NUCLEAR REACTOR DESIGNS

Hand-waving
by
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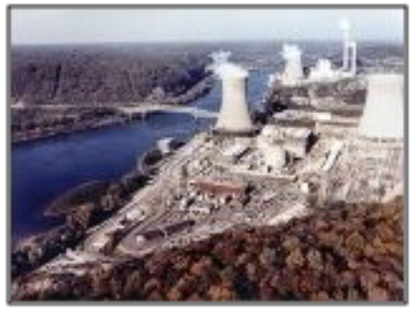
Gen-IV Roadmap (Wikipedia)

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

Generation I

Early Prototype Reactors



–Shippingport
–Dresden, Fermi I
–Magnox

Generation II

Commercial Power Reactors

–LWR–PWR, BWR
–CANDU
–VVER/RBMK

Generation III

Advanced LWRs

–ABWR
–System 80+
–AP600
–EPR

Near-Term Deployment

Generation III+ Evolutionary Designs Offering Improved Economics

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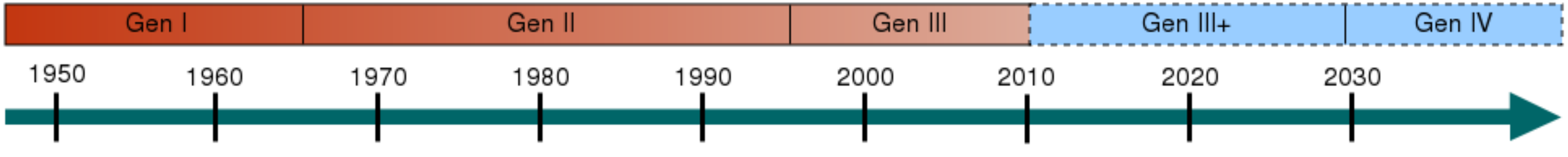
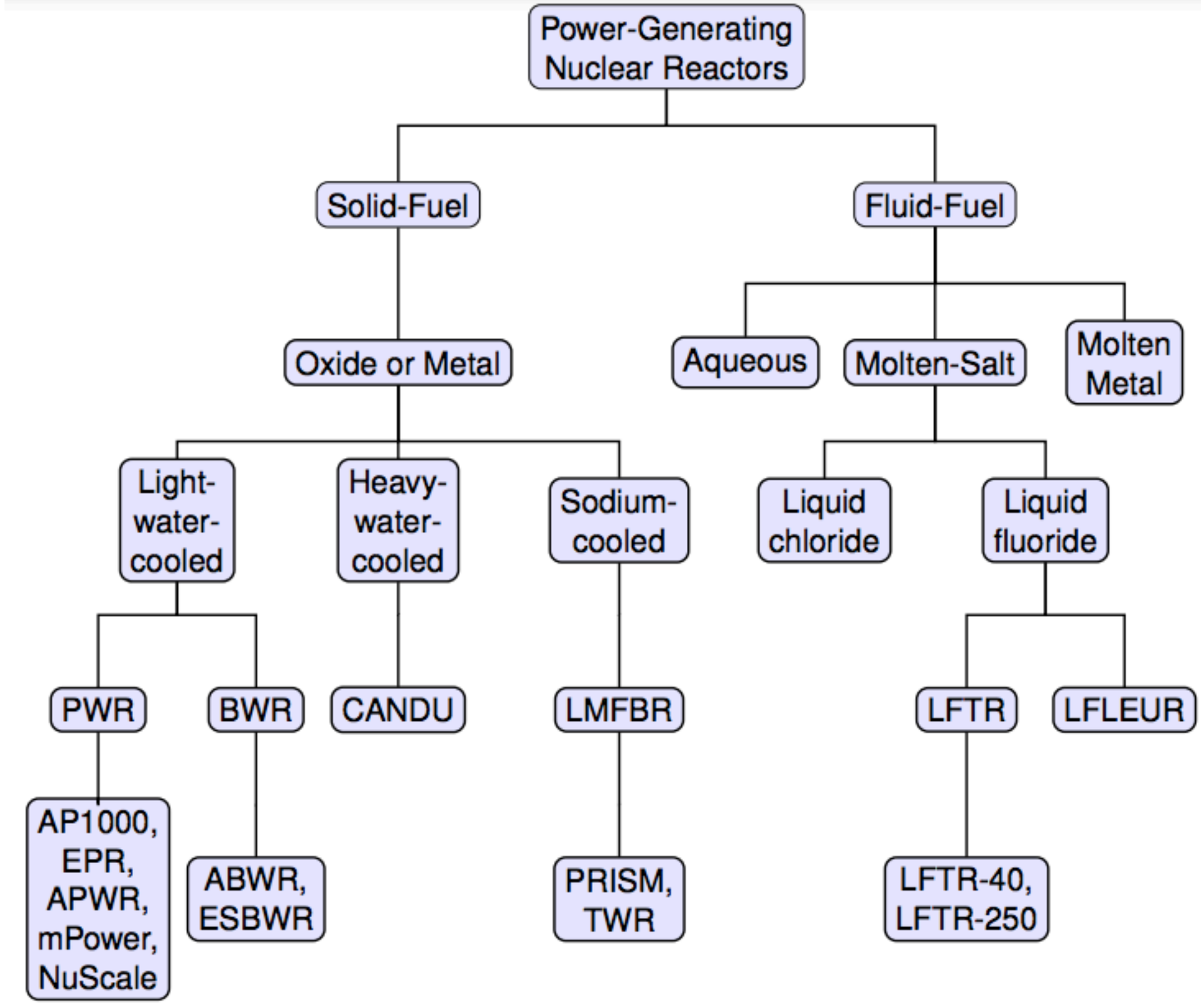
Generation IV

–Highly Economical
–Enhanced Safety
–Minimal Waste
–Proliferation Resistant



Nuclear Reactor "Families"



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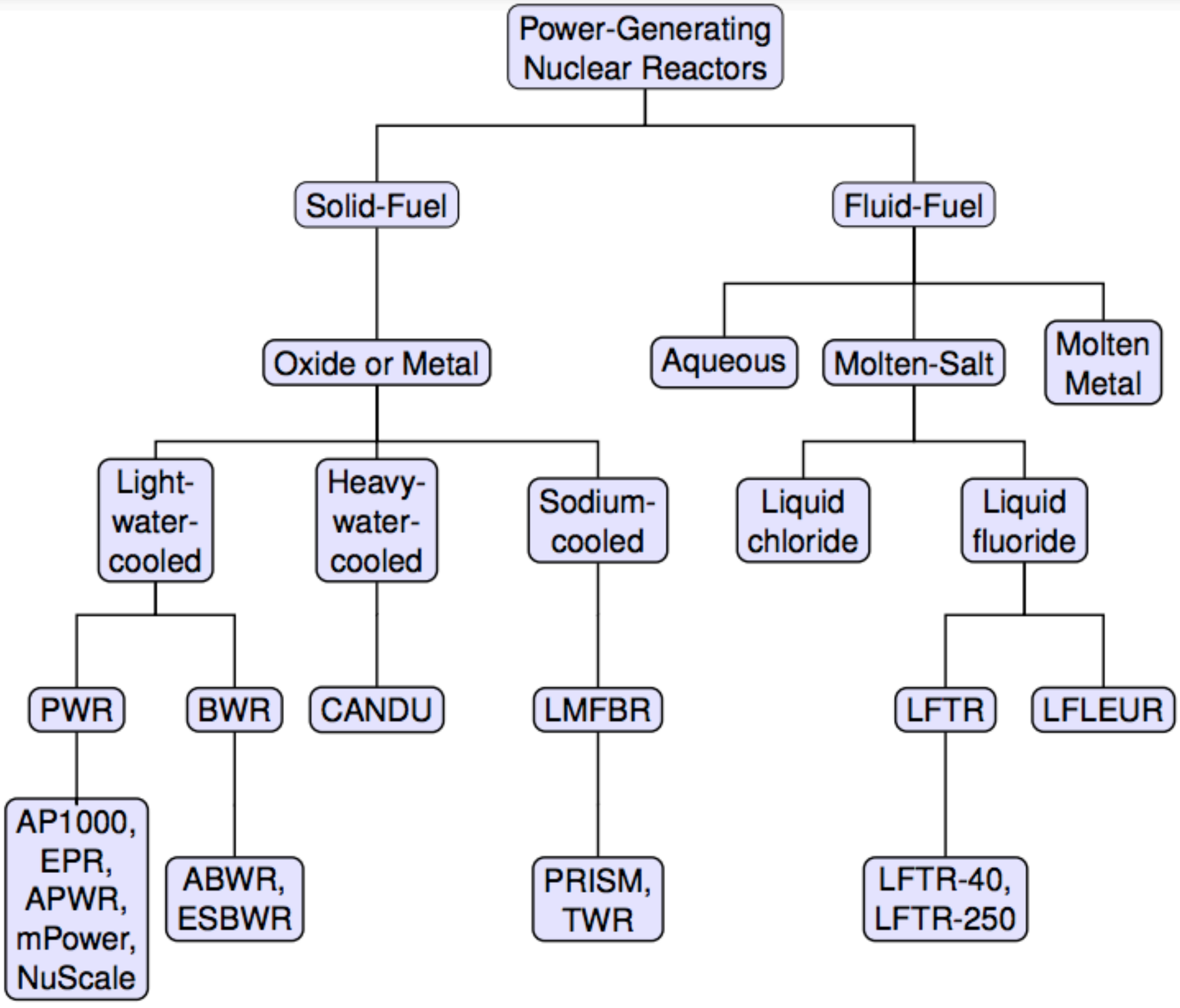
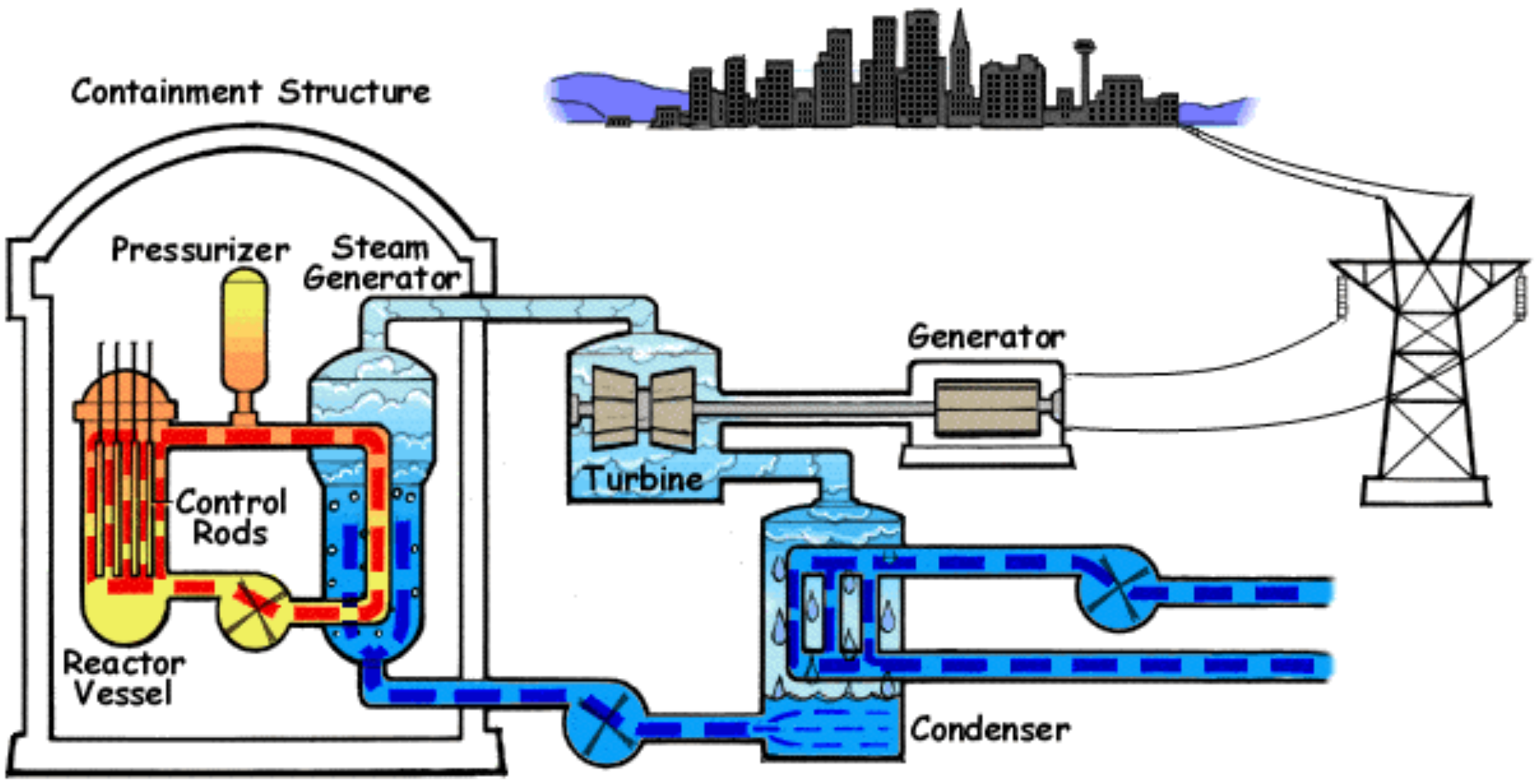
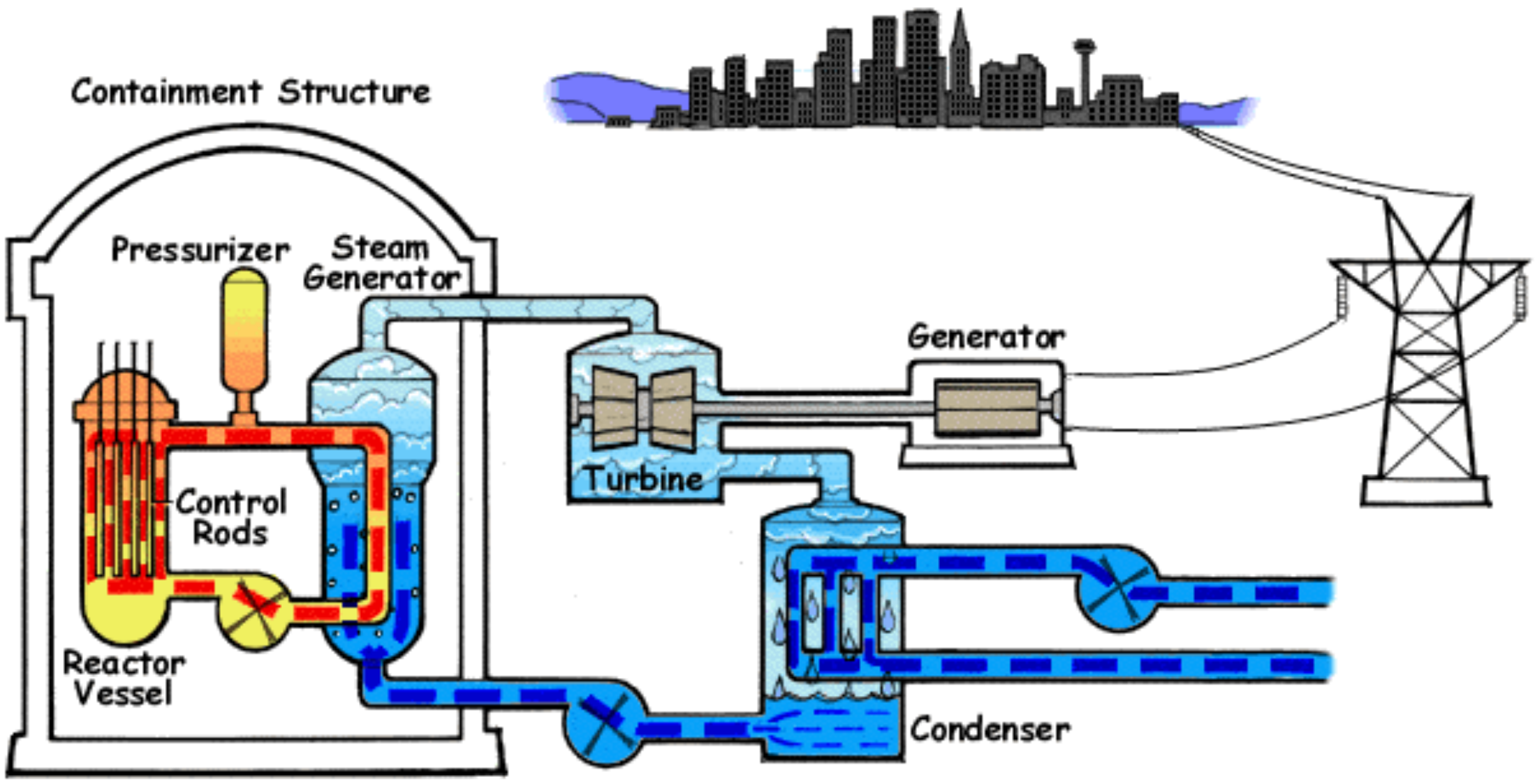


(from Kirk Sorensen’s presentation at Delft in 2015)

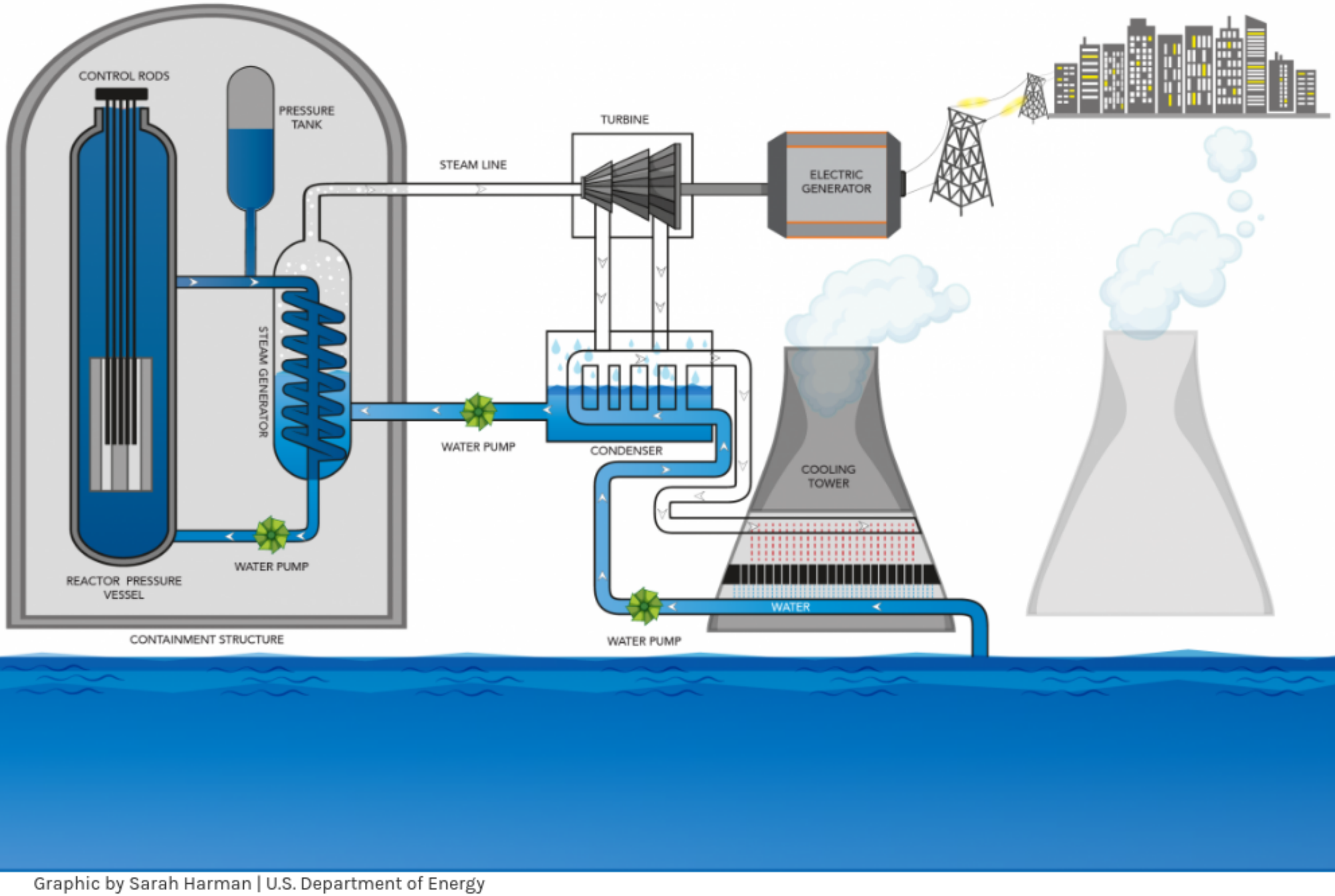
Pressurized Water Reactors



Pressurized Water Reactors

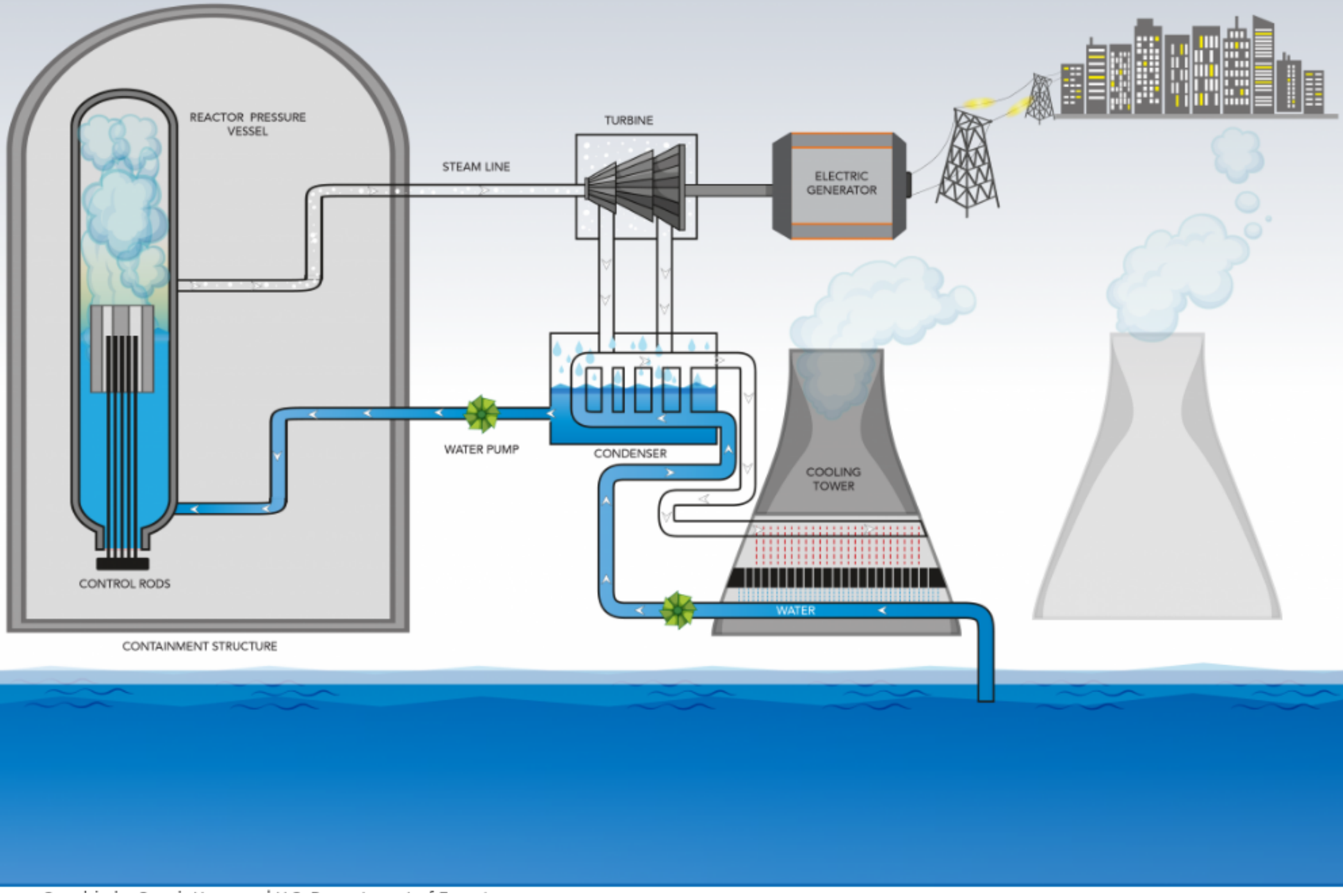


PRESSURIZED WATER REACTOR (PWR)

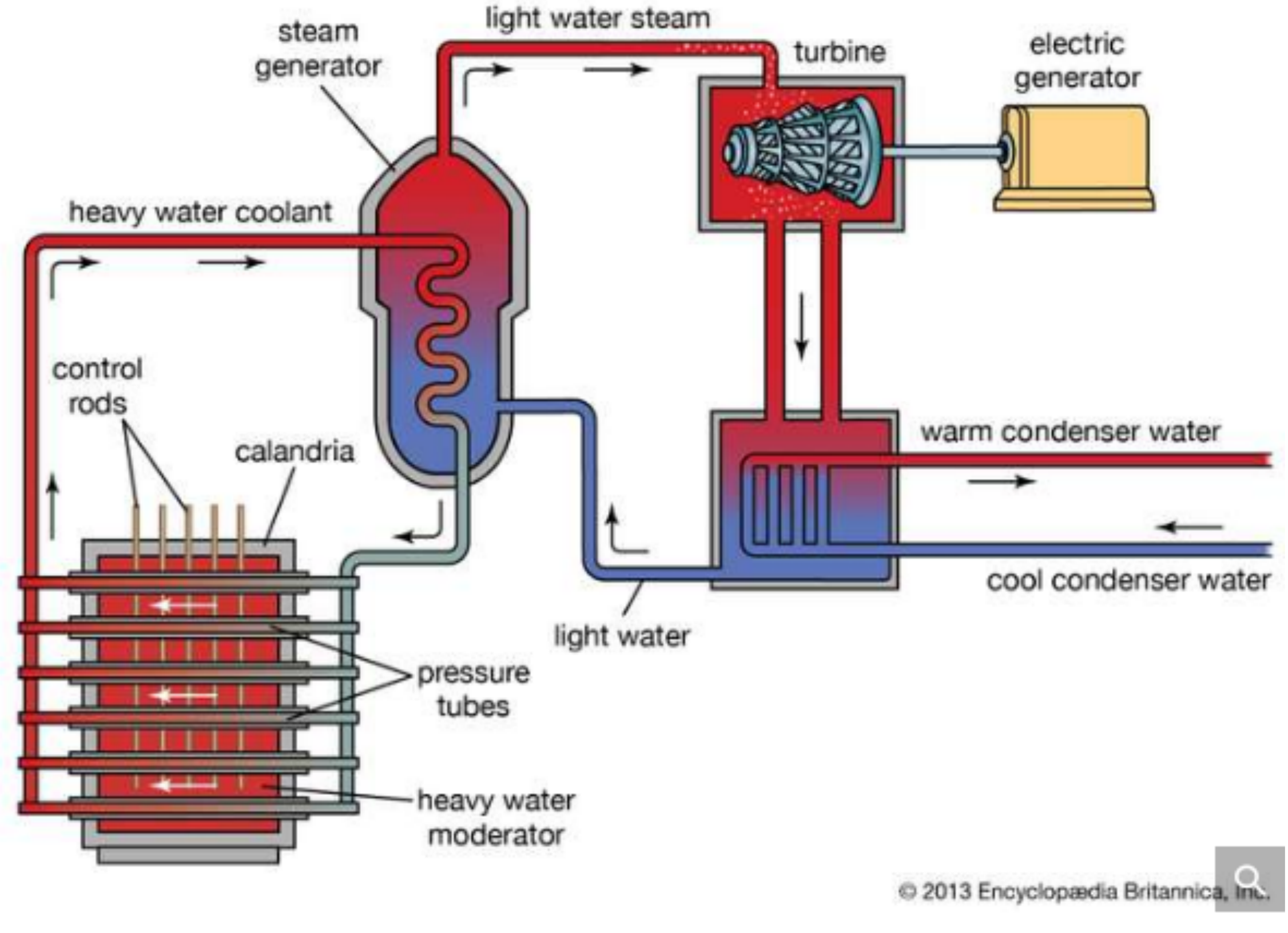


Graphic by Sarah Harman | U.S. Department of Energy

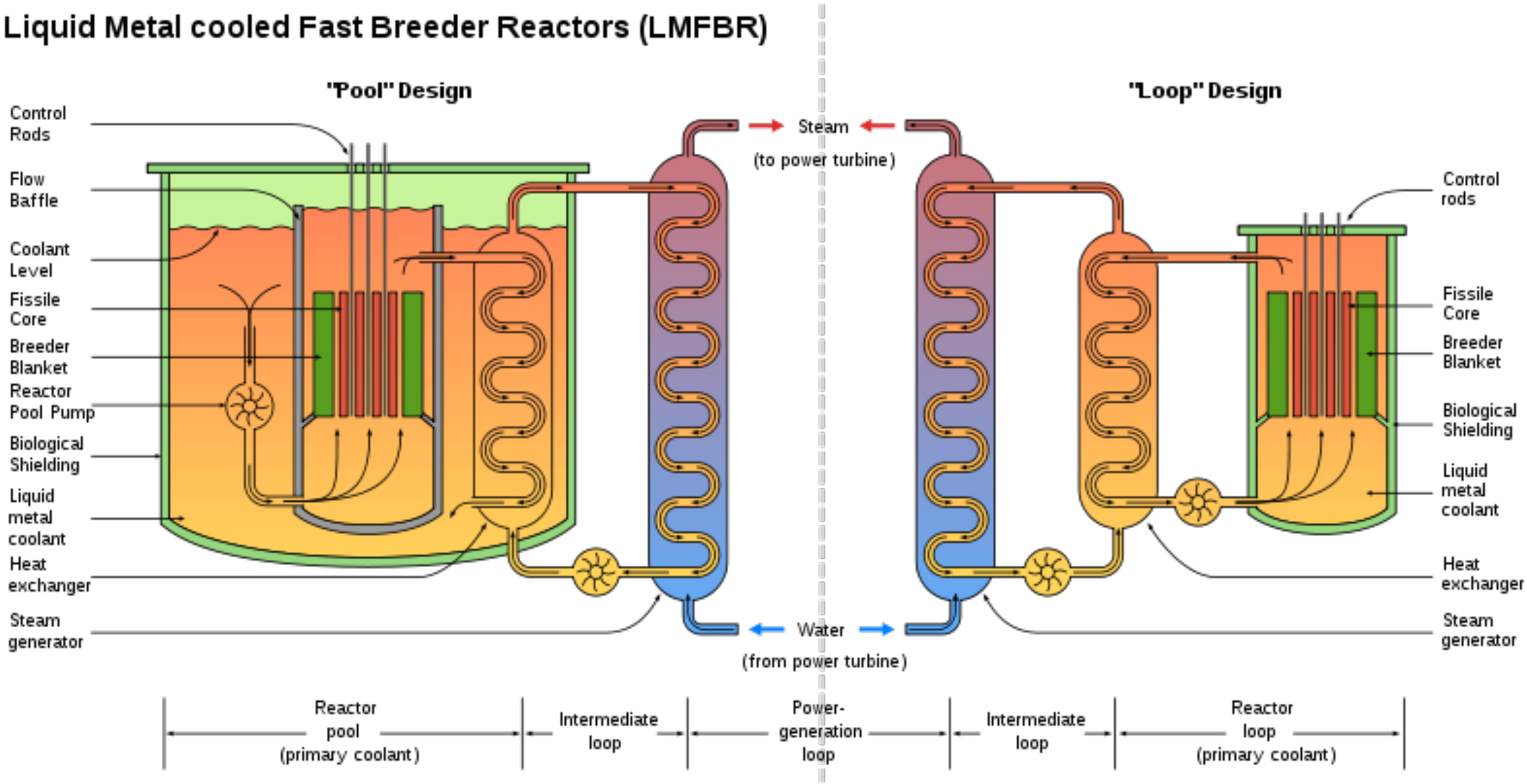
BOILING WATER REACTOR (BWR)



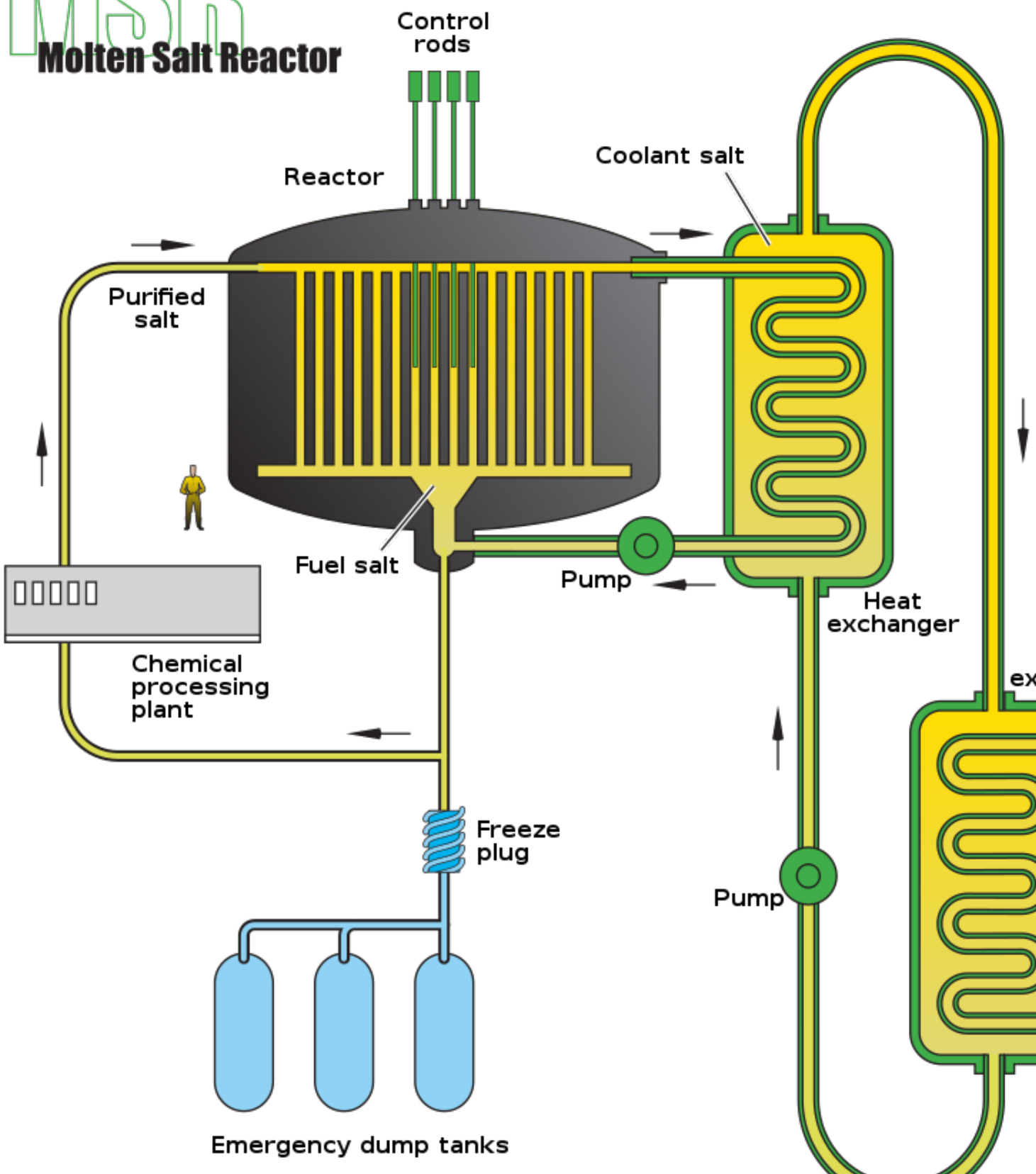
Canada Deuterium Uranium (CANDU) reactor

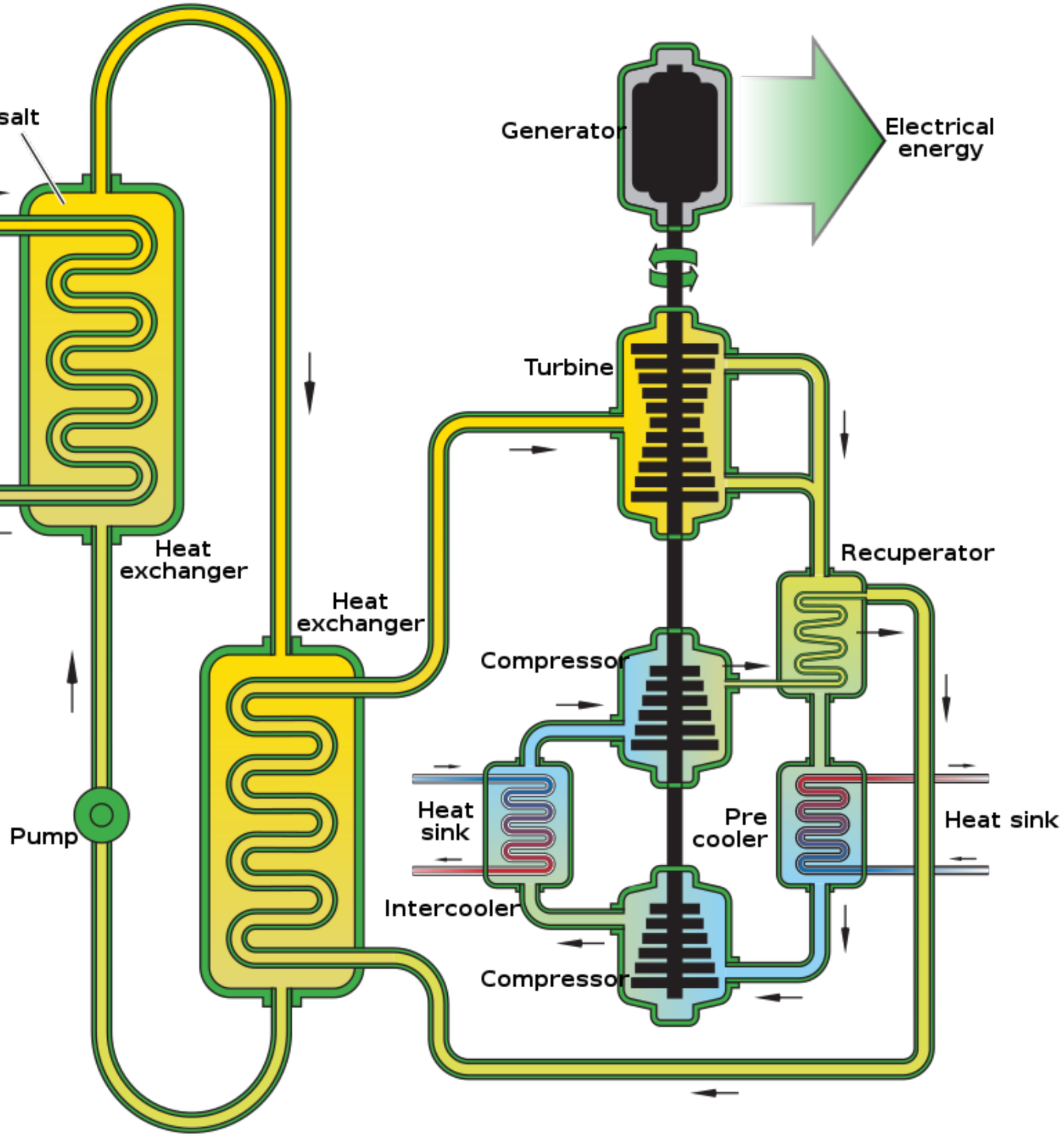


LMFBR


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

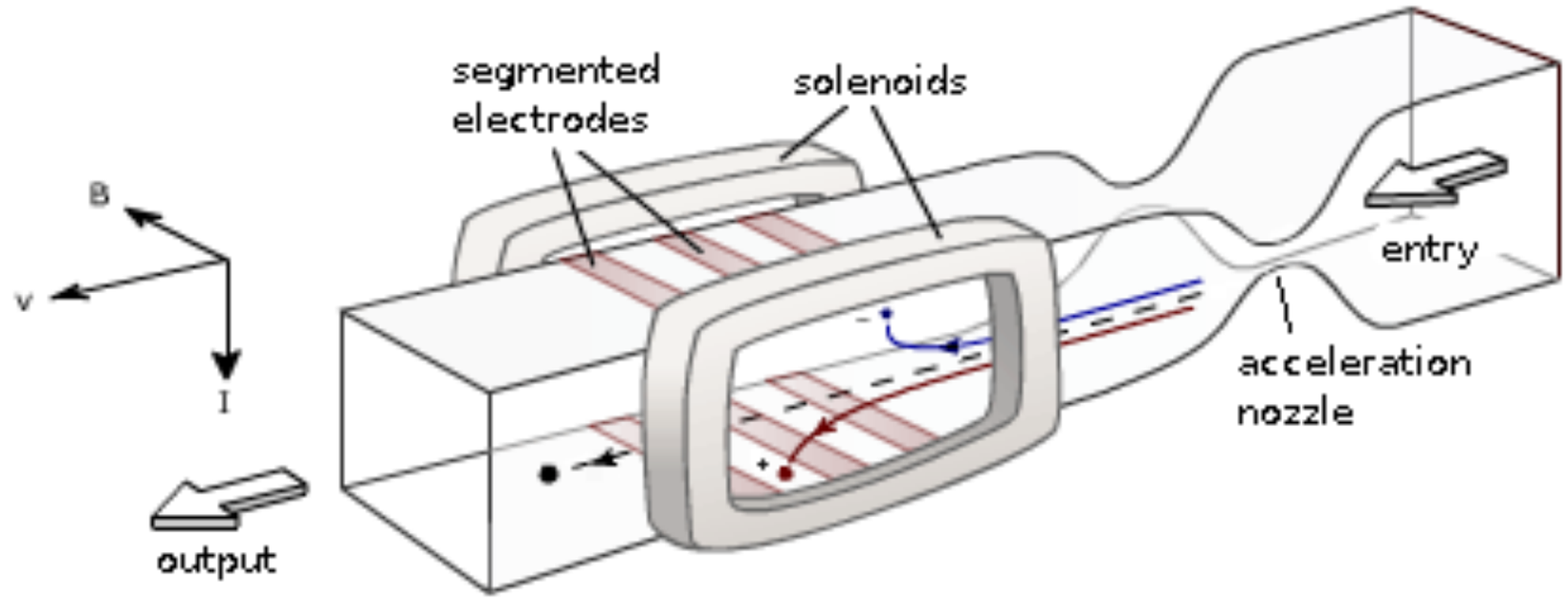




Alternatives to Steam Turbines

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

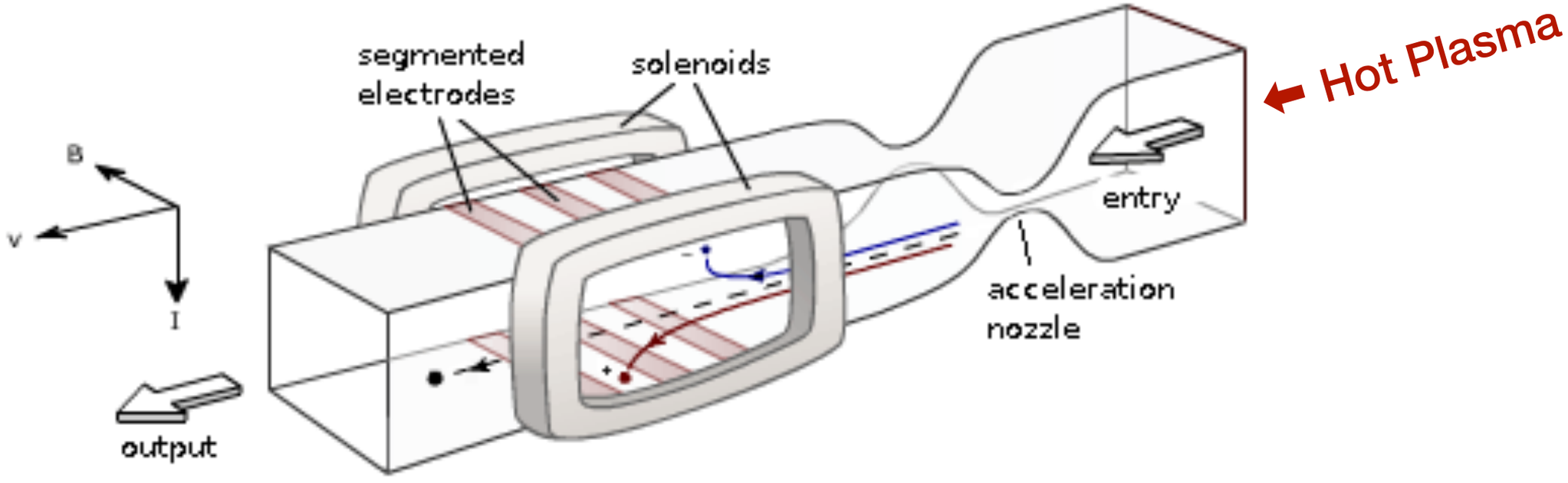
Magnetohydrodynamic Generators

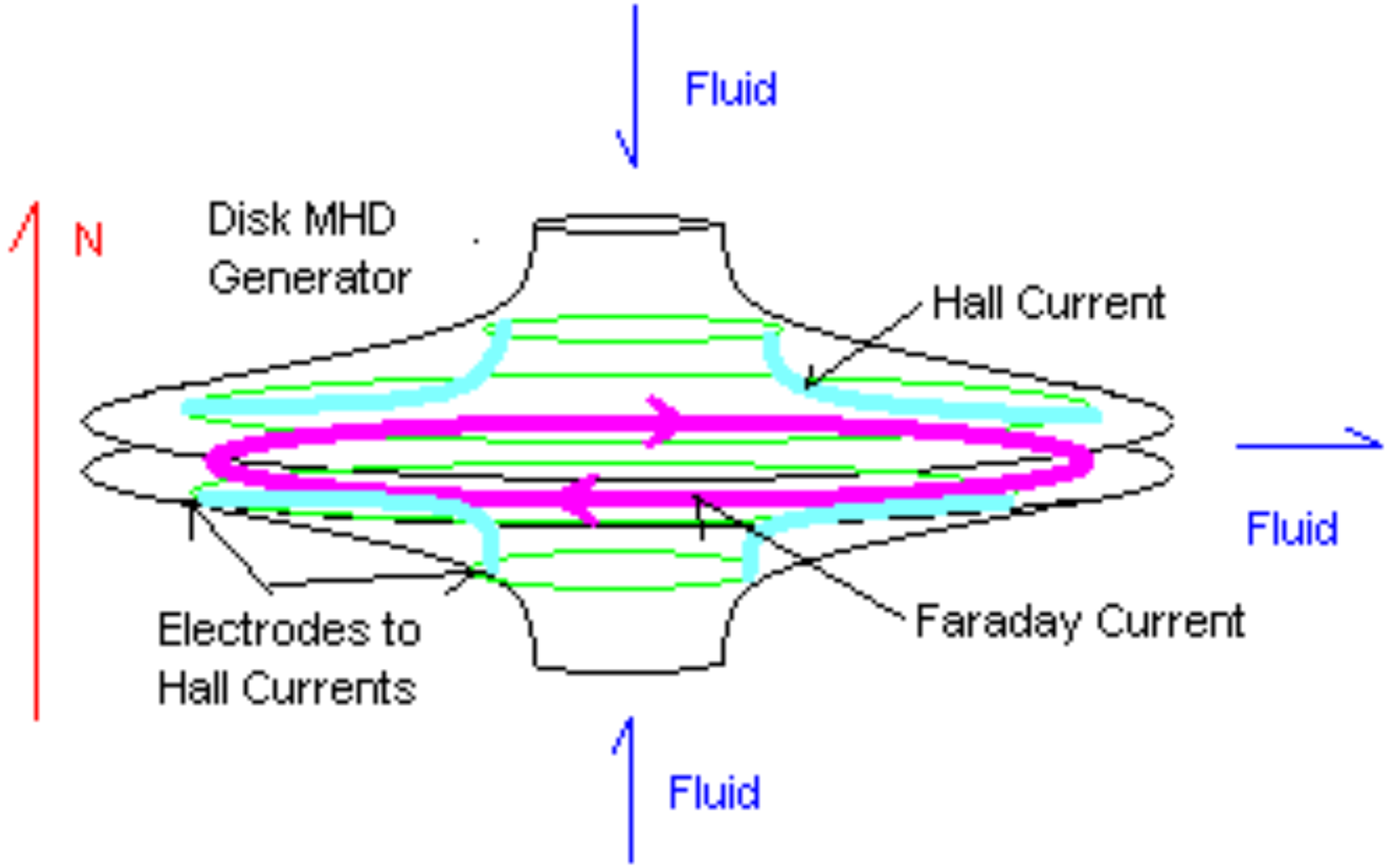


MHD Generator

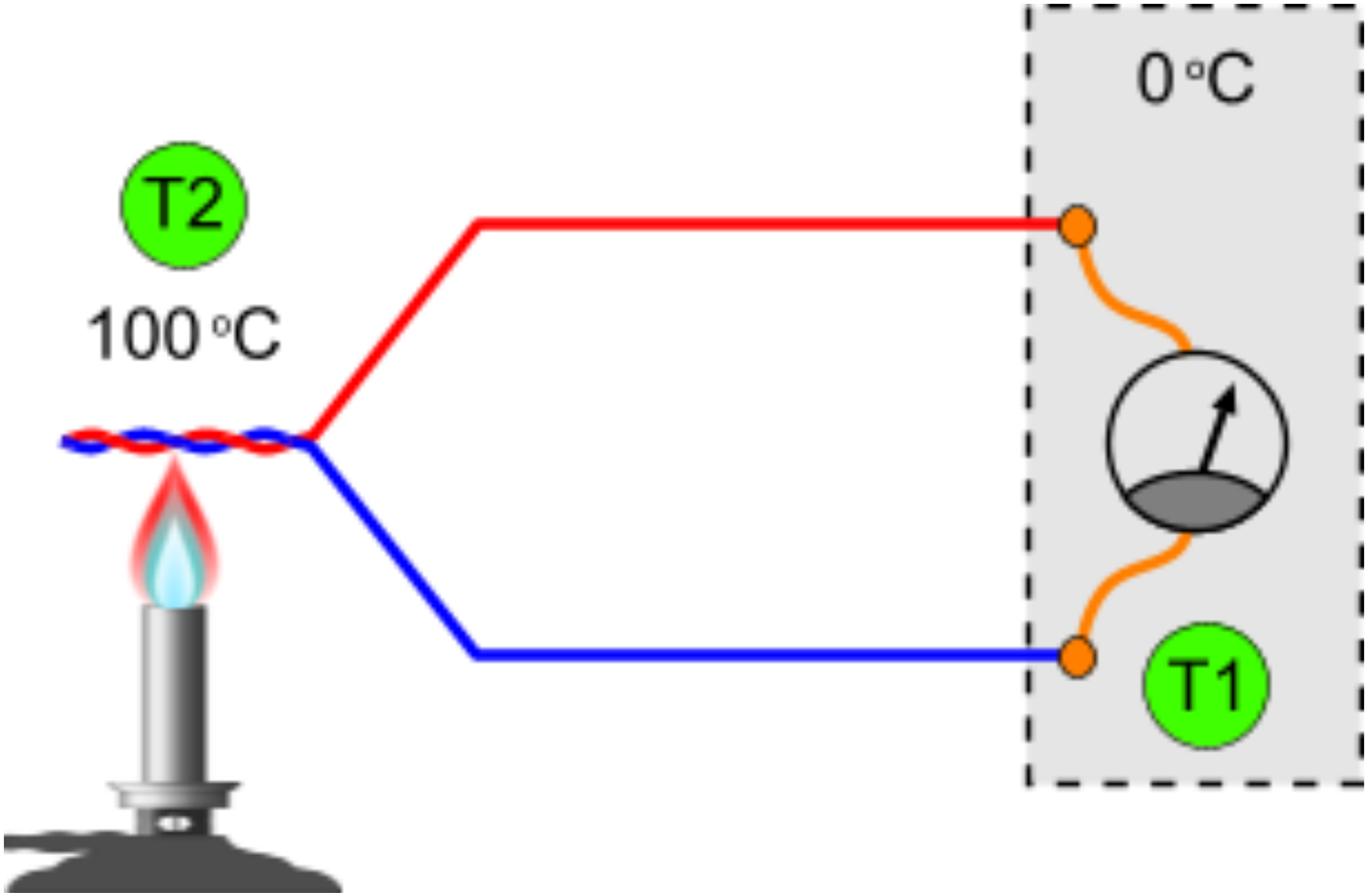
Faraday linear nozzle with segmented electrodes

Magnetohydrodynamic Generators



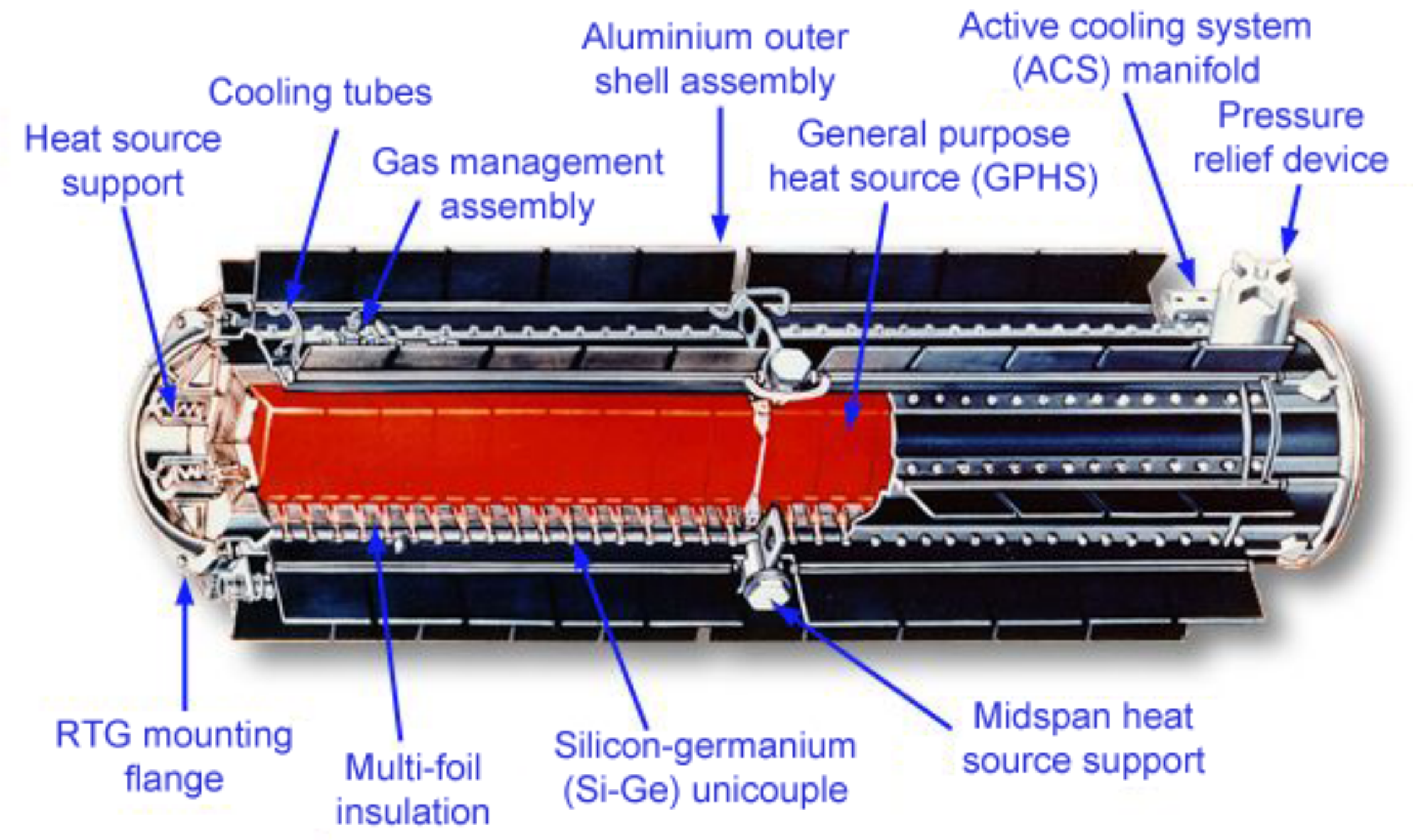


The Thermocouple



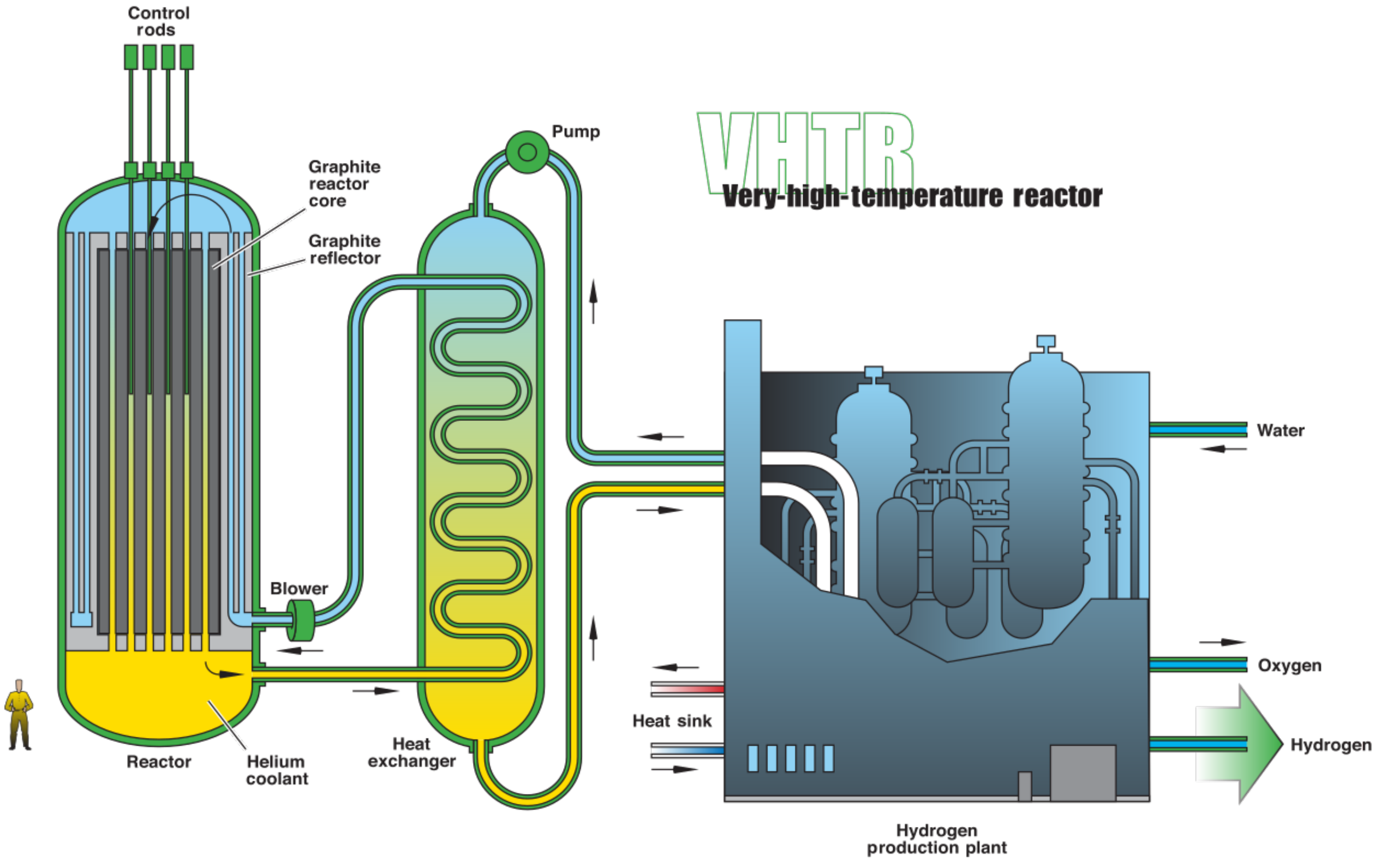
Radioisotope Thermoelectric Generator

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



VHTR

Very-high-temperature reactor



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

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- 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.)