NUCLEAR REACTOR DESIGNS

Hand-waving
by
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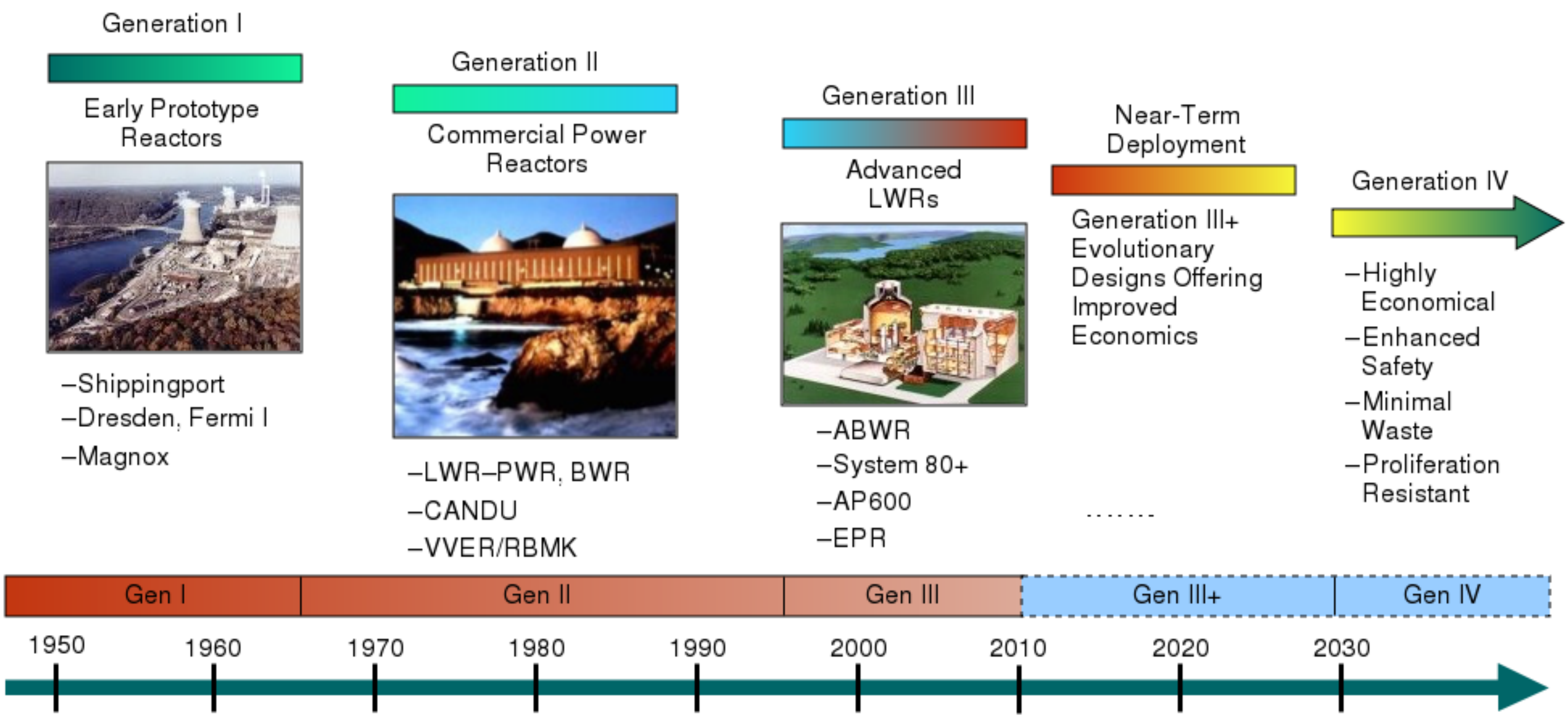
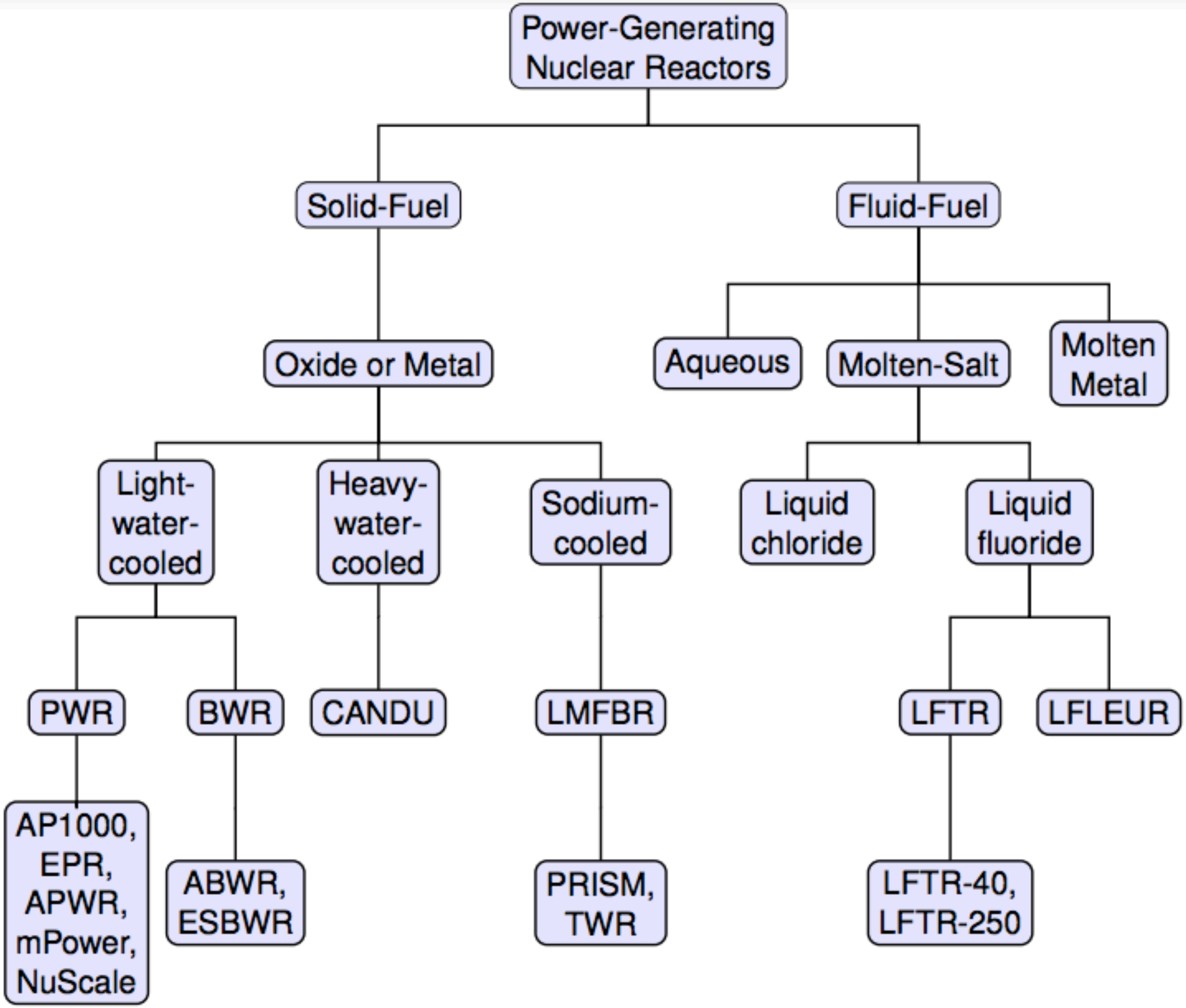
Gen-IV Roadmap (Wikipedia)

Generation IV: Nuclear Energy Systems Deployable no later than 2030 and offering significant advances in sustainability, safety and reliability, and economics

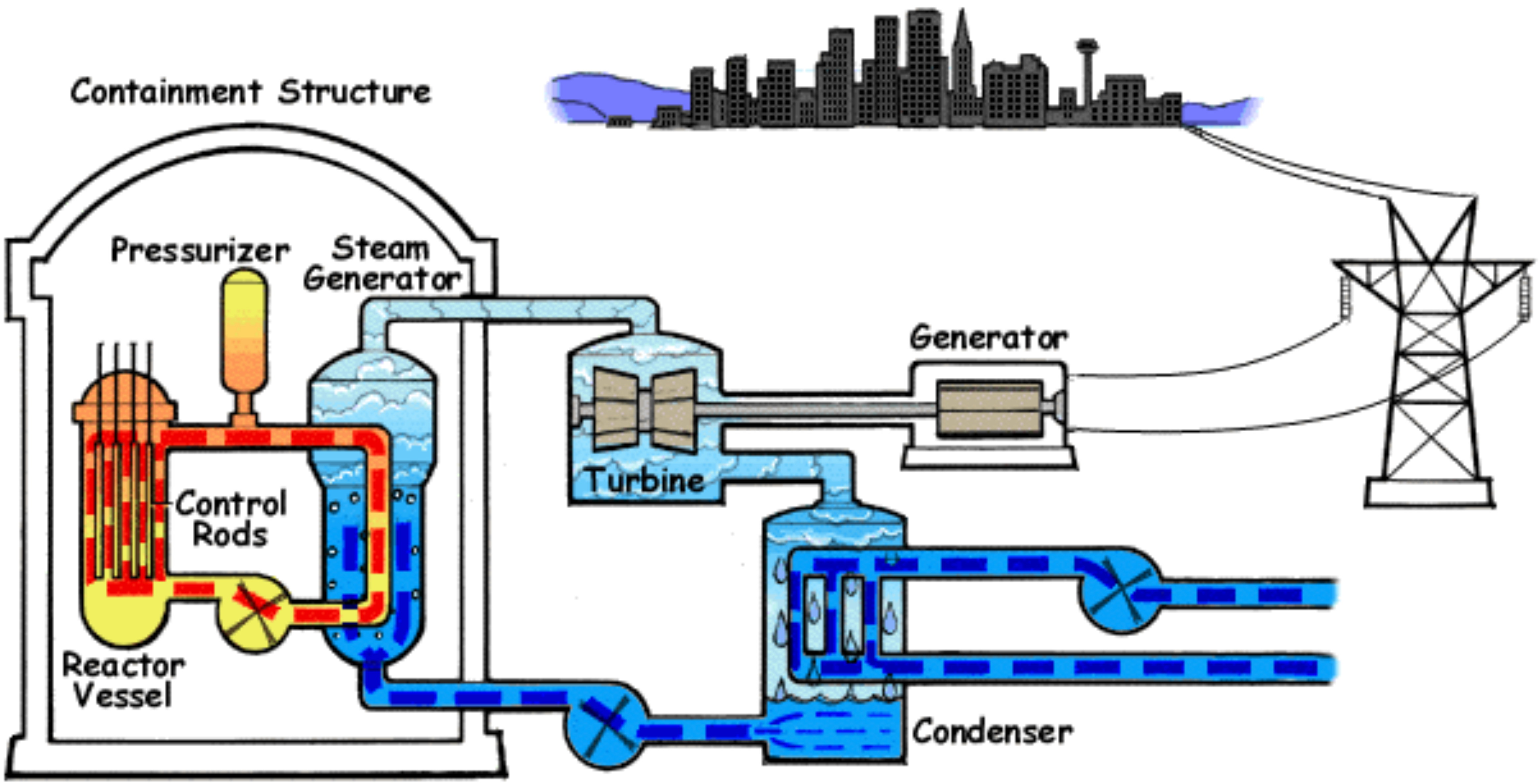


Nuclear Reactor "Families"

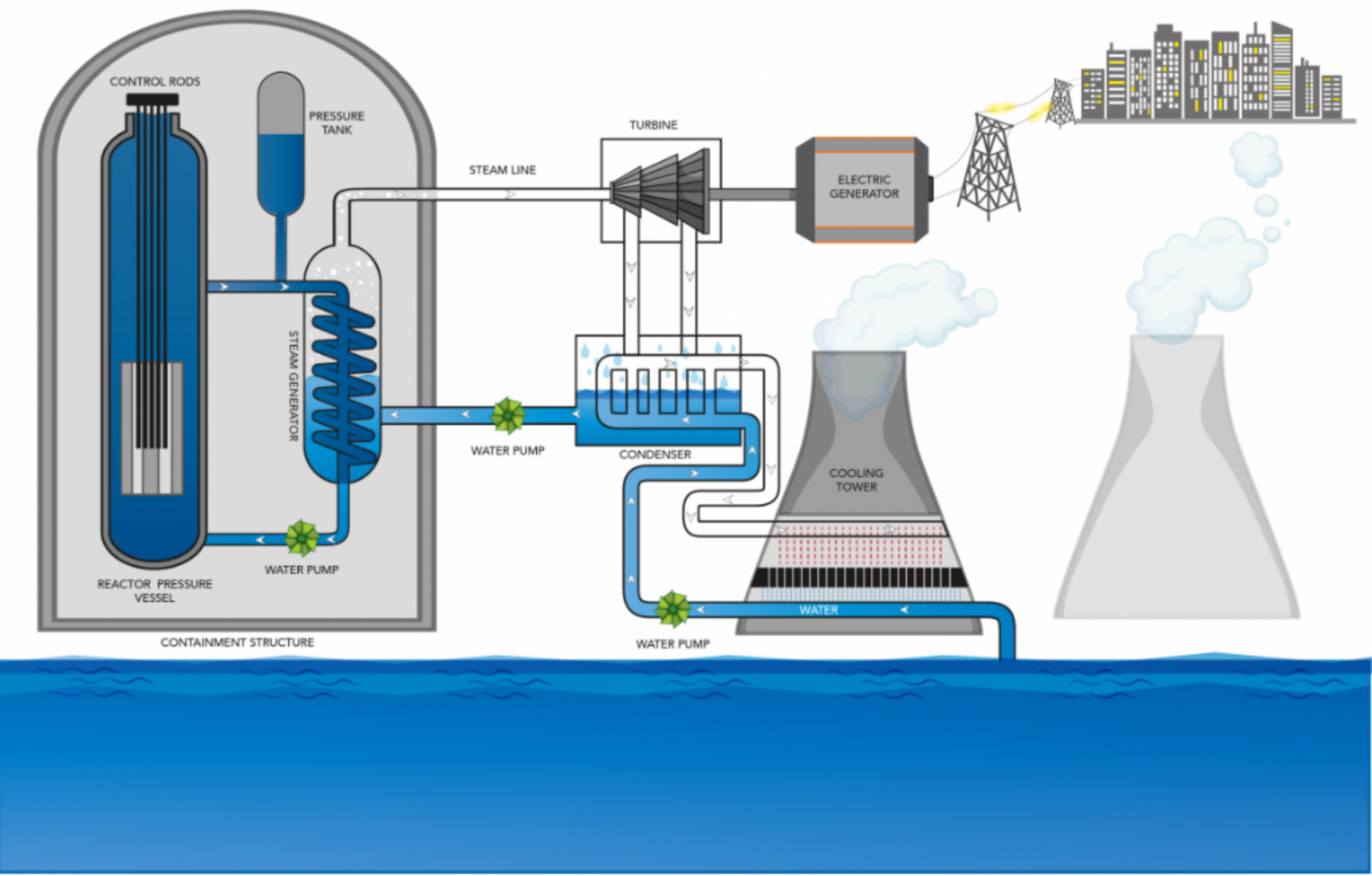


(from Kirk Sorensen's presentation at Delft in 2015)

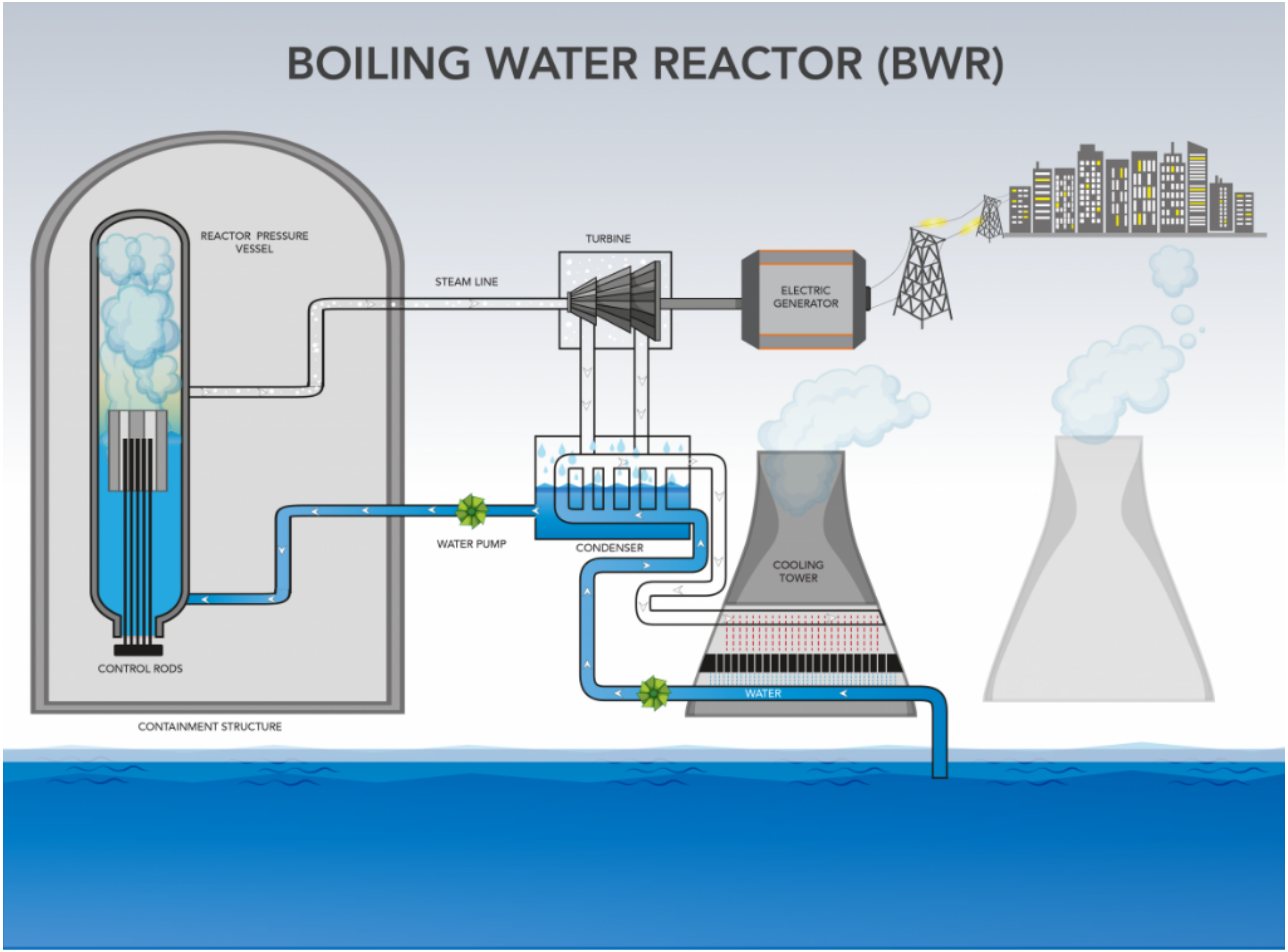
Pressurized Water Reactors



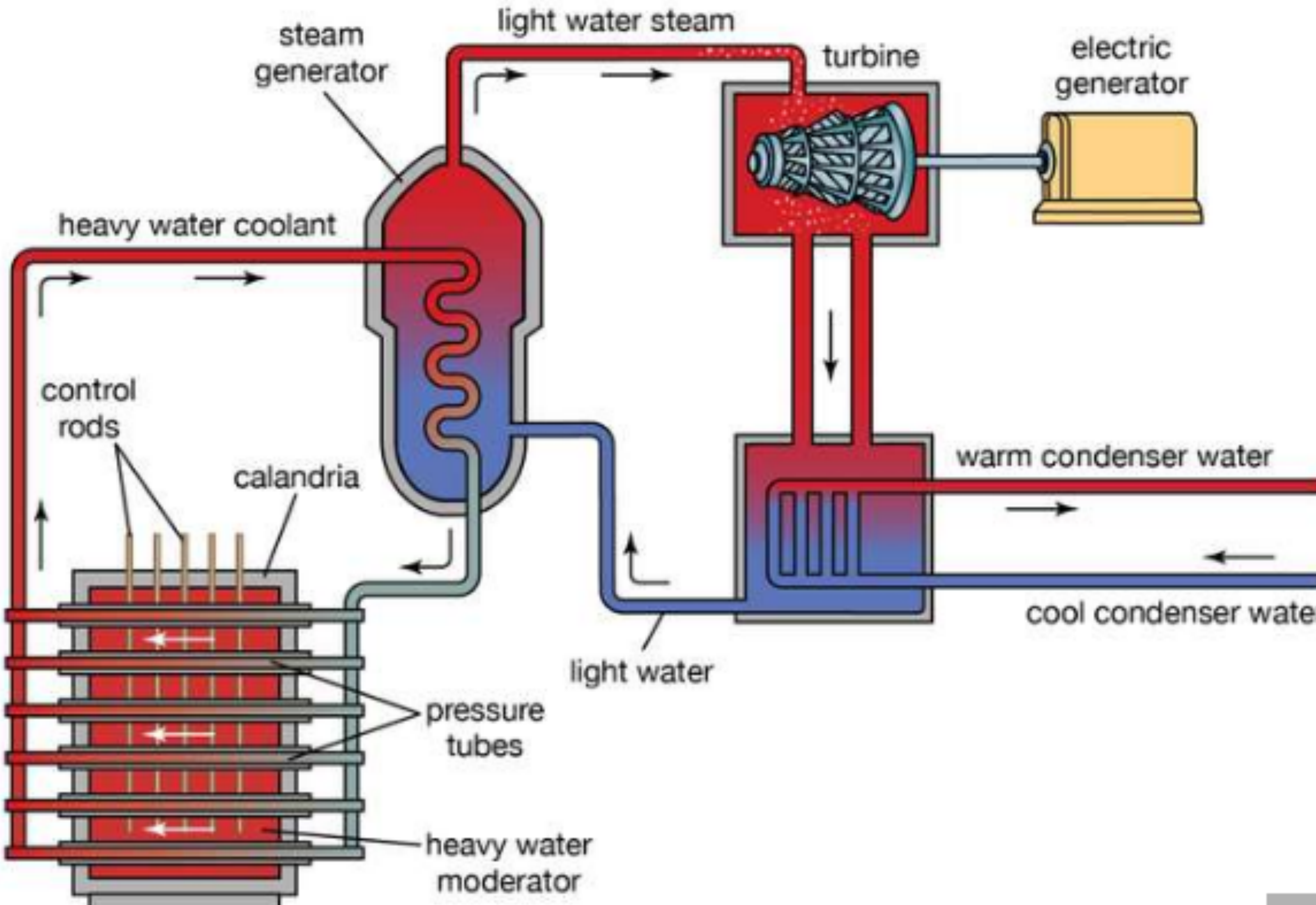
PRESSURIZED WATER REACTOR (PWR)



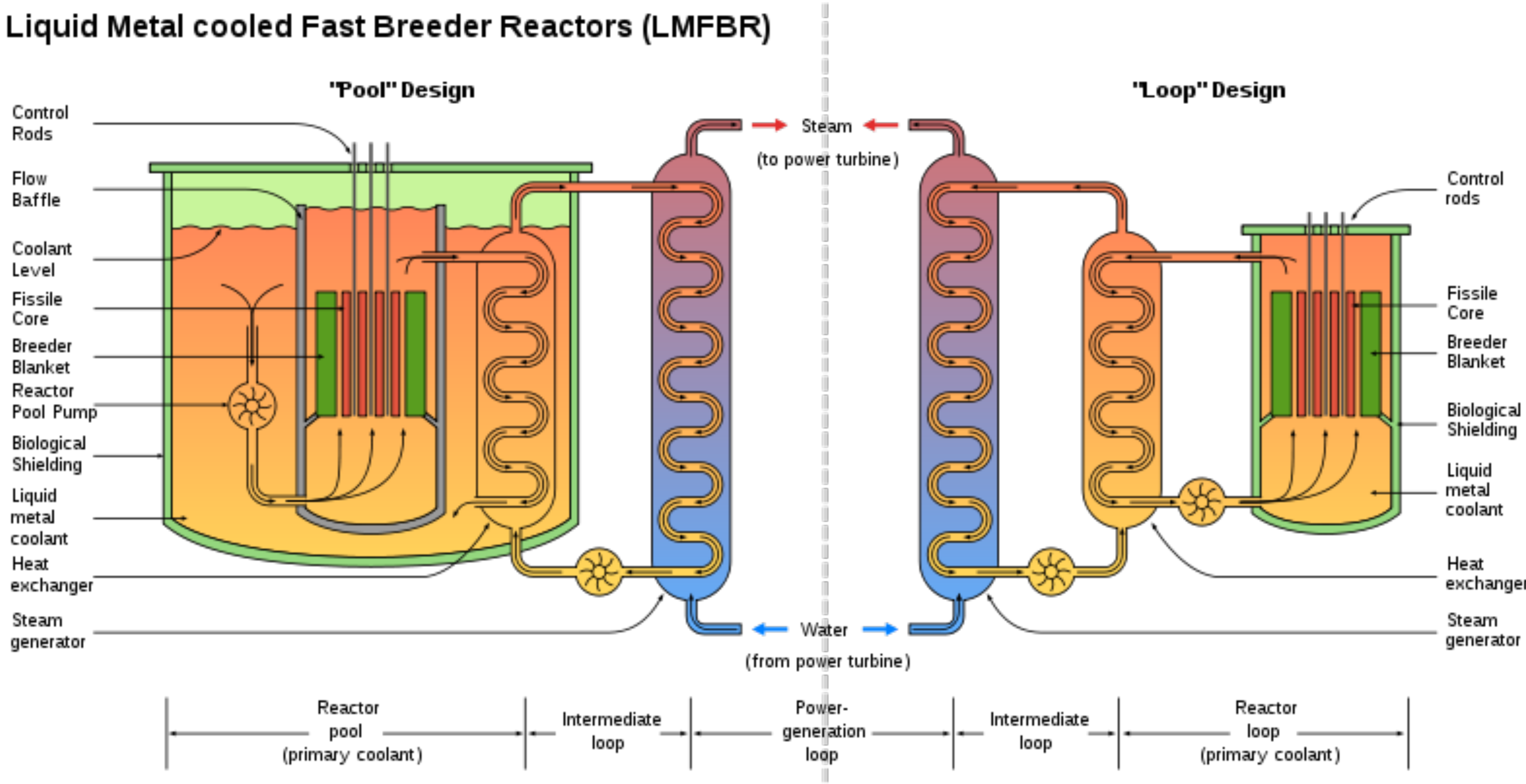
Graphic by Sarah Harman | U.S. Department of Energy


BOILING WATER REACTOR (BWR)
REACTOR PRESSURE VESSEL
STEAM LINE
TURBINE
ELECTRIC GENERATOR
WATER PUMP
CONDENSER
COOLING TOWER
CONTROL RODS
CONTAINMENT STRUCTURE
WATER

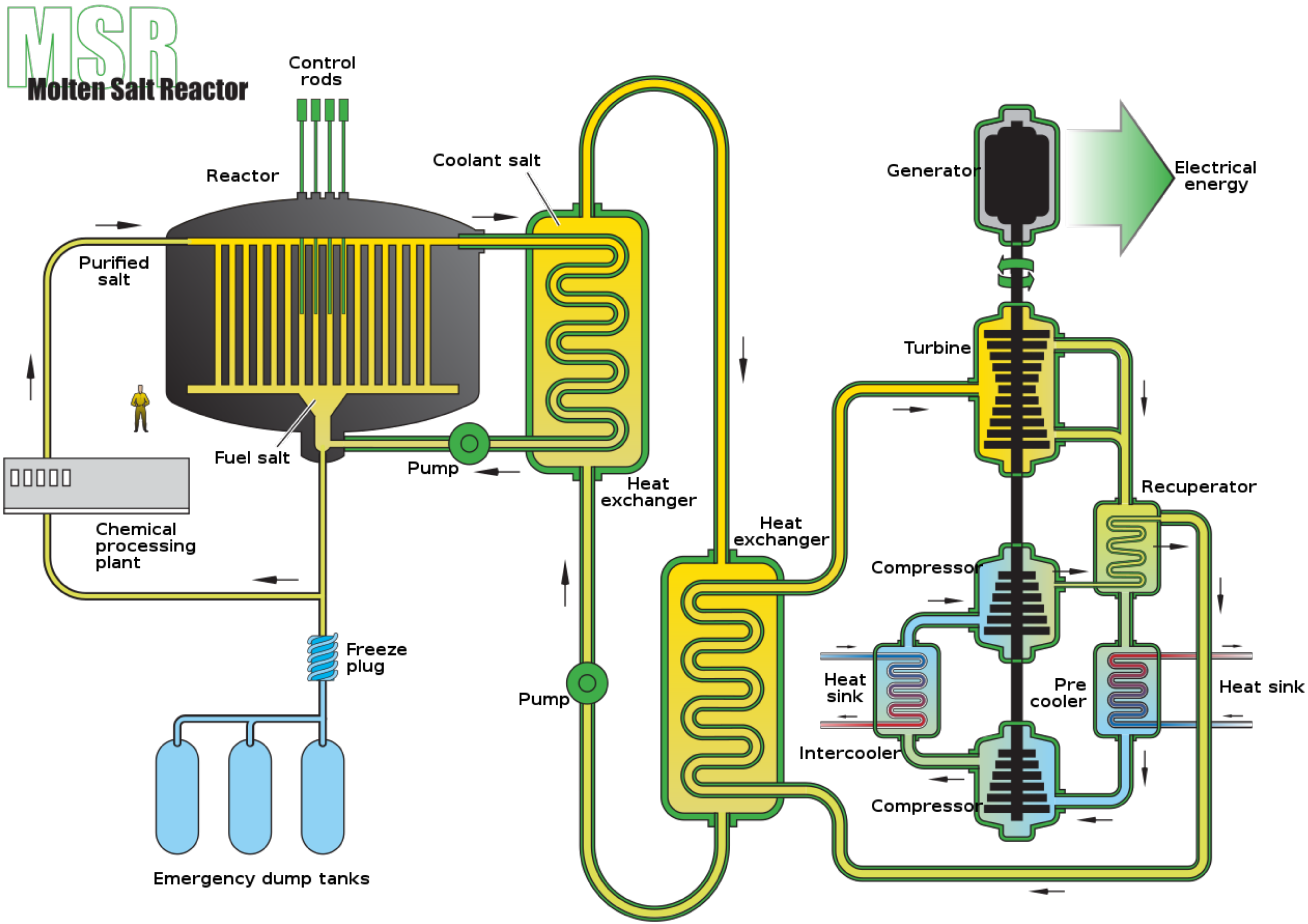
Canada Deuterium Uranium (CANDU) reactor



LMFBR



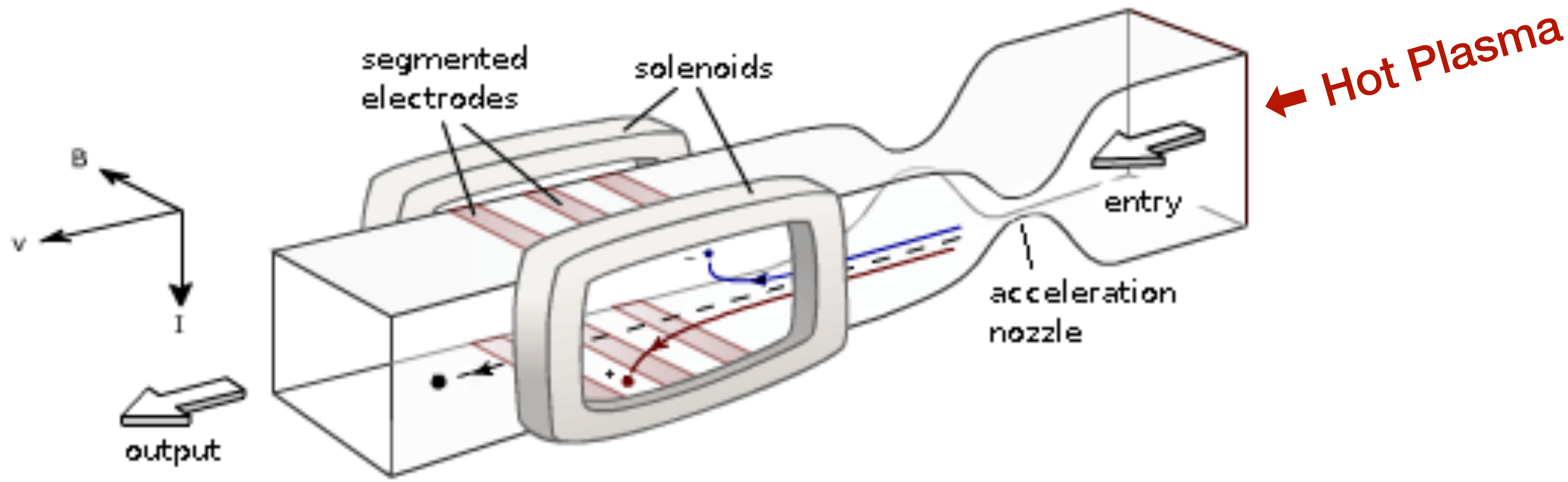
Liquid Metal cooled Fast Breeder Reactors (LMFBR)
"Pool" Design
"Loop" Design
Control Rods
Flow Baffle
Coolant Level
Fissile Core
Breeder Blanket
Reactor Pool Pump
Biological Shielding
Liquid metal coolant
Heat exchanger
Steam generator
Steam
(to power turbine)
Water
(from power turbine)
Control rods
Fissile Core
Breeder Blanket
Biological Shielding
Liquid metal coolant
Heat exchanger
Steam generator
Reactor pool (primary coolant)
Intermediate loop
Power-generation loop
Intermediate loop
Reactor loop (primary coolant)

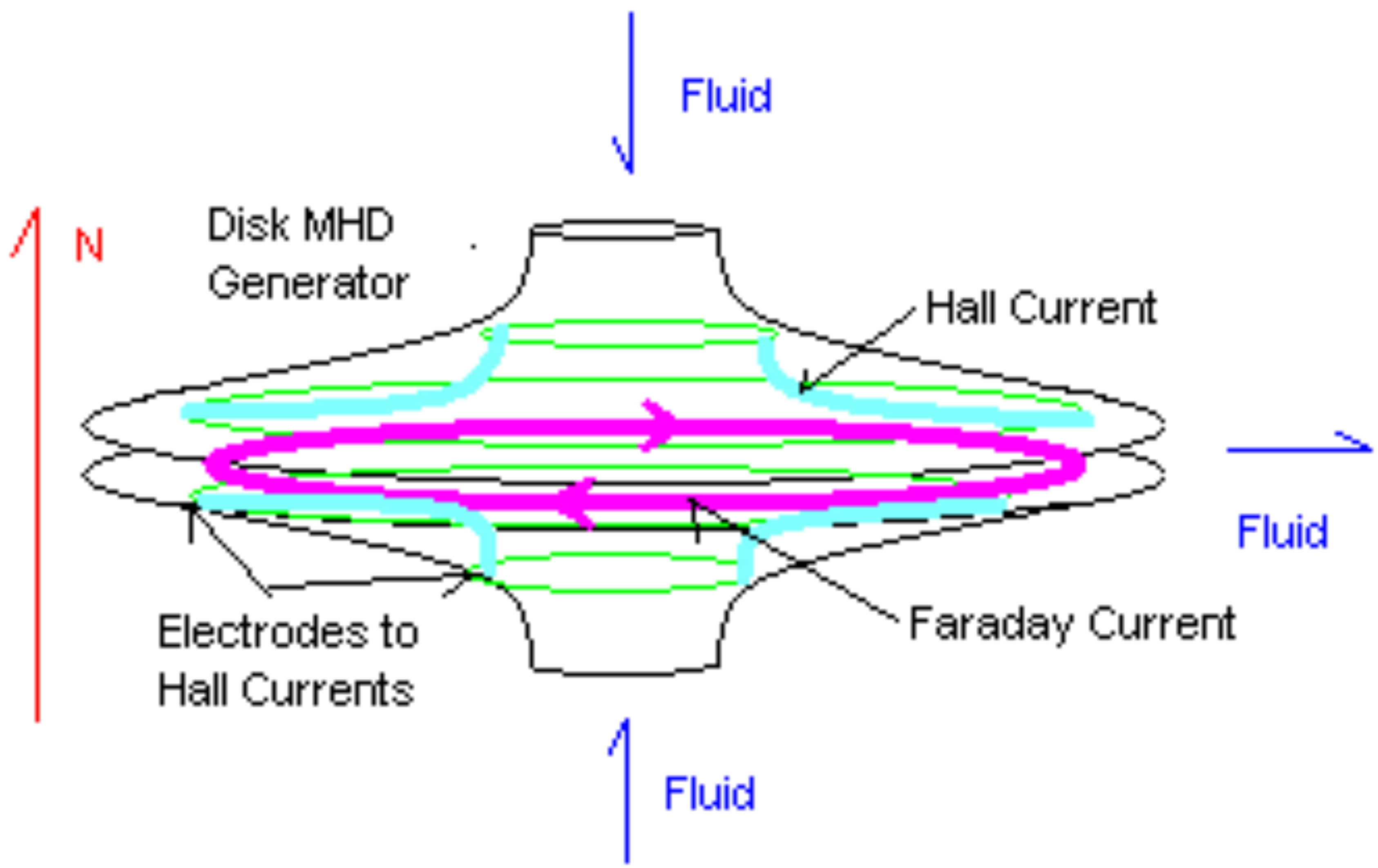

MSR
Molten Salt Reactor
Control rods
Reactor
Coolant salt
Generator
Electrical energy
Purified salt
Turbine
Fuel salt
Pump
Heat exchanger
Recuperator
Chemical processing plant
Heat exchanger
Compressor
Freeze plug
Heat sink
Pre cooler
Heat sink
Pump
Intercooler
Compressor
Emergency dump tanks

Alternatives to Steam Turbines

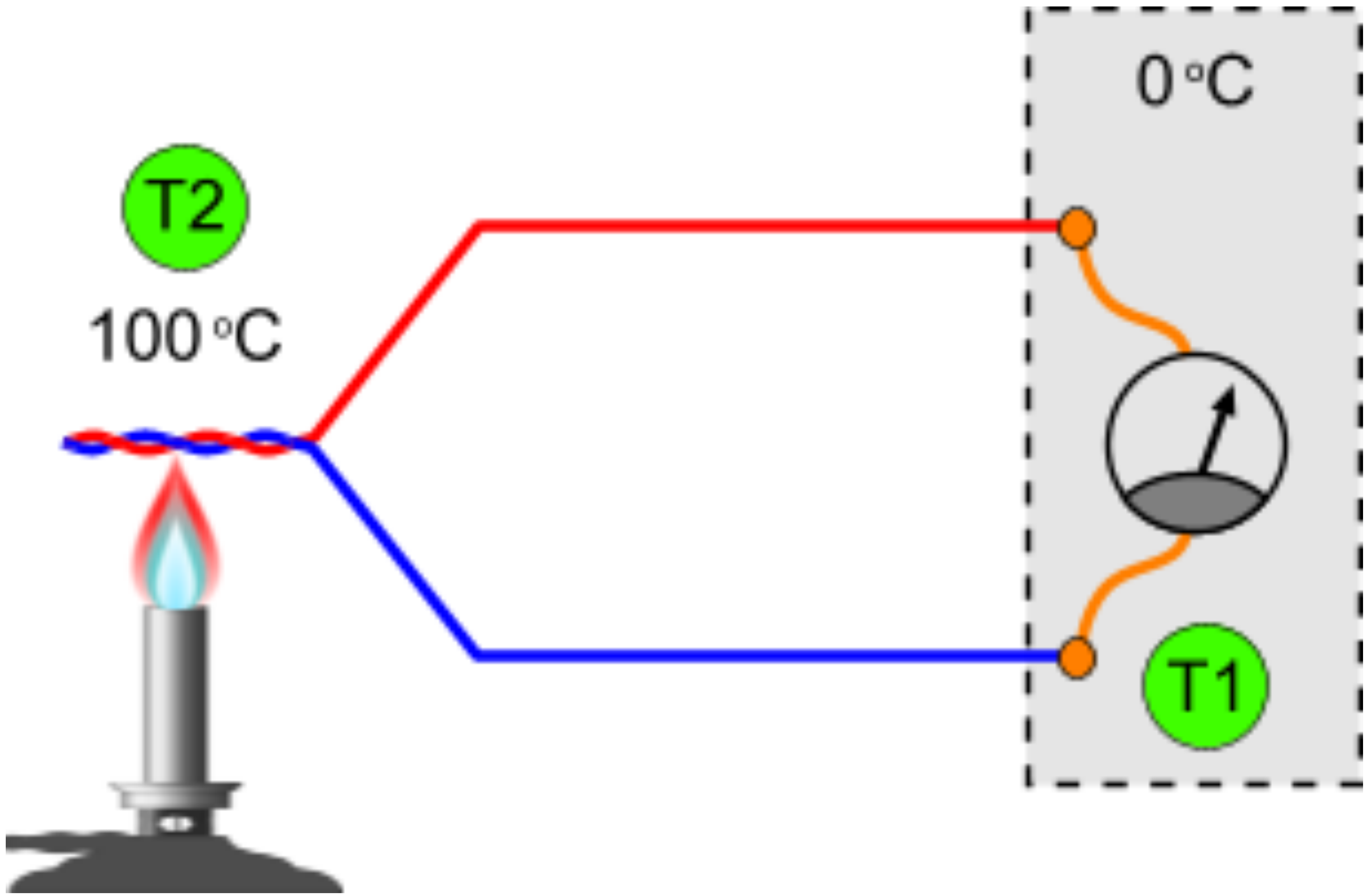
- Magnetohydrodynamic Generators
- Radioisotope Thermoelectric Generators
- High Temperature Electrolysis of H_2O to H_2 & O_2

Magnetohydrodynamic Generators



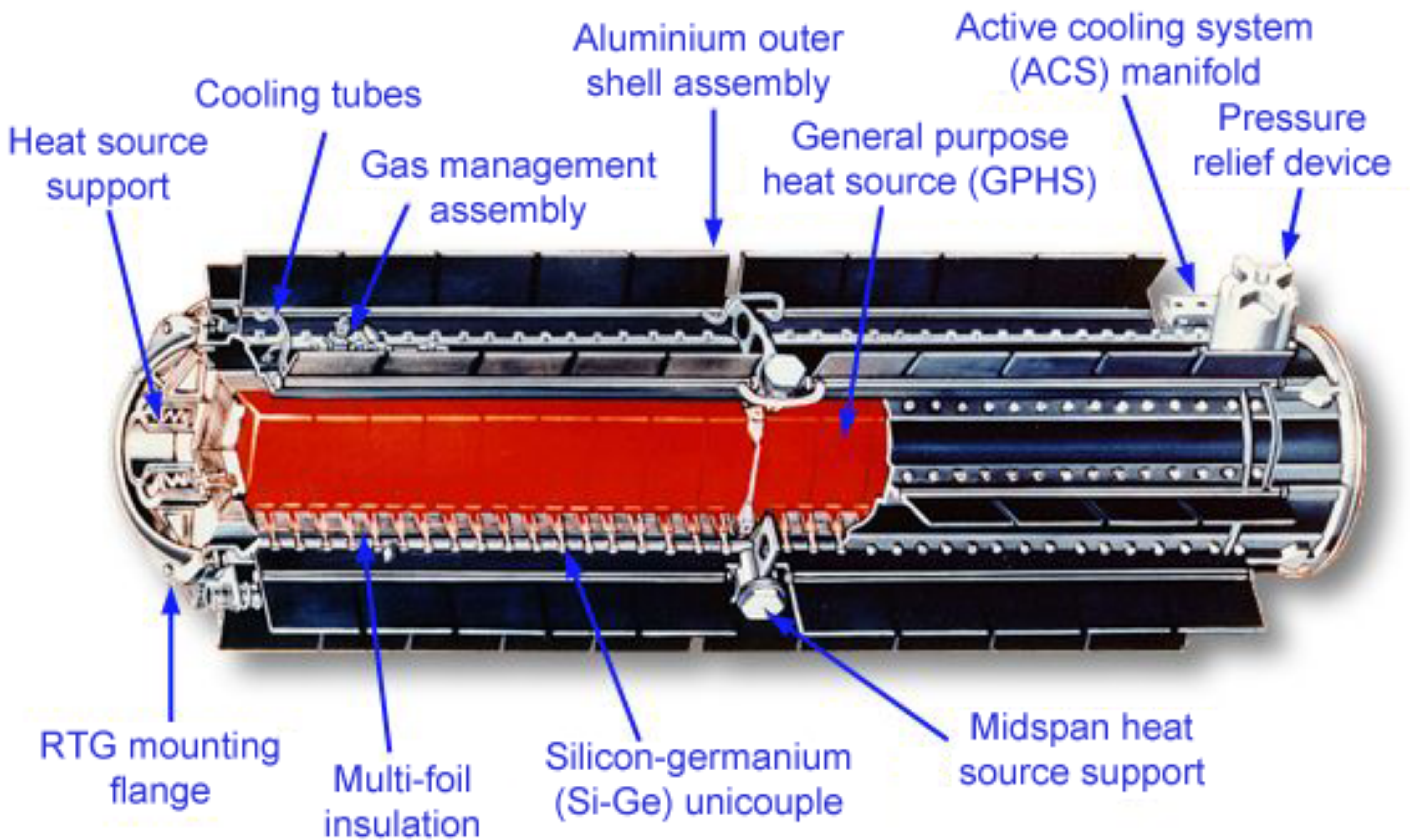


The Thermocouple



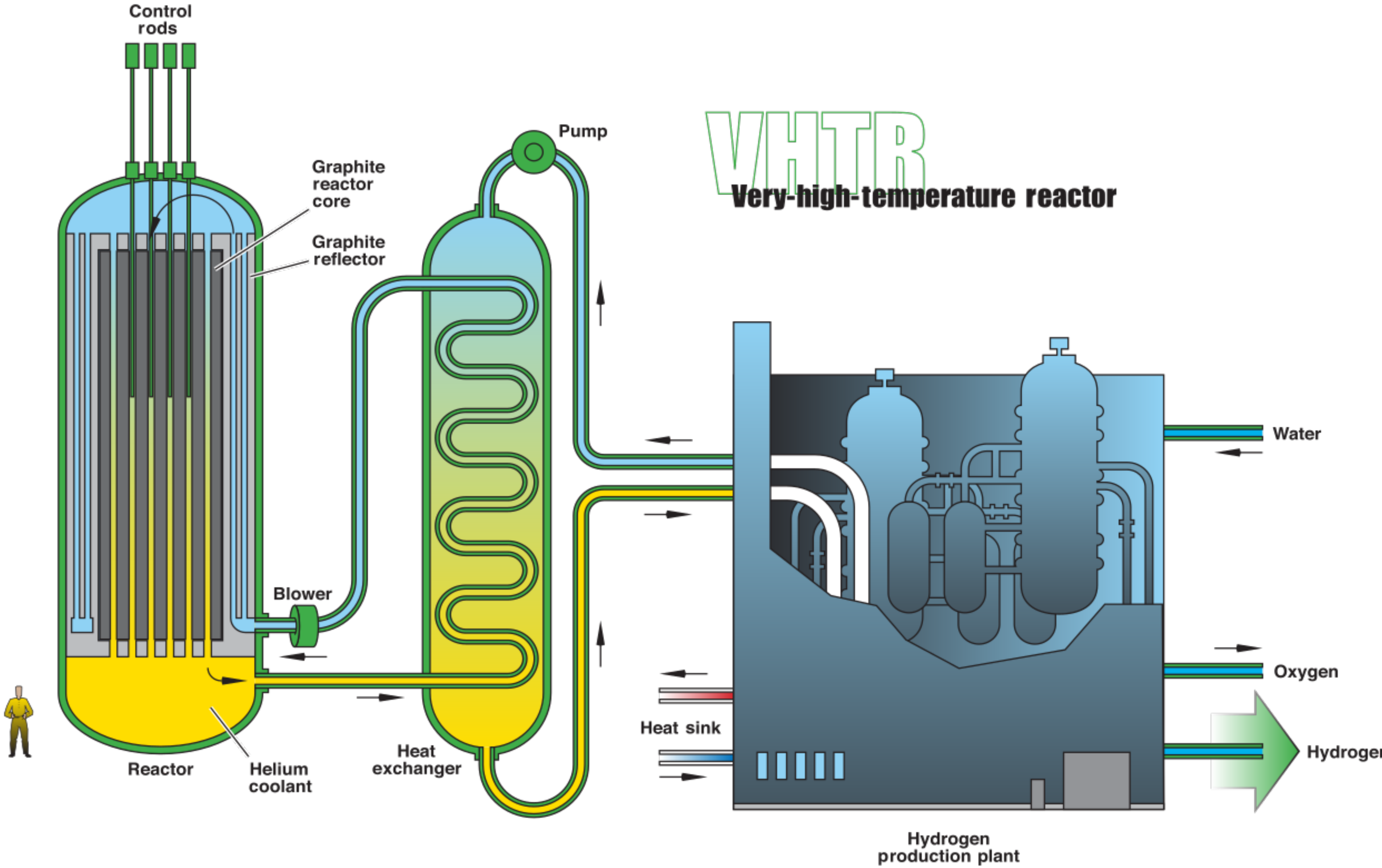
Radioisotope Thermoelectric Generator

(basically a huge number of *thermocouples* in parallel)



VHTR

Very-high-temperature reactor



Reactor “Fuels”

- Enriched Uranium (^{238}U with more than natural 0.7% ^{235}U)

- Plutonium ^{239}Pu (weapons-grade fissionables)

- Thorium $^{232}Th + n \rightarrow {}^{233}Th \rightarrow {}^{233}Pa + \beta^- \rightarrow {}^{233}U + \beta^-$
  and then the ^{233}U makes a chain reaction.

- A *Subcritical* Reactor (too few fission neutrons to sustain a chain reaction) can be “lit up” by ***spallation*** neutrons from a high-energy proton ***accelerator***. (Rubbia et al.)