NUCL 402 Engineering of Nuclear Power Systems

Lecture 4: CANDU, VVER, RBMK

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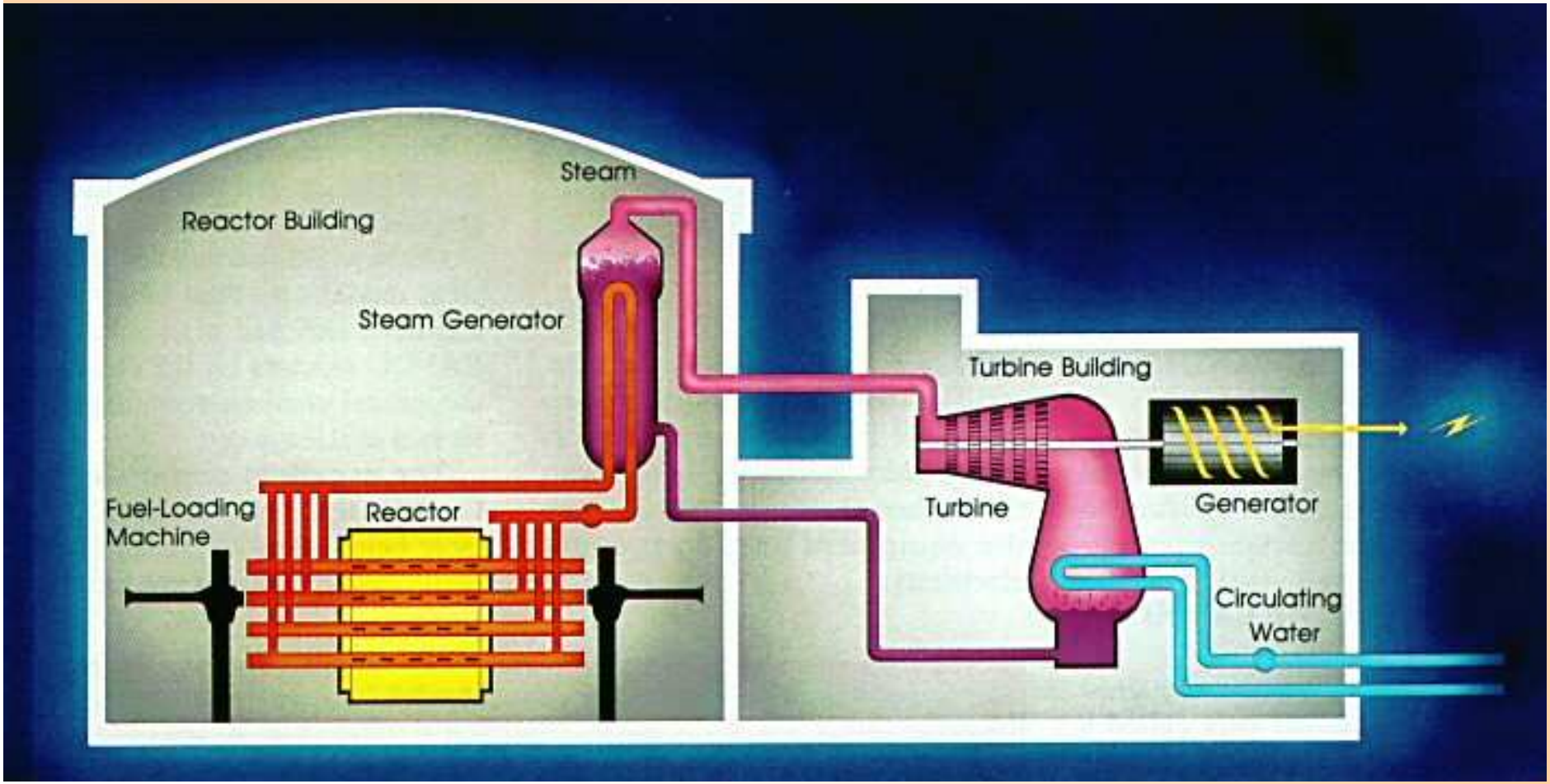
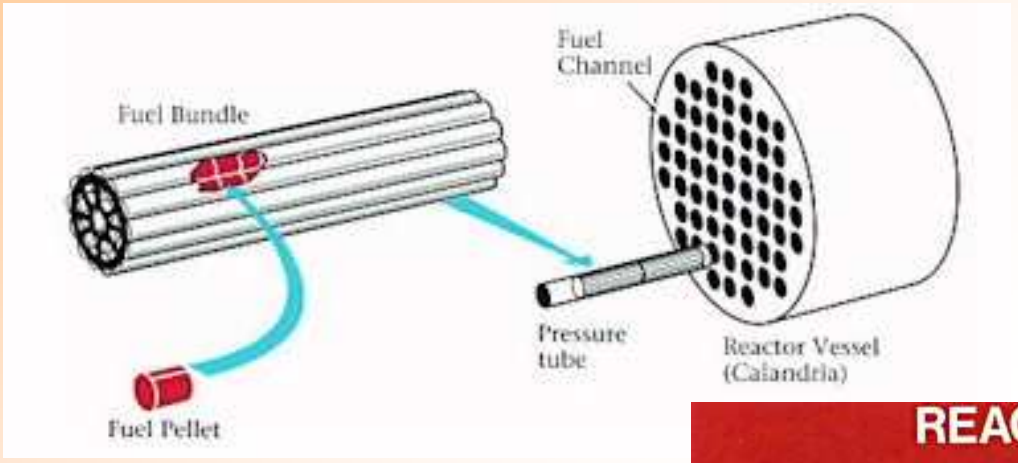
CANDU (Canadian deuterium natural uranium) Reactor

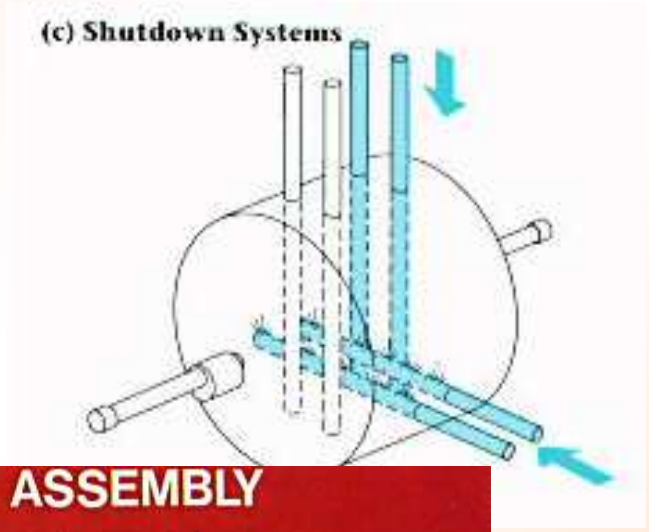
- ✓ Designed by Atomic Energy Canada Limited (AECL)
- ✓ fuel pellets made of uranium dioxide with natural uranium (0.7% U-235).
- ✓ The CANDU design consists of a horizontal calandria (Vessel) which has tubes for the fuel rods and cooling water (heavy water).
- ✓ Longer operating cycles are possible-highest world capacity factors.
- ✓ Fuel burnup in a CANDU is only 6500 to 7500 MWD per metric ton uranium (MTU). compared with 33000 to 50000 MWD/MTU obtained by many PWR and BWR reactors.
- ✓ Multi-unit stations (1 and 8 reactors per site) use a vacuum building as a special containment protection feature.

CANDU

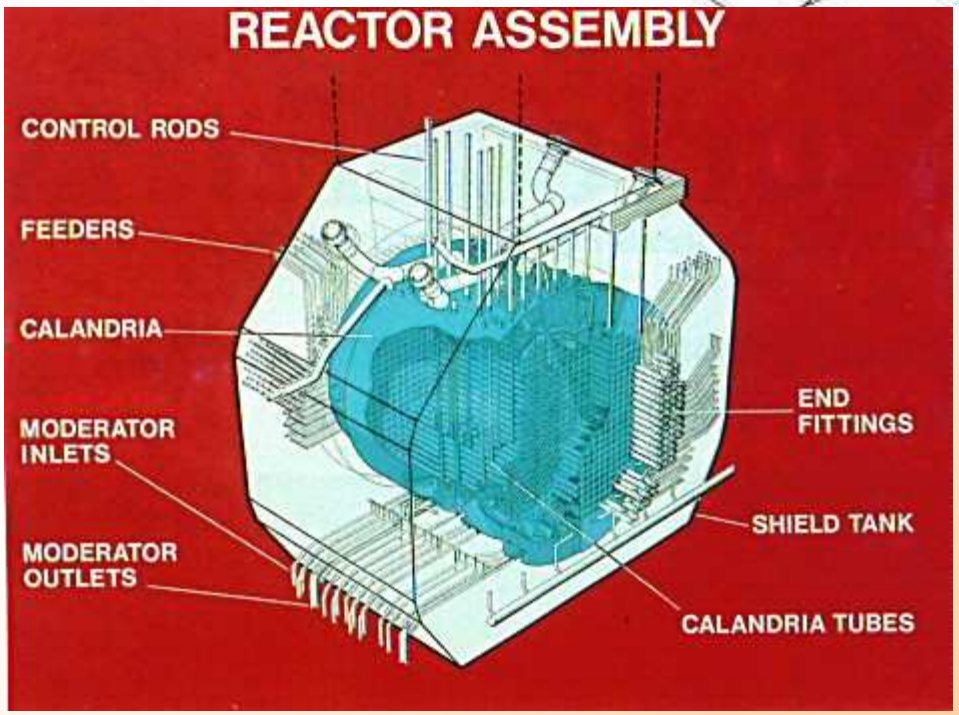

Steam
Reactor Building
Steam Generator
Turbine Building
Fuel-Loading
Machine
Reactor
Turbine
Generator
Circulating
Water

CANDU

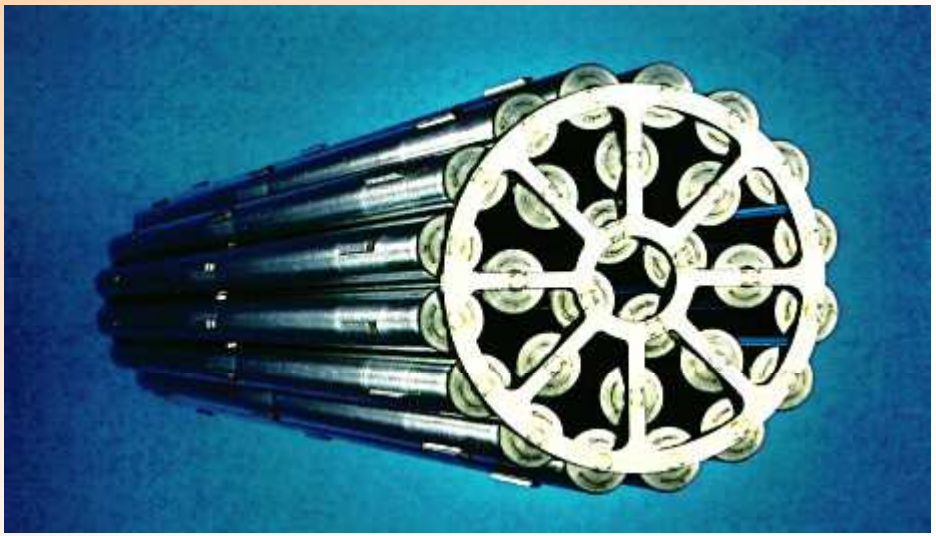


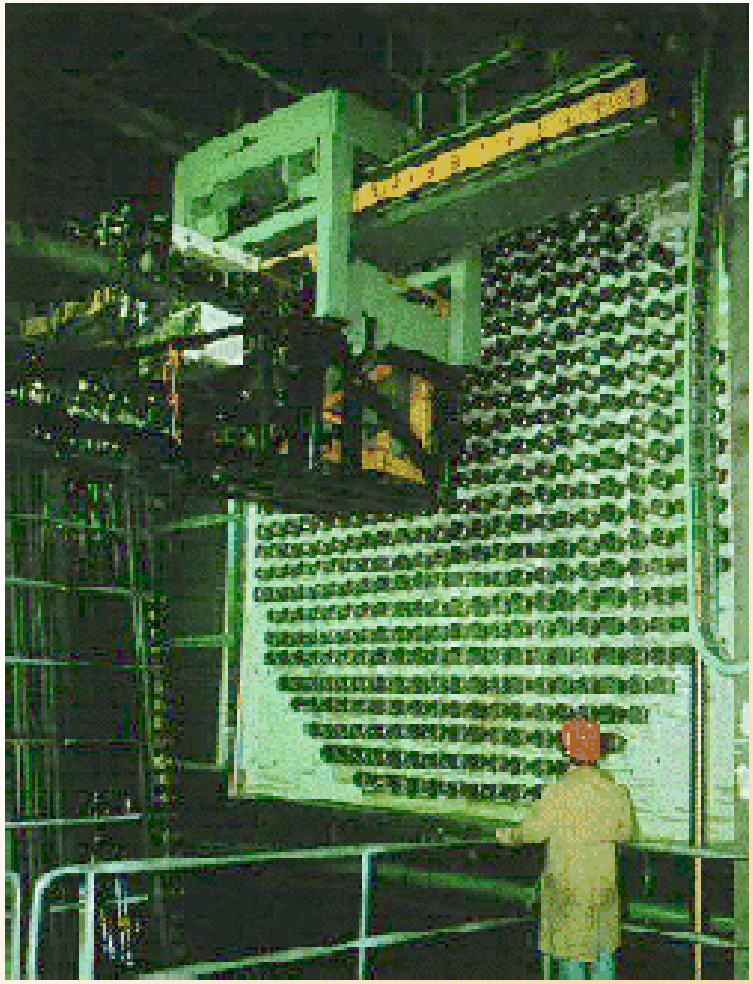


fuel pellets loaded into fuel rods in a fuel bundle (fuel assembly). Then within the pressure tube and calandria.

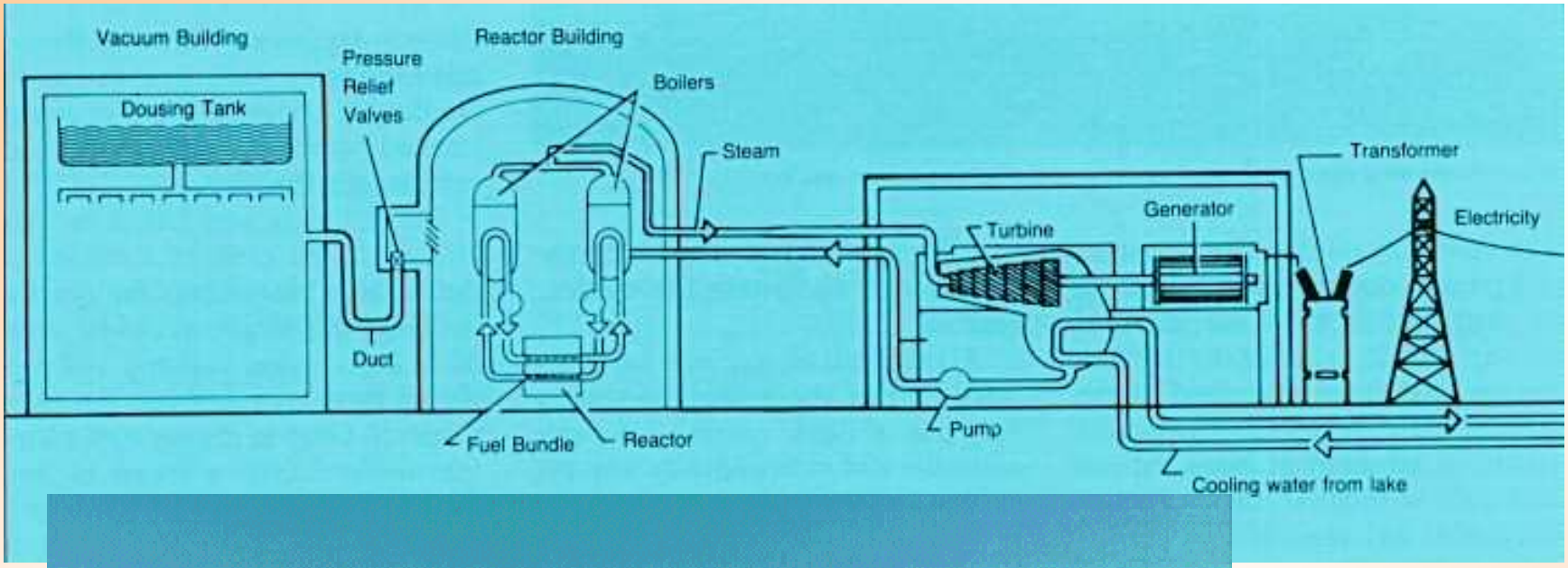


Candu

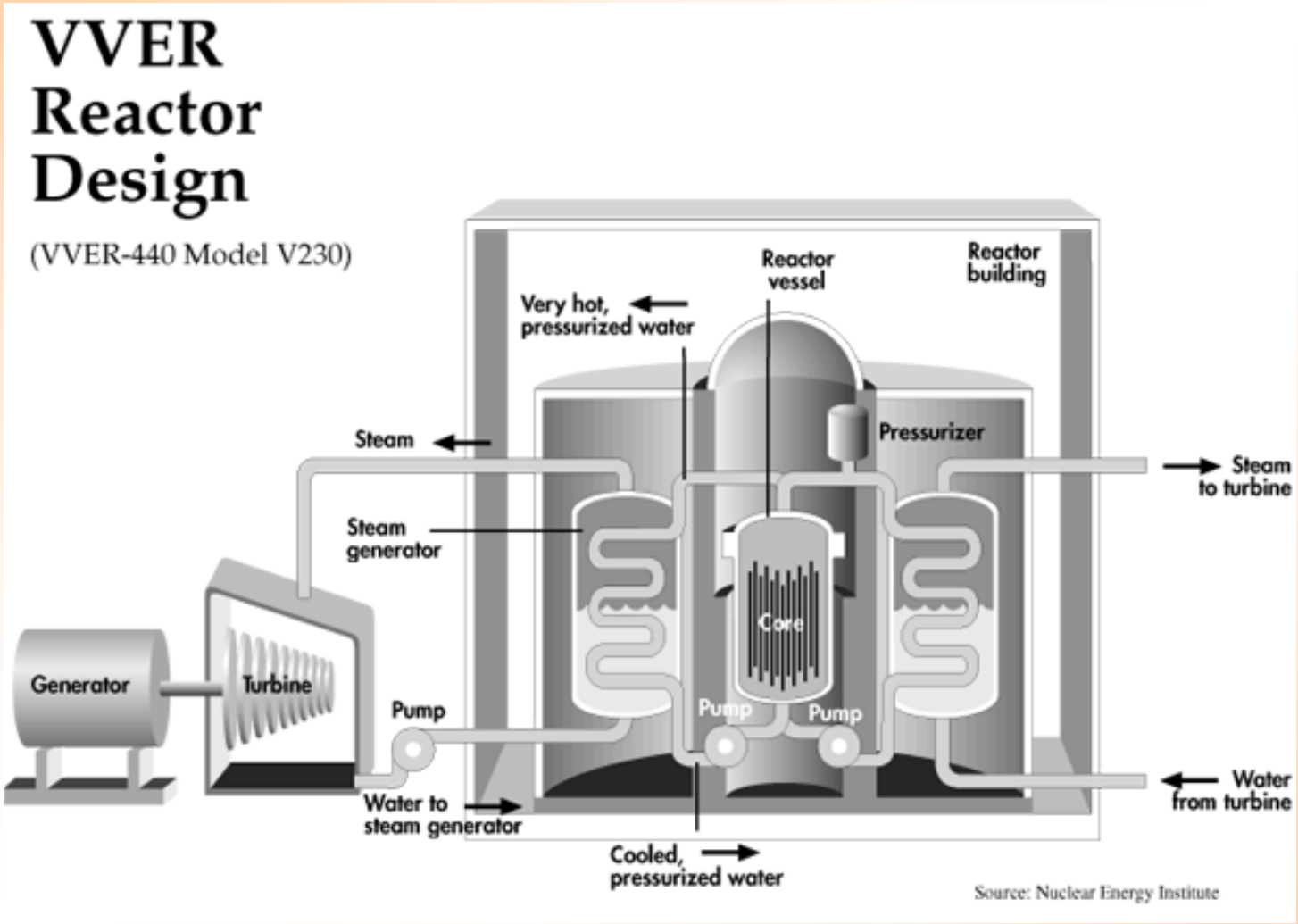


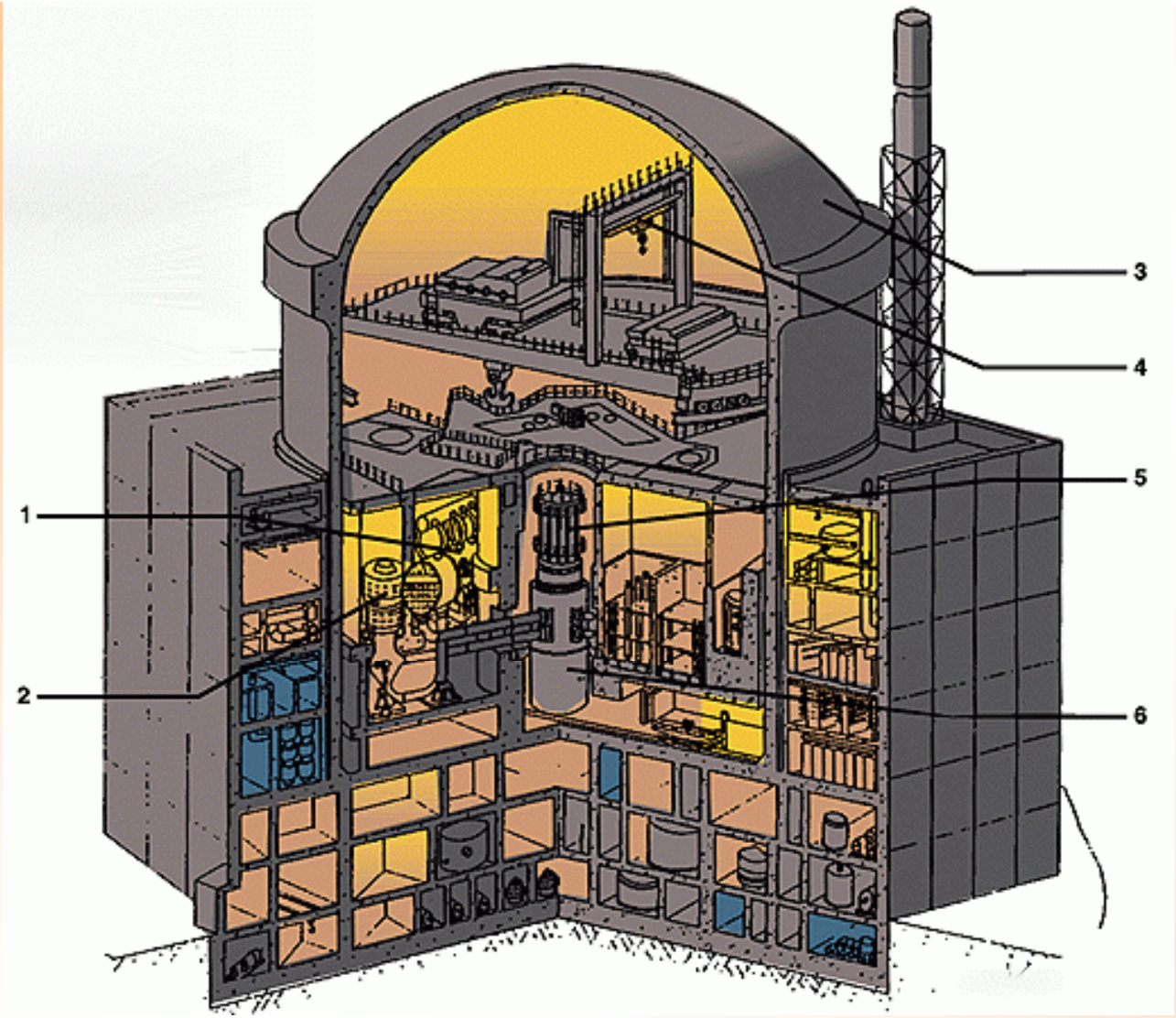


CANDU


Vacuum Building
Reactor Building
Pressure
Relief
Valves
Dousing Tank
Boilers
Steam
Transformer
Generator
Turbine
Electricity
Duct
Fuel Bundle
Reactor
Pump
Cooling water from lake

VVER (Russian version of the PWR)





1.Horizontal steam generator, 2.Reactor coolant pump, 3.Containment building, 4. Refueling crane, 5.Control rod assemblies, 6.Reactor vessel.

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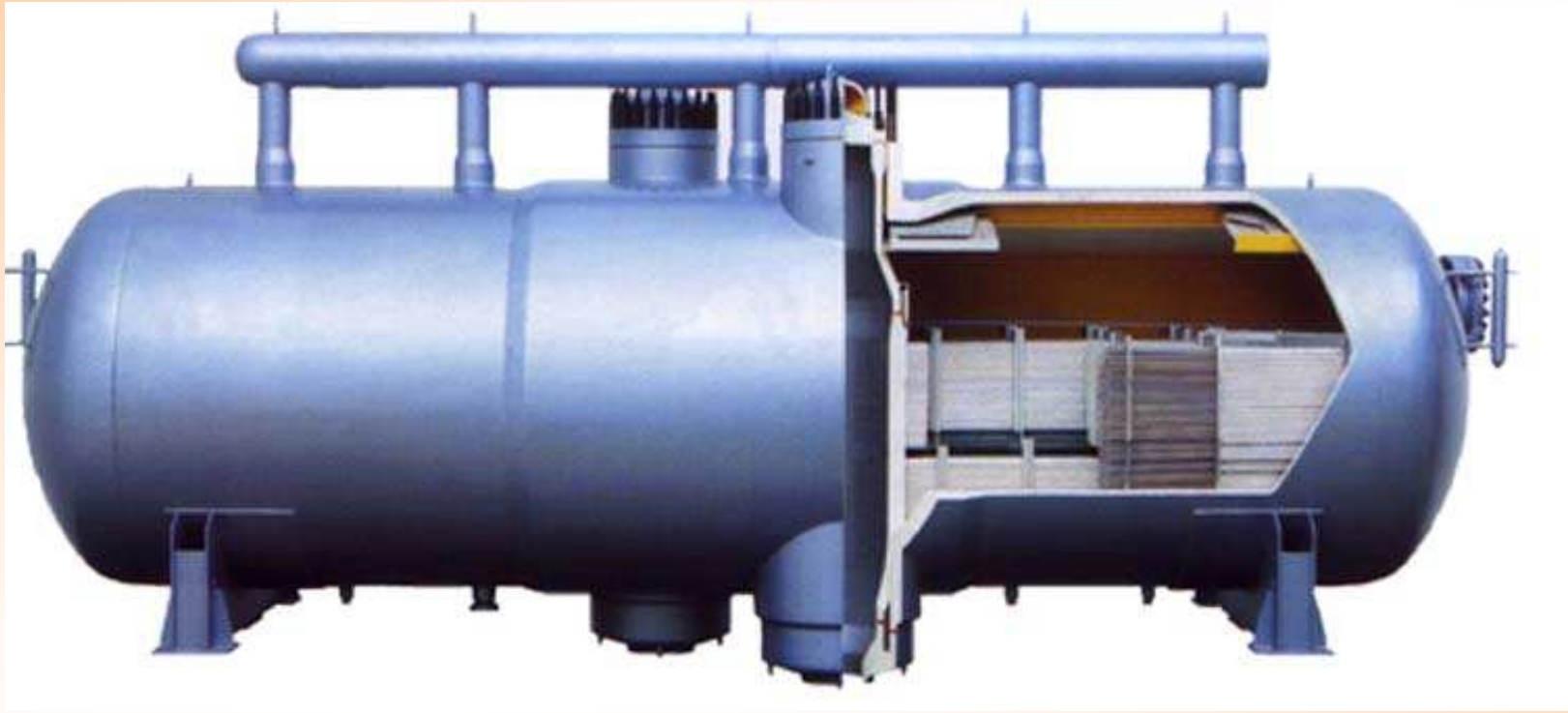
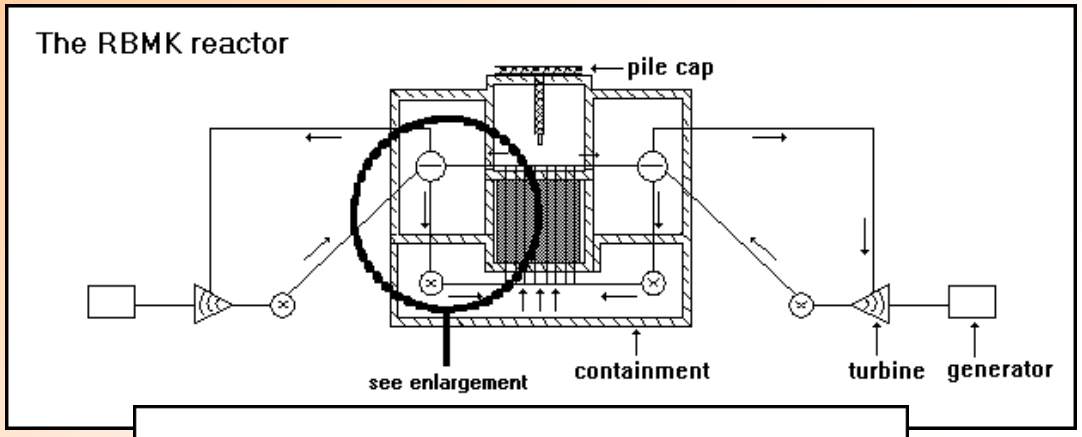
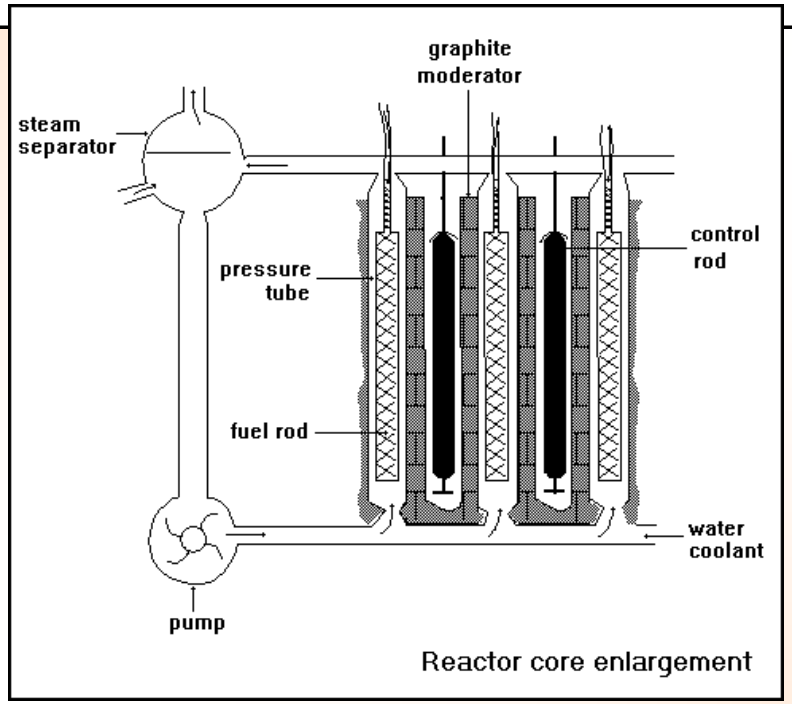
Horizontal steam generator



RBMK





- ✓ Graphite moderator with fuel tubes and coolant tubes passing vertically through the graphite.
- ✓ The coolant tubes (~ 1600) carry water at 1000 psi pressure - boiling occur.
- ✓ As with the CANDU design, these reactors can be refueled on-line.
- ✓ Low core power density- can withstand station blackout

RBMK Plant Layout

The Reactor Bolshoi Moschnosti Kanalynyi (RBMK) reactor is a boiling-water, graphite-moderated, pressure-tube reactor. The nuclear fuel is contained in about 1700 individual tubes that are vertically mounted in a large graphite core. Cooling water passes through these pressure tubes and is boiled by the nuclear heat to produce steam. The steam is then routed to the turbine generator, which produces electricity. The RBMK does not meet international safety standards, and deficiencies are known to exist in the emergency core cooling system, the fire protection system, and the instrumentation and control systems. The RBMK also lacks an internationally accepted containment system. RBMK reactors are found at the Chornobyl, Ignalina, Kursk, Leningrad, and Smolensk sites.