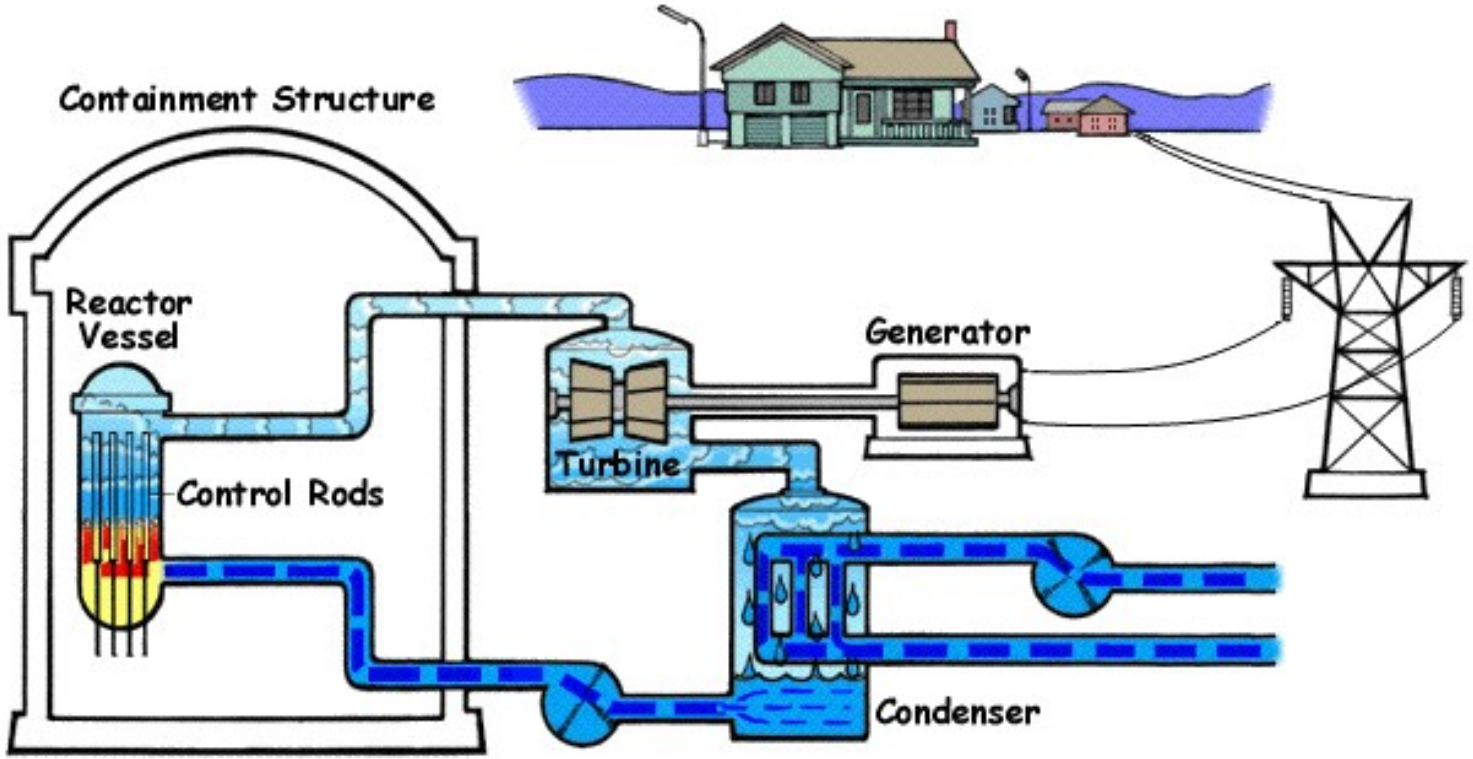
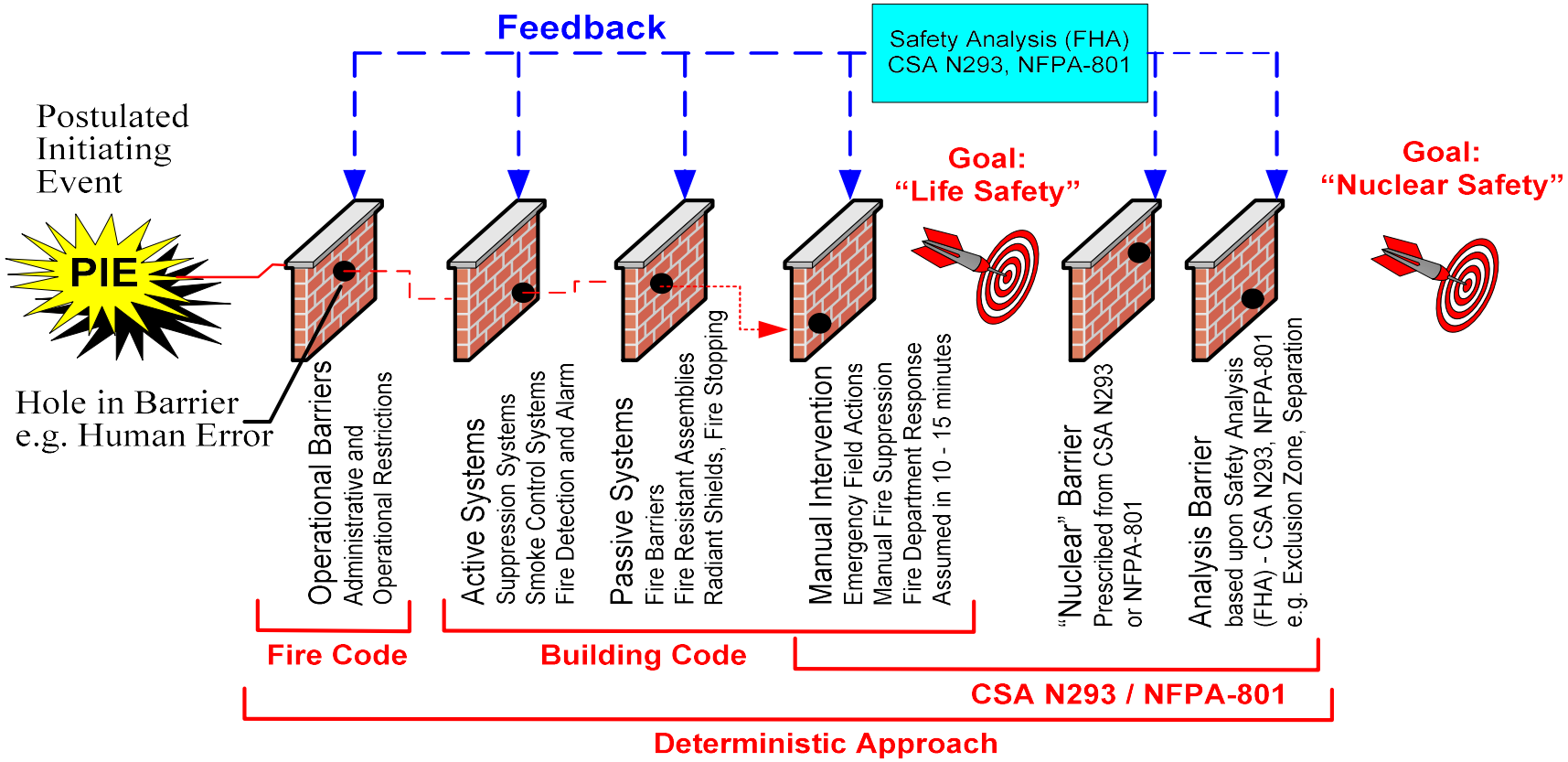
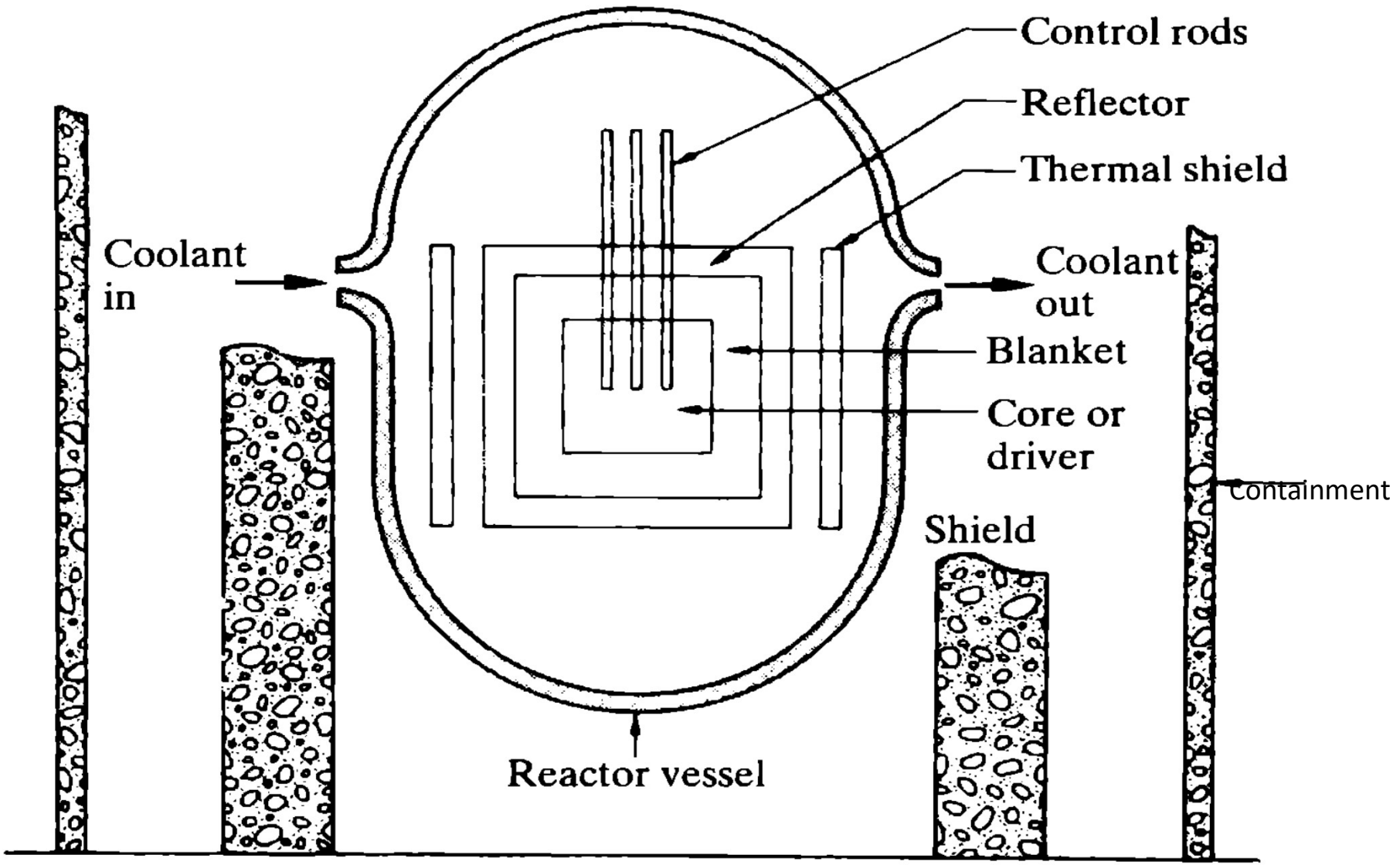
Reactor Types and Reactor Design

How Reactor Works



Defence in Depth - Nuclear Facility



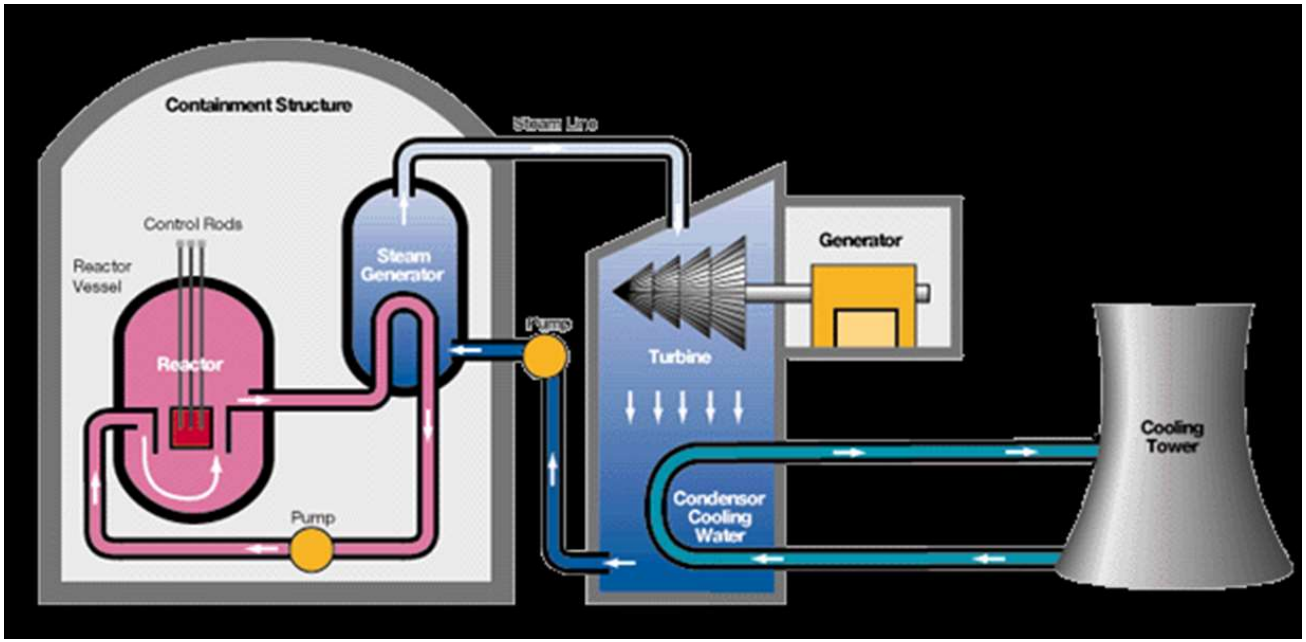

Control rods
Reflector
Thermal shield
Coolant in
Coolant out
Blanket
Core or driver
Containment
Shield
Reactor vessel

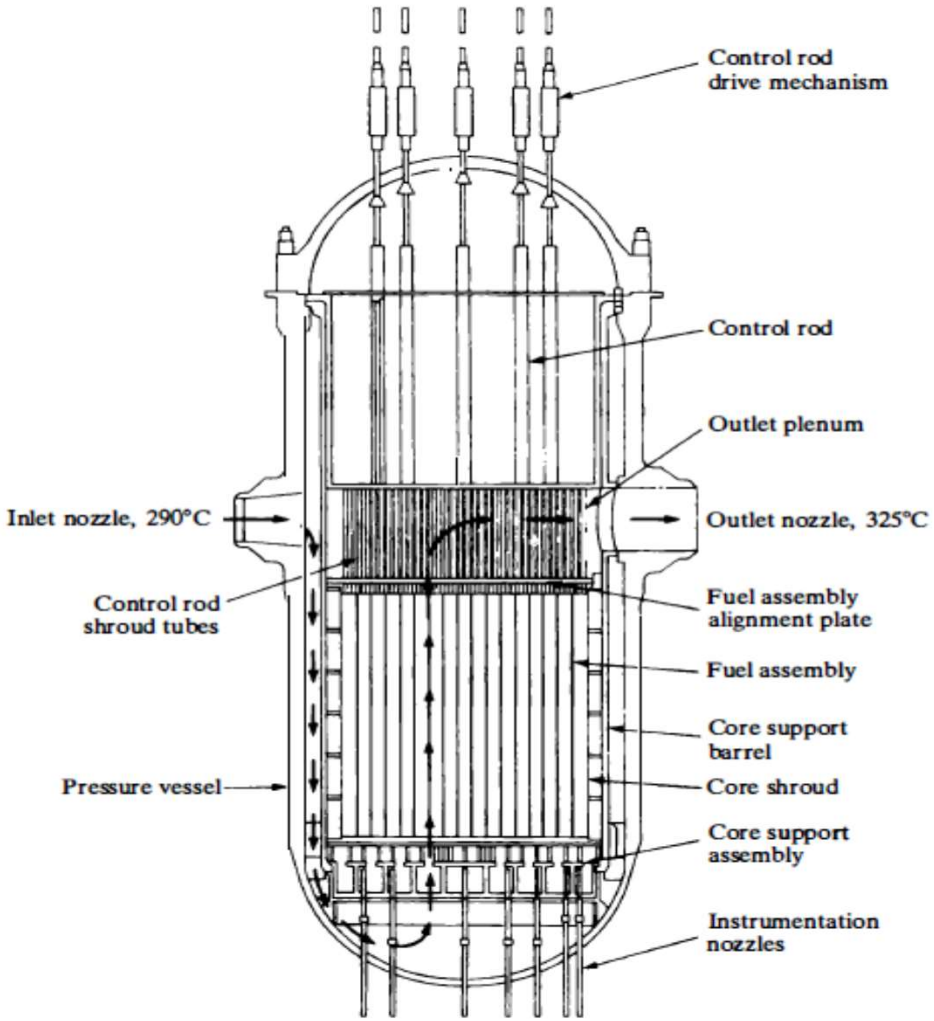
Principles of Classification of Nuclear Reactors

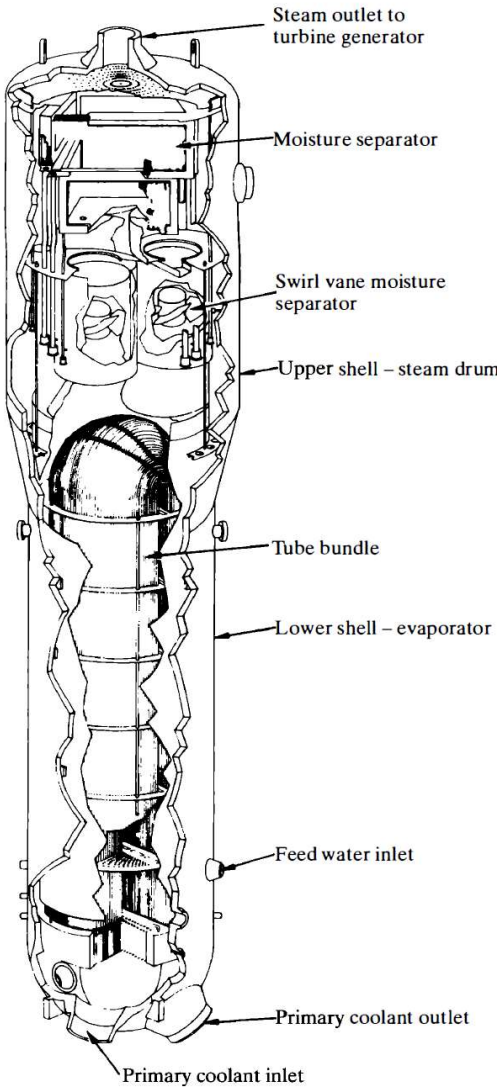
- Energy spectrum utilized for fission:
  - Thermal Energy - Power reactors: BWR, PWR, VVER, RBMK; CANDU
  - Fast Energy: BN350, BN600, Super Phenix, Naval reactors
- Prime purpose:
  - Electric Power Production, Pu Production, Propulsion, R&D
- Fuel: Natural Uranium, SEU, LEU, HEU, Mox, Th.
- Cooling medium
- Coolant system
- Moderator
- Generation “ Marketing Tool”

Light Water Reactors

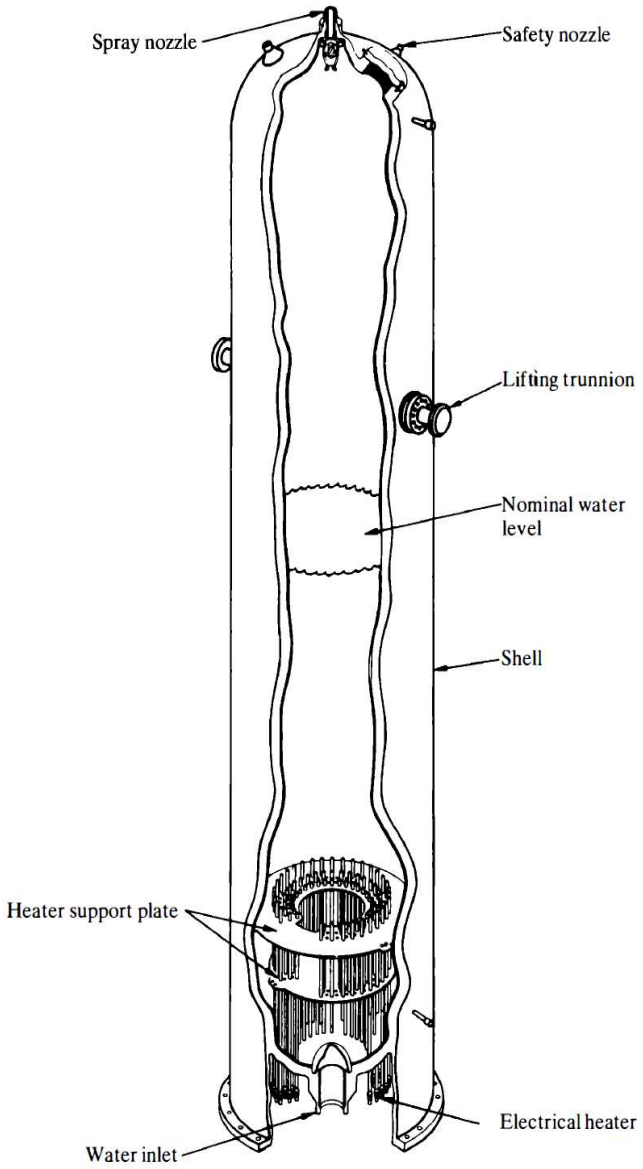
Pressurized Water Reactor (PWR)



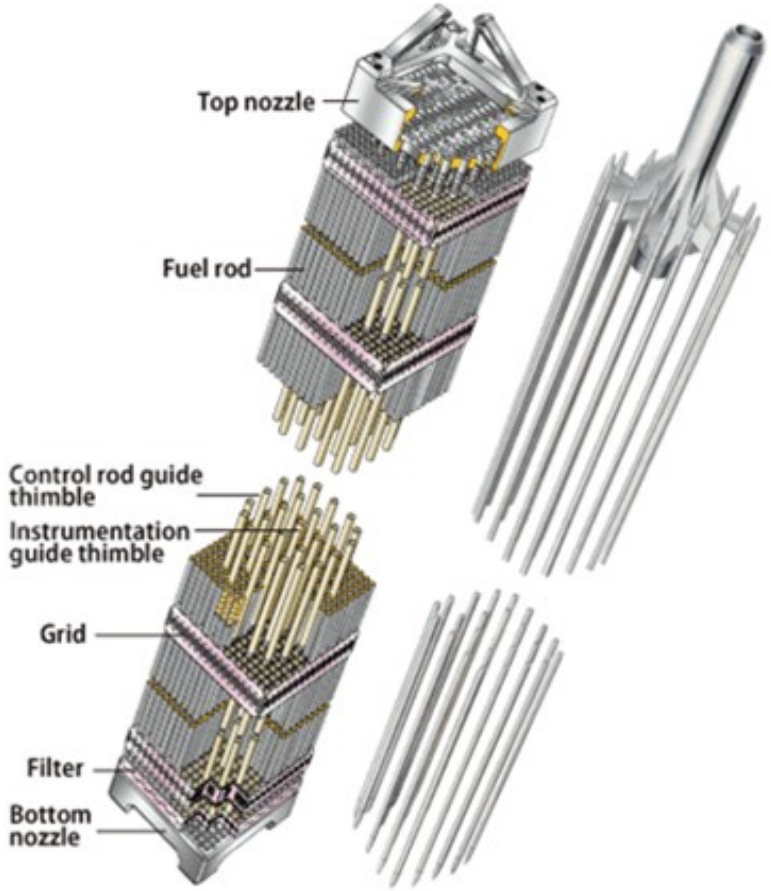

Control rod drive mechanism
Control rod
Outlet plenum
Inlet nozzle, 290°C
Outlet nozzle, 325°C
Control rod shroud tubes
Fuel assembly alignment plate
Fuel assembly
Core support barrel
Pressure vessel
Core shroud
Core support assembly
Instrumentation nozzles


Steam outlet to
turbine generator
Moisture separator
Swirl vane moisture
separator
Upper shell – steam drum
Tube bundle
Lower shell – evaporator
Feed water inlet
Primary coolant outlet
Primary coolant inlet

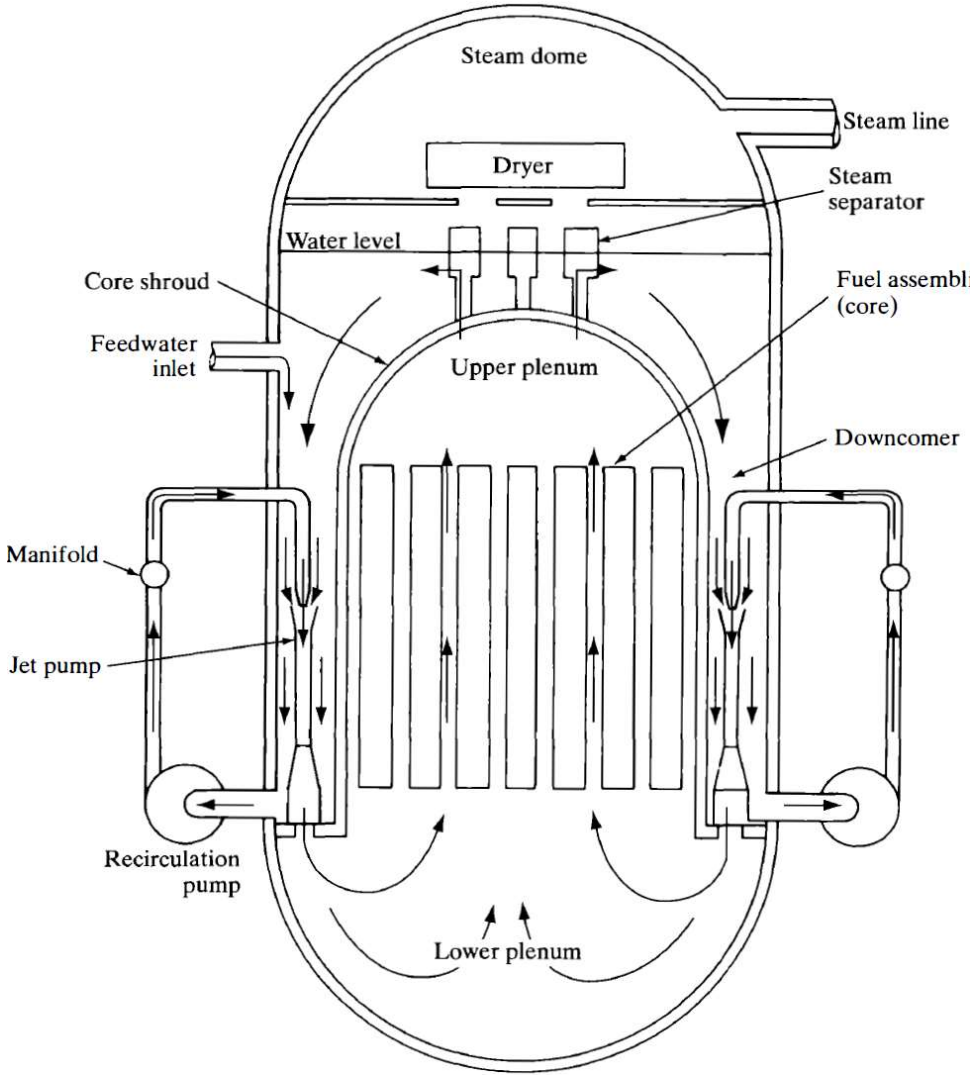
Pressurizer

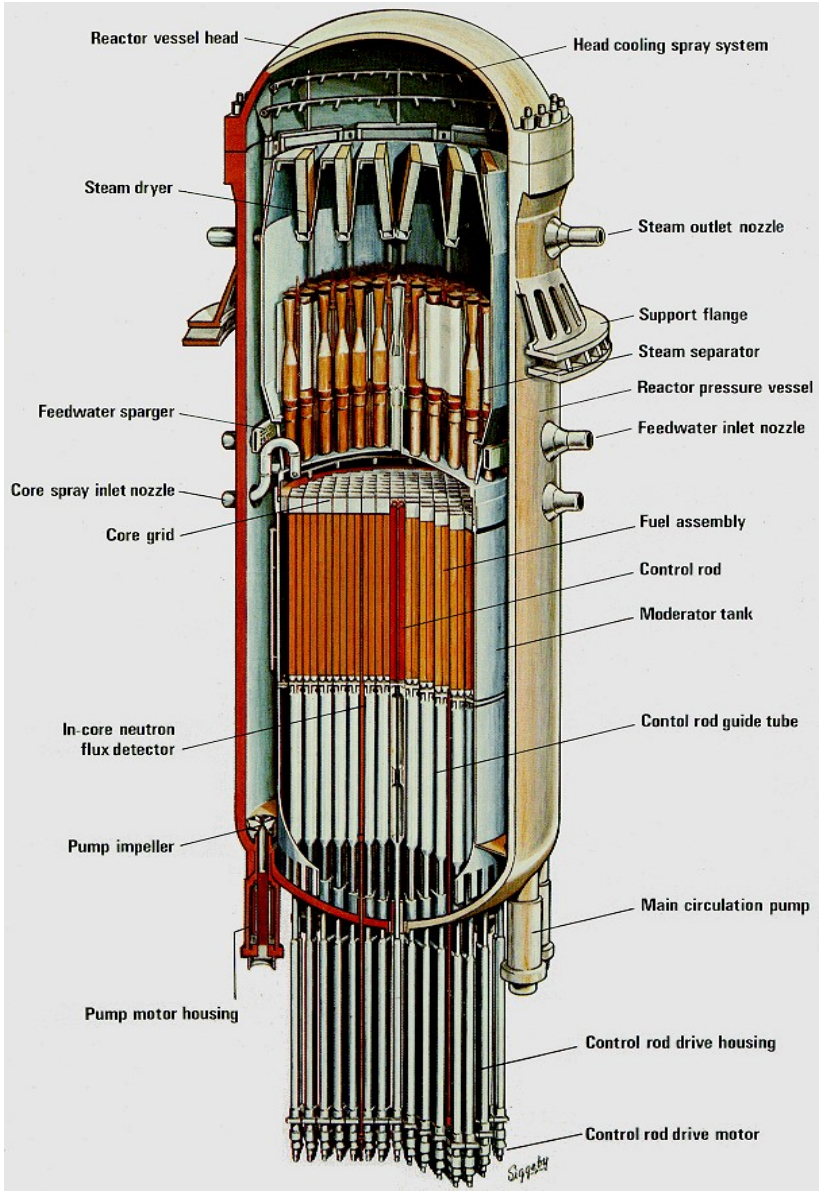


Fuel Assembly



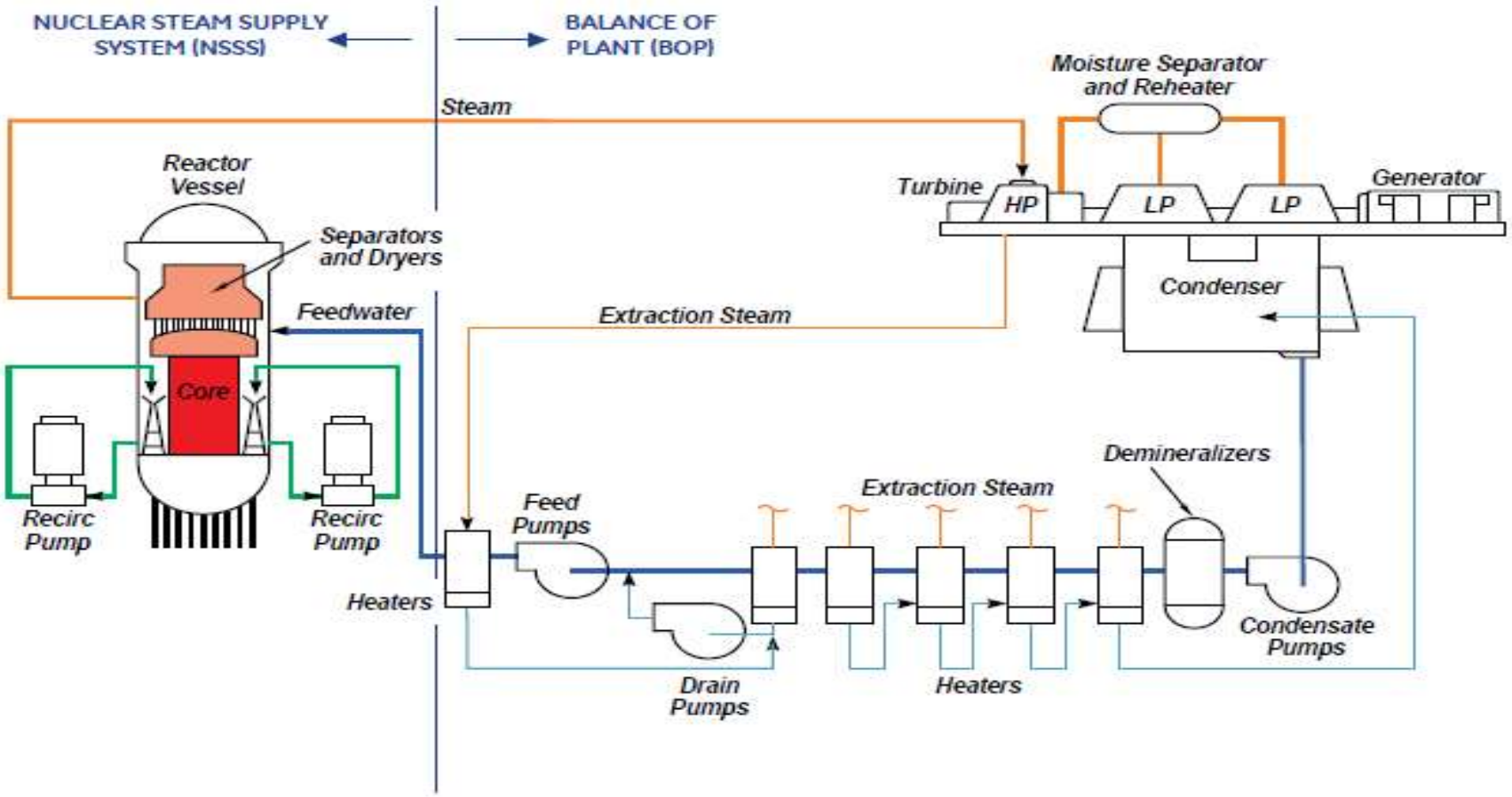
Boiling Water Reactor



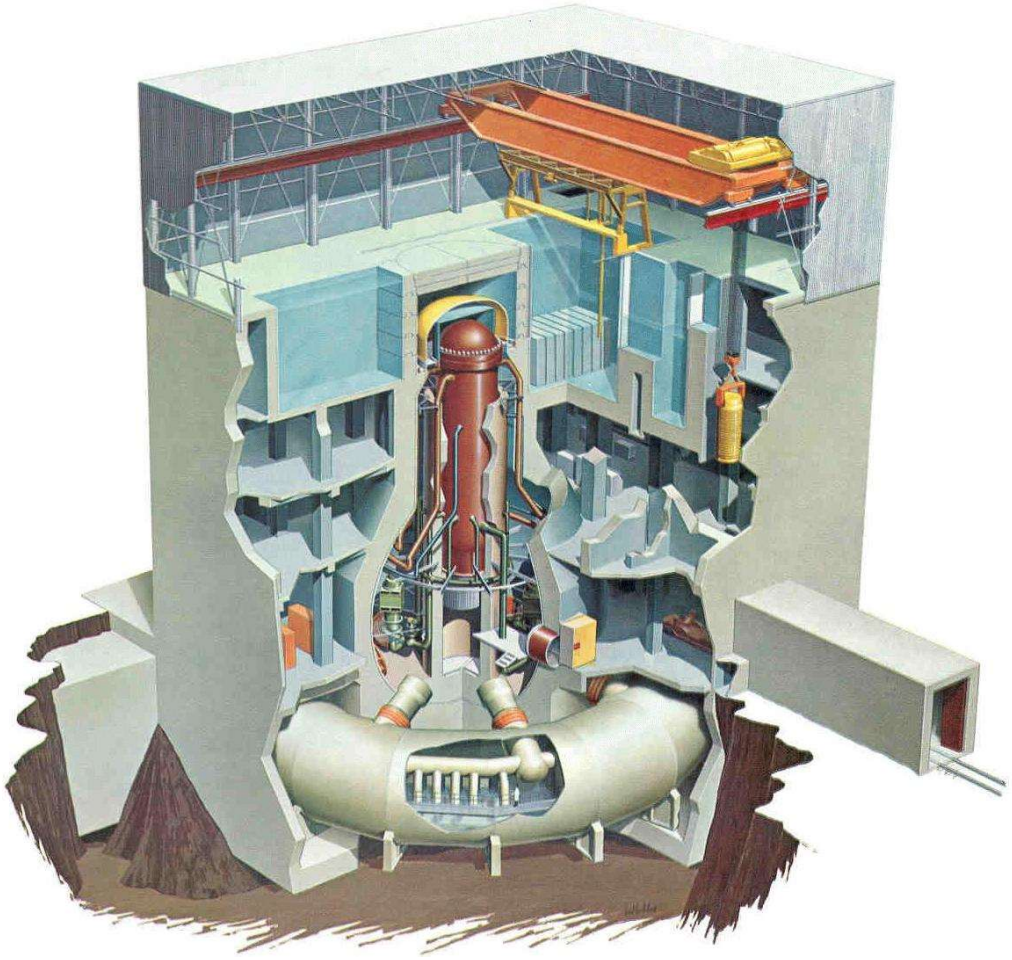


Boiling Water Reactor

BWR Power Cycle



MARK I BWR



First Nuclear Power Plants (NPPs) Starting in 1950's

- Period of experimentation with many different ways to achieve and control a fission chain reaction
  - many were being designed to produce power (electricity)
  - early designs produced power on small scale (between 50 and 300 MWe was typical)
- Proof-of-Concept was the main goal - economics was a secondary consideration
- Many concepts were ahead of their time and could not go forward because of materials limitations or lack of analytical tools (e.g. computer simulations)

Each country chose “champion” design(s)

- Generally based on domestic capabilities
- UK
  - gas-cooled reactors (MAGNOX)
- Canada
  - pressurized heavy water reactor (PHWR, CANDU) - with natural uranium core
- USA
  - pressurized water reactors – land and marine-based
  - boiling water reactors – land-based
  - research continued into 1980s gas-cooled, liquid metal and molten salt reactors (many types)
- USSR
  - light water-cooled graphite moderated
  - pressurized water reactors – marine based
  - liquid metal reactors (many types) – land and marine based