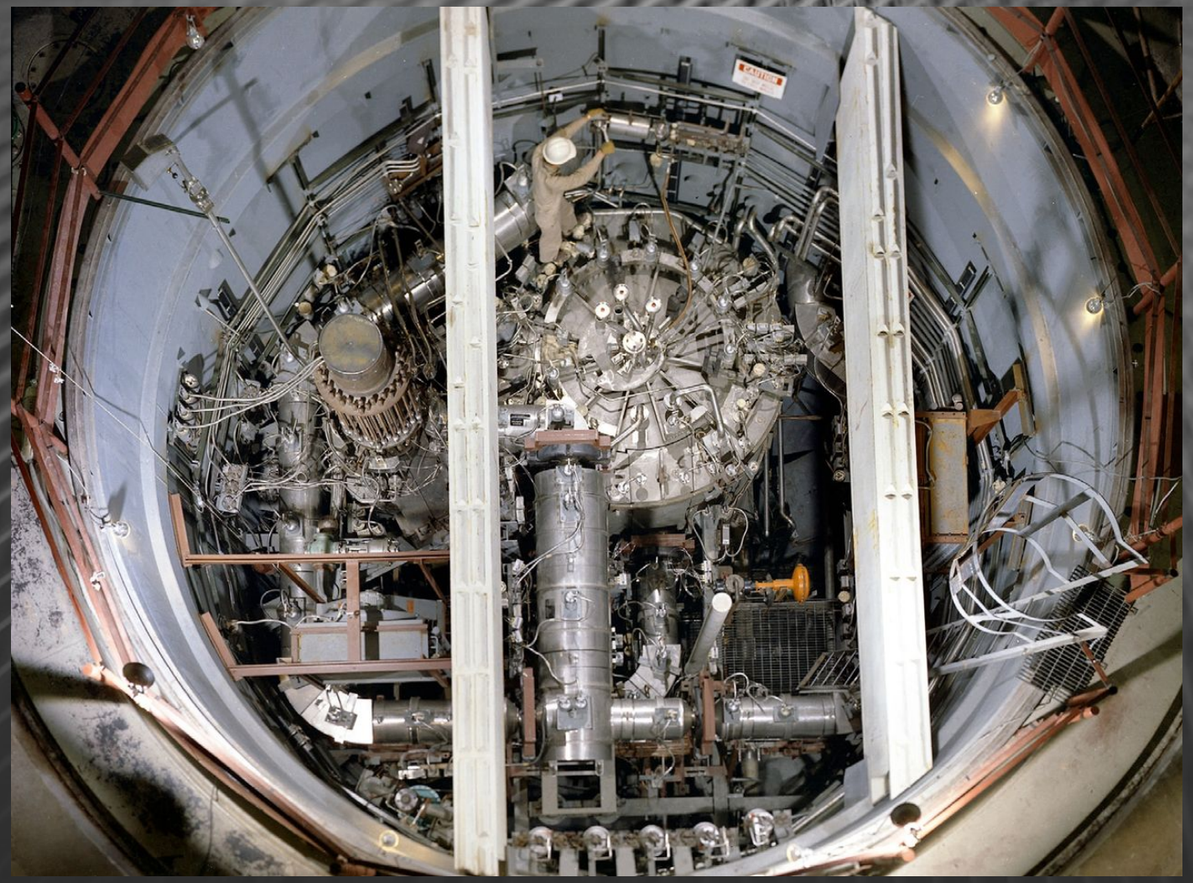
The impact of molten salt reactors



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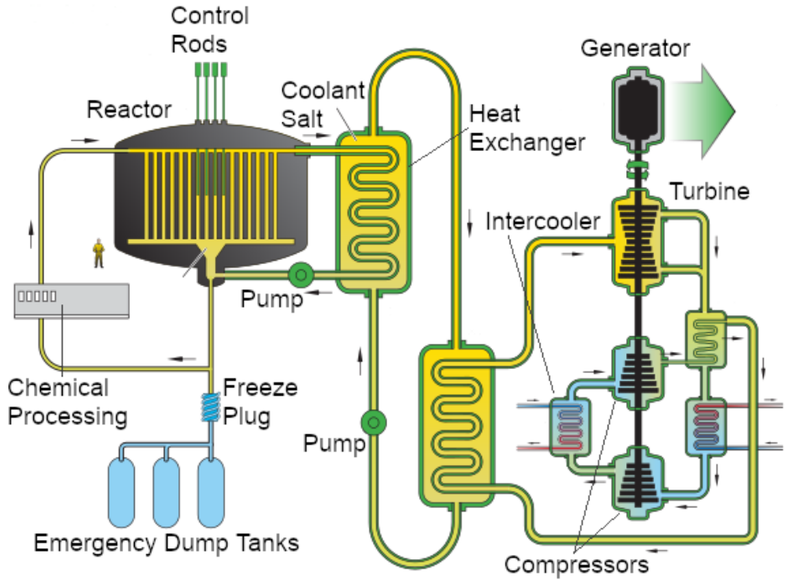
U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

What are molten salt reactors?

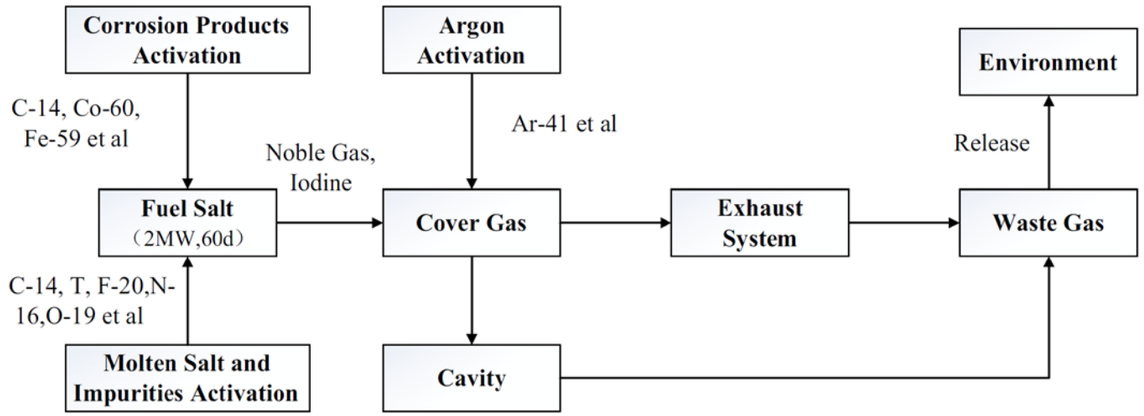
- MSRs are a Gen IV reactor design where the fuel (U, Pu or Th) is dissolved in a molten salt mixture.
- This is unlike a conventional reactor such as a PWR or LWR where the fuel is encapsulated.
- The design was first demonstrated by the Molten Salt Reactor Experiment (MSRE) at Oak Ridge National Laboratory (ORNL) from 1965 to 1969.
- Advantages include a compact, flexible, more efficient and intrinsically safer design.
- Thorium MSRs are capable of closing the fuel-cycle and utilizing ^{232}Th as a fuel source to breed ^{233}U.
- China is the world-leader in MSR technology with a research system scheduled to go critical in 2020.



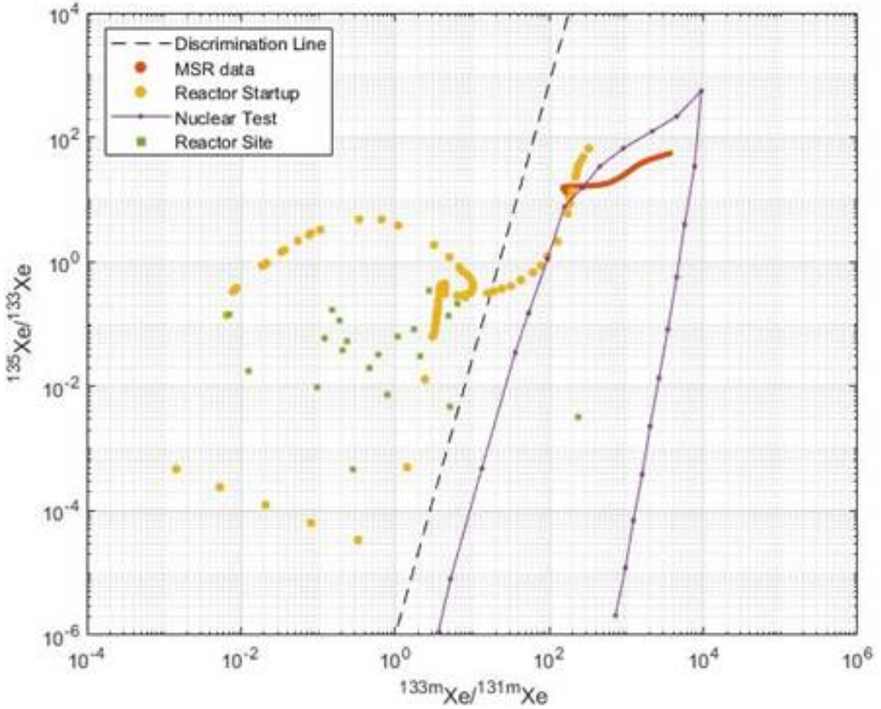
MSRs compared to PWRs	
Safer	No meltdowns possible Low operating pressure Noble gases removed No steam explosions
More economic	More compact, efficient and scalable Online refueling and fission product removal Less waste
Flexible	Th, U, Pu, waste Wide applications (power, military, research)
Non-proliferation	May or may not be better

What are the impacts?

- Their unique molten design has important implications for the radionuclide signatures that could be detectable by IMS stations.
- Short-lived gaseous and volatile radionuclides could more readily escape molten fuels and coolants, producing emissions with a different isotopic signature.
- This effect could be further enhanced by the online removal of accumulating fission products in MSR designs.



Major radionuclide migration pathways. After Chen et al. 2019



- Activation products may be produced from corrosion products, salt impurities and cover gas (e.g. ^{54}Mn, ^{56}Mn, ^{60}Co, ^{3}H, ^{41}Ar)

Research at PNNL

- 2-year study to understand the contribution of MSRs to the verification regime of the CTBT
  - Assessment of fission and activation product signatures that arise from the fuel, cooling and cover-gas components of an MSR
  - Potential signatures that would be detected by IMS radionuclide stations
  - Assessment of the interference of these signatures on the detection of nuclear explosive tests detected by the IMS
- Assessment of the properties of an MSR useful for other non-proliferation activities including IAEA safeguards

- For further information please contact jonathan.burnett@pnnl.gov

- See also: Burnett JL et al. (2019). *Time sequence gamma-spectrometry of irradiated salt*. Nuclear Instruments and Methods A 947.

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Thank you

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