NATIONAL NUCLEAR LABORATORY

AMR technologies

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Why AMR ?

Why Advanced Modular Reactors ?

Range of technologies which share common attributes –

•Smaller than conventional nuclear power station reactors
•Designed so that much of the plant can be fabricated in a factory environment and transported to site, reducing construction risk and making them less capital-intensive

Technology types –

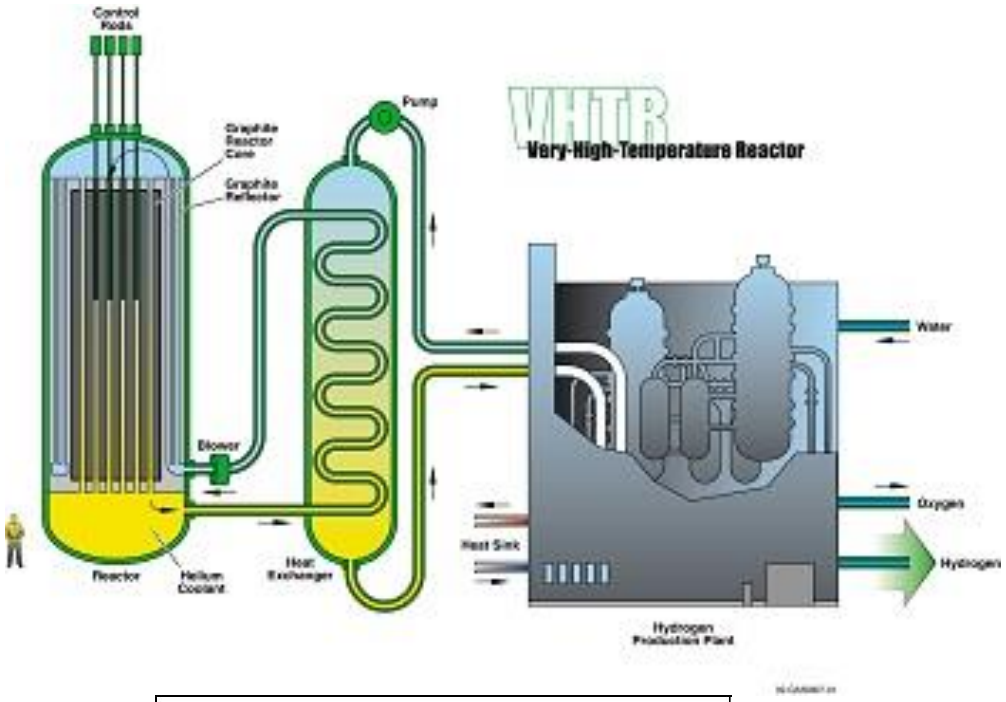
Generation IV and beyond AMRs, which use novel cooling systems or fuels to offer new functionality (such as industrial process heat) and potentially a step change reduction in costs

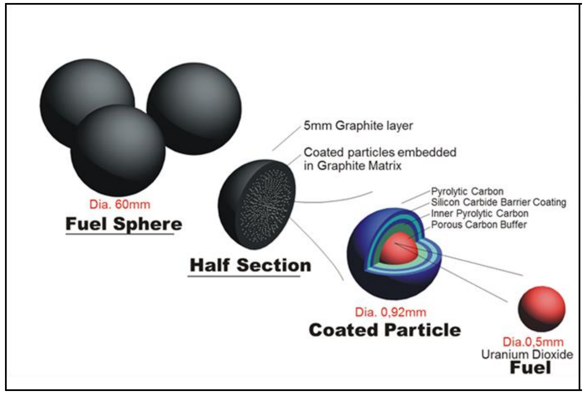
Technology types

Generation IV types -

- High / Very High Temperature Reactor
- Sodium Cooled Fast Reactor
- Lead Cooled Fast Reactor
- Molten Salt Reactor
- Gas Cooled Fast Reactor
- Super Critical Water Cooled Reactor

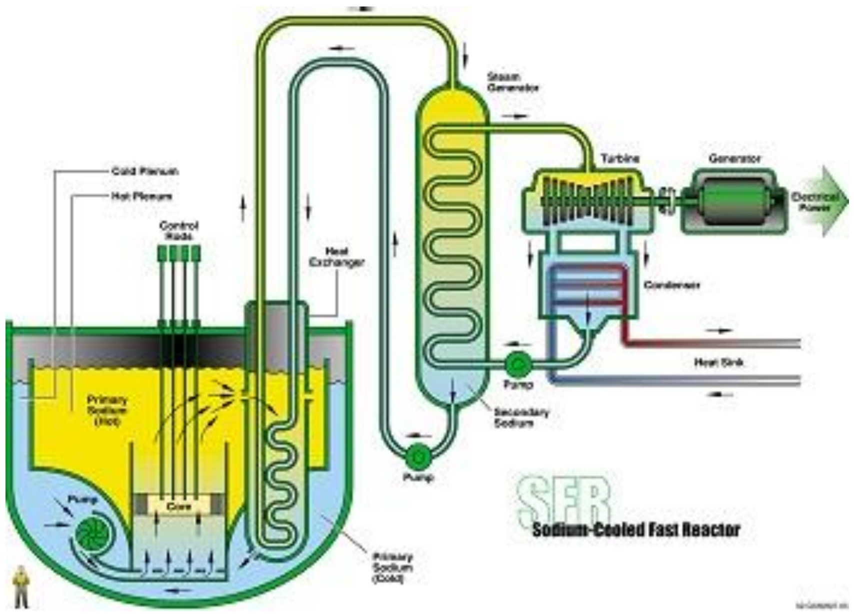
High / Very High Temperature Reactor





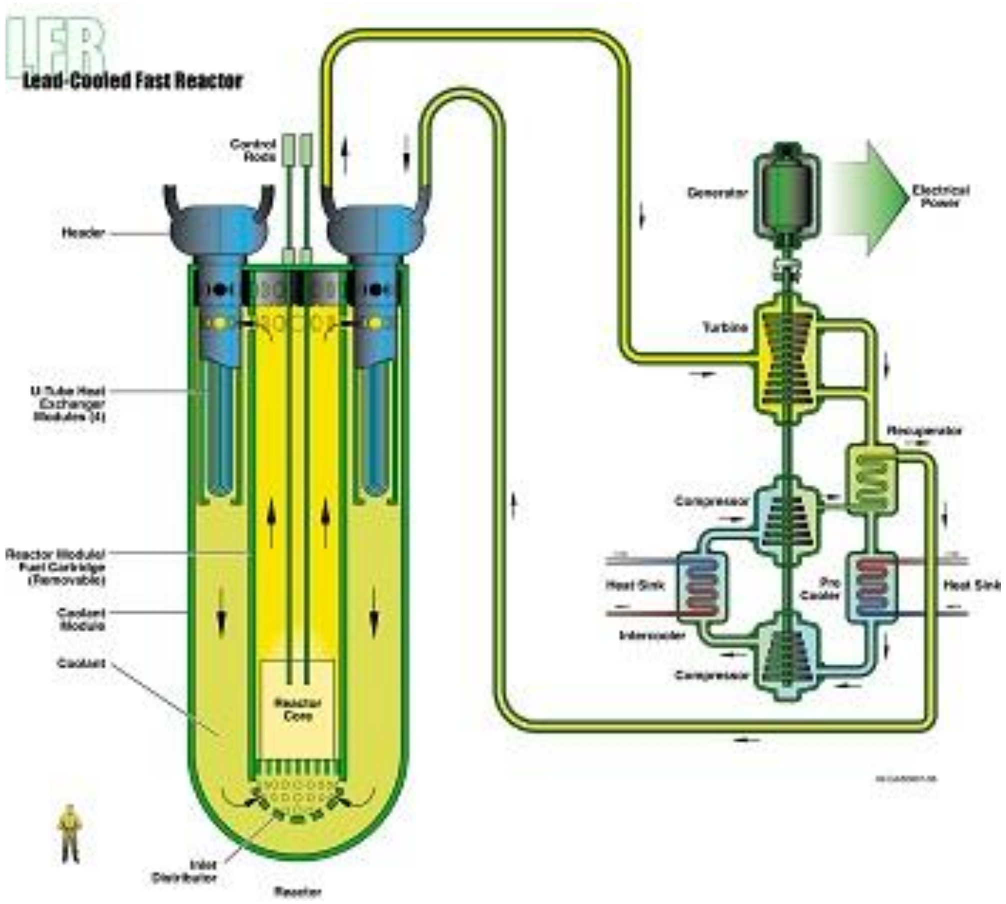
- UK has historic track record (Magnox, AGR's, Dragon reactor) – transferrable knowledge
- Closest to market (TRL 7)
- Can be used for Electricity and High Temperature Steam generation due to high outlet temp (typically 700-950^{o}C)
- High outlet temperature desirable for downstream applications (Hydrogen, Chemical production)
- TRISO (Coated Particle Fuel) viewed as increase in safety – UK has some historic experience on fuel. New capability being developed

Sodium-Cooled Fast Reactor



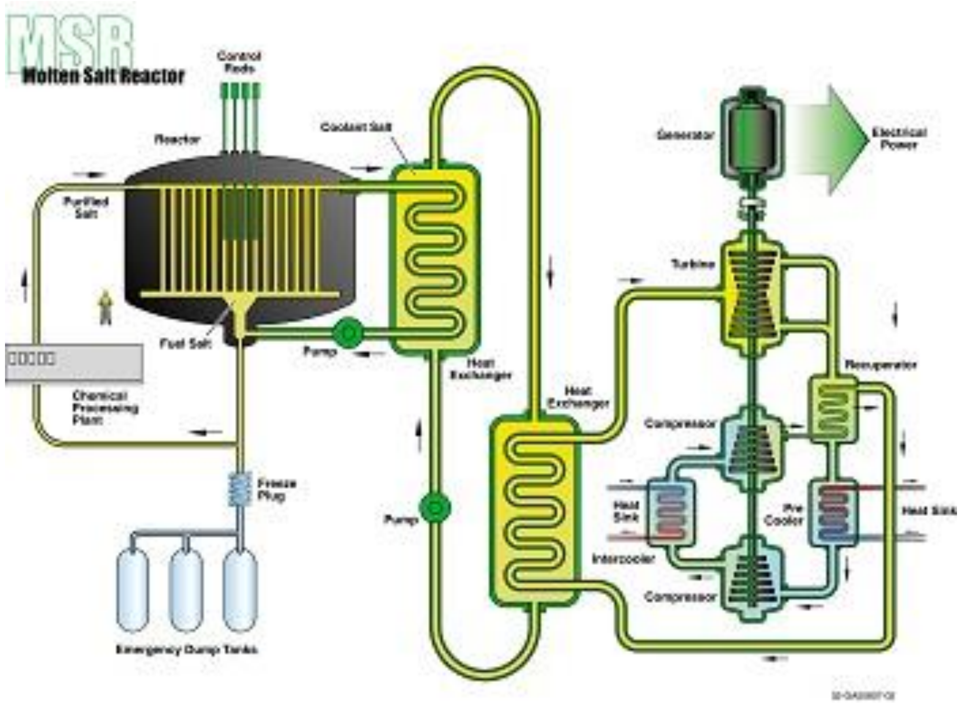
- UK has some historic track record (Dounreay)
- High – international commercial scale prototypes have been built (TRL 7)
- Utilises liquid sodium as reactor coolant, allows high power density and operation at low pressure.
- High outlet temperature – helpful for downstream processes
- Some key technical challenges due to the nature of the coolant (sodium) including material corrosion, ability to inspect, potential interaction with water etc.
- Fuel requires additional treatment to make inherently safe.

Lead-Cooled reactors



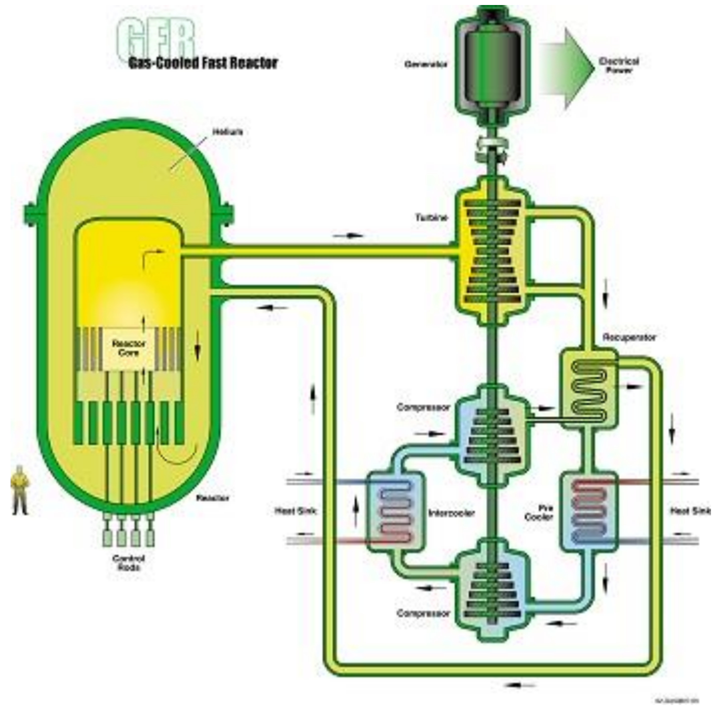
- UK has little track record – transferrable knowledge from Sodium Cooled.
- Some challenges to overcome (TRL 4)
- Improved thermodynamic ability increases overall efficiency, potentially offset by higher capital costs
- Outlet temperature in the mid range buts still suitable for some downstream applications.
- Lead presents challenges in terms of corrosive behaviour, ability to monitor etc but is less reactive to water than Sodium.

Molten Salts Reactor



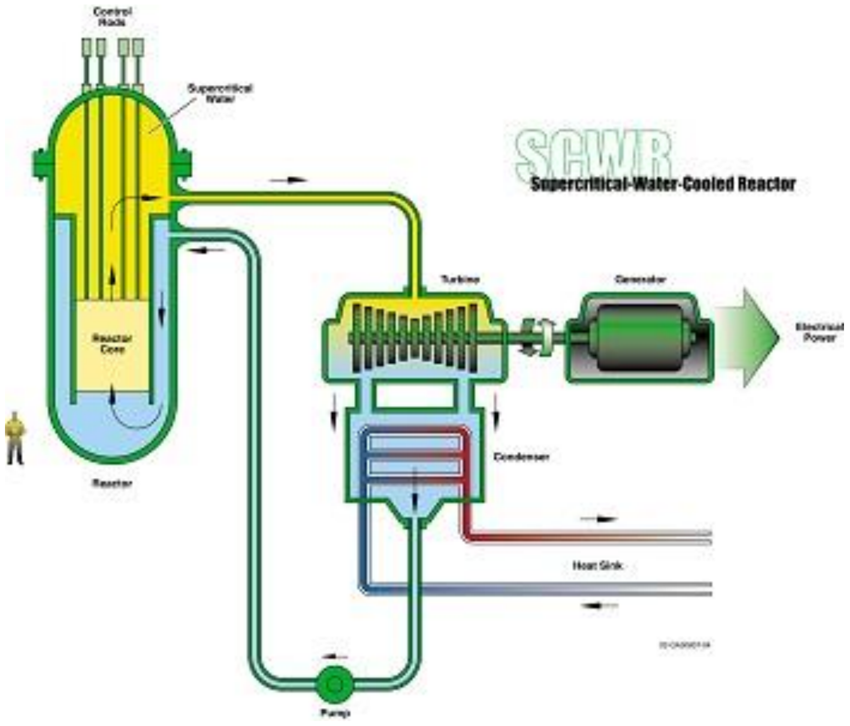
- UK experience and capability limited. Number of international R&D programmes in flight.
- Some significant technical challenges - pre concept design stage (TRL 3/4)
- MSR is distinguished by its core in which the fuel is dissolved in molten fluoride or chloride salt. No solid fuel.
- Materials challenge: suitability for operating lifetime need to be developed, tested and qualified.
- Challenge to reprocess and recycle
- Although not pressurised, containment of high standard will be required - cost and safety

Gas-cooled fast reactors



- High-temperature helium-cooled fast-spectrum reactor with a closed fuel cycle
- Early stages of development with many unproven concepts and design features (TRL 2)
- High outlet temperature desirable for downstream applications (Hydrogen, Chemical production)
- No known UK expertise

Super-Critical Water-Cooled Reactor



- High temperature, high-pressure, light-water-cooled reactors that operate above the thermodynamic critical point of water (374°C, 22.1 MPa)
- No known UK experience
- Low TRL – R&D activities only (TRL 2)
- SCWRs are in the early stages of development with many unproven concepts and design features
- The goal of SCWR conceptual design is to reduce waste mass, volume, thermal load on the repository, and the level of radiotoxicity – watching brief

In summary....

- Lots of different types – each with inherent challenges and benefits
- Some are more mature that others – time to deploy varies
- Opportunities around downstream coupling for some
- Increased safety features
- All based on modular (factor) design

Thank you.