

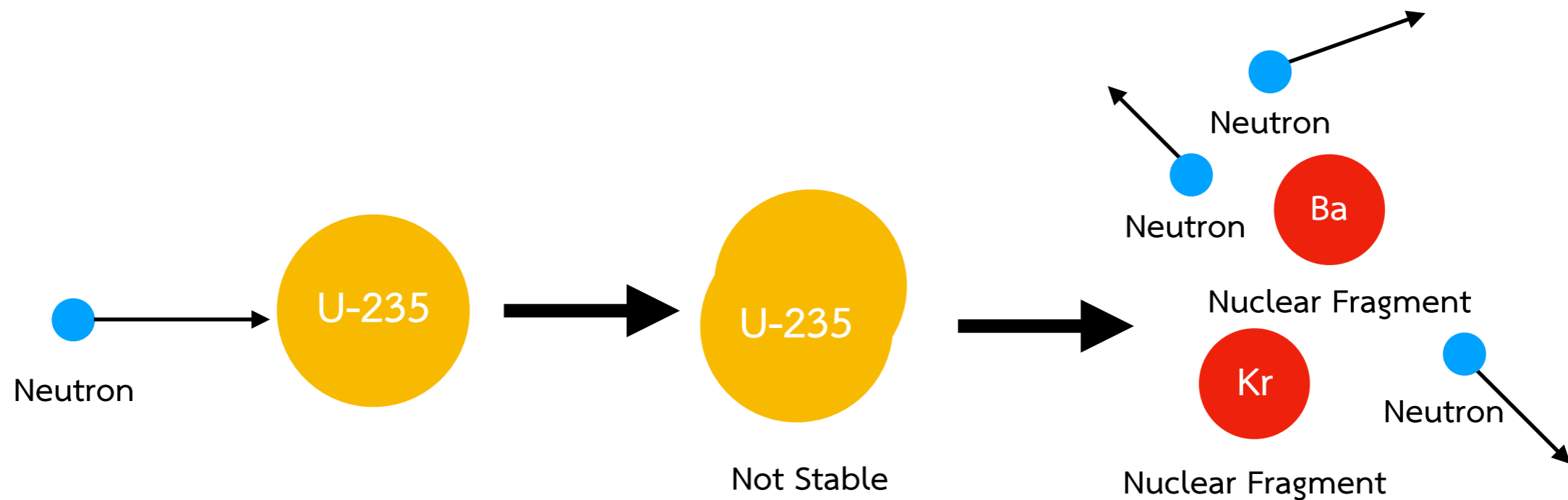


Nuclear Power Plants

1

The principle of nuclear power plants

- Nuclear Fission



$$Q = (m_i - m_f)c^2$$

2

Common types of nuclear reactors

- Pressurised water reactor (PWR)
- Boiling water reactor (BWR)
- Pressurised heavy water reactor (PHWR)
- Gas-cooled reactor (GCR)
- Light water graphite reactor (LWGR)
- Fast neutron reactor (FBR)

2.1 Pressurised water reactor (PWR)

Fuel : Enriched Uranium dioxide (UO_2)

Produces energy around 275 GW_e



◀ Uranium dioxide fuel pellet
Source : en.wikipedia.org/wiki/Uranium_dioxide



▲ Watts Bar Nuclear power plant

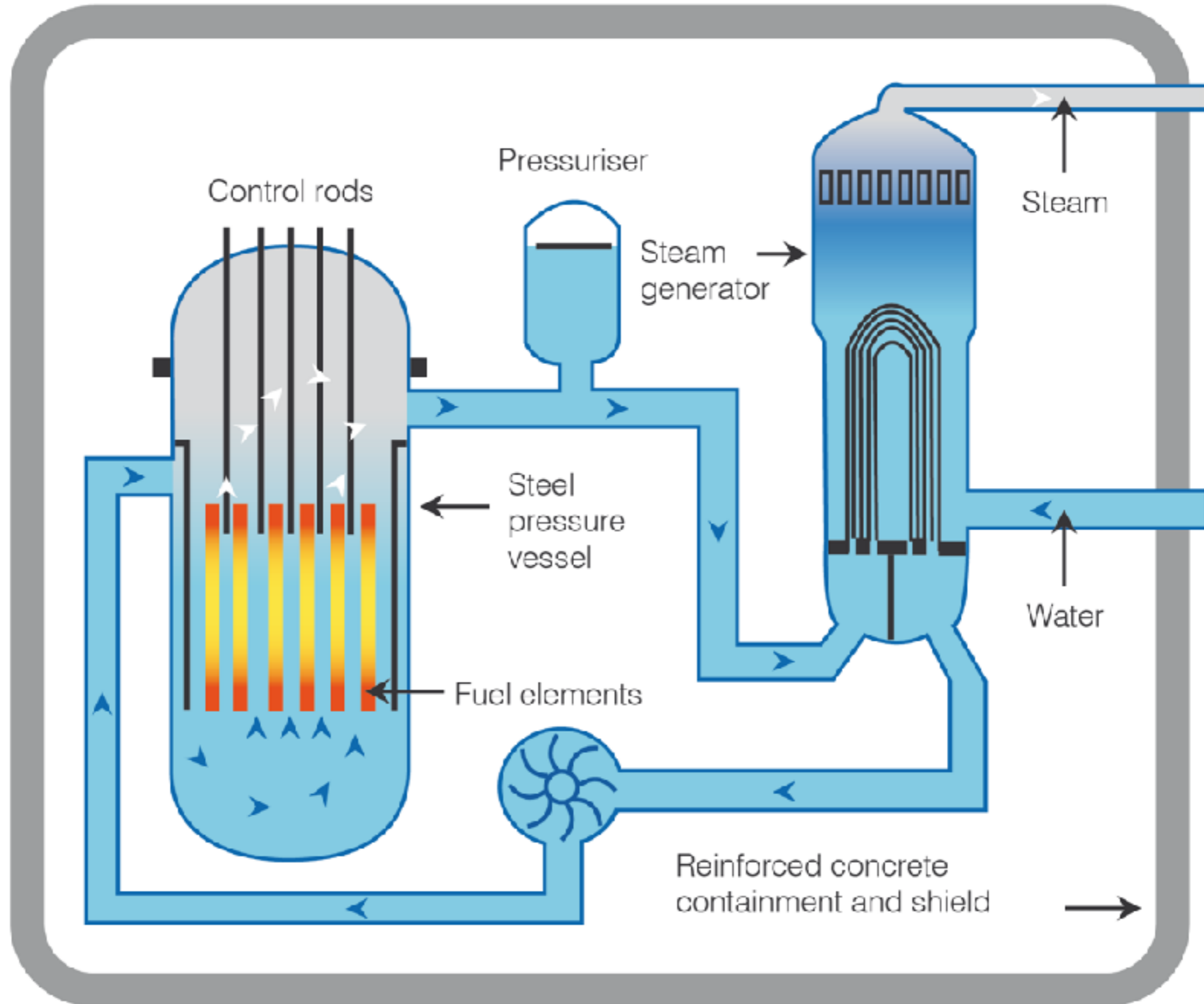
Source : en.wikipedia.org/wiki/Watts_Bar_Nuclear_Plant

Advantages

- Easy to operate because less power is being produced as the heat increases.
- It contains less fissile material than is required for them to go prompt critical.

Disadvantages

- The reactor requires very strong piping and a heavy pressure vessel making the construction of the PWR costly.
- Boric acid contamination.



2.1

Pressurised water reactor (PWR)



Generated by mapchart.net

Data from https://en.wikipedia.org/wiki/List_of_nuclear_reactors

2.2

Boiling water reactor (BWR)

Fuel Enriched Uranium dioxide (UO_2)

Gross Energy Produces 73 GW_e



▲ Gundremmingen Nuclear power plant

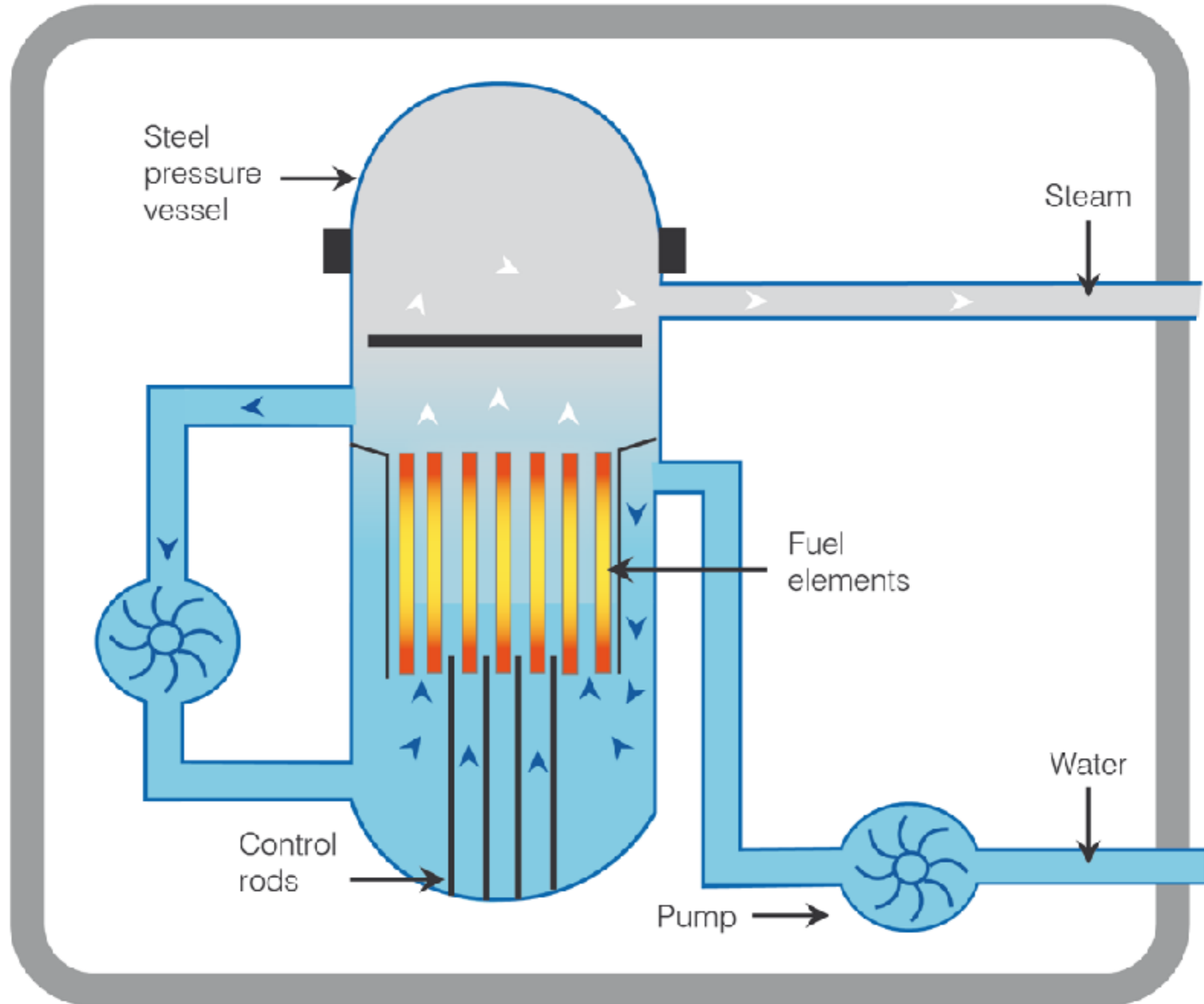
Source : en.wikipedia.org/wiki/Gundremmingen_Nuclear_Power_Plant

Advantages

- It uses less pressure and temperatures to produce energy so it is harder to prompt critical.
- There is no Boric acid contamination.

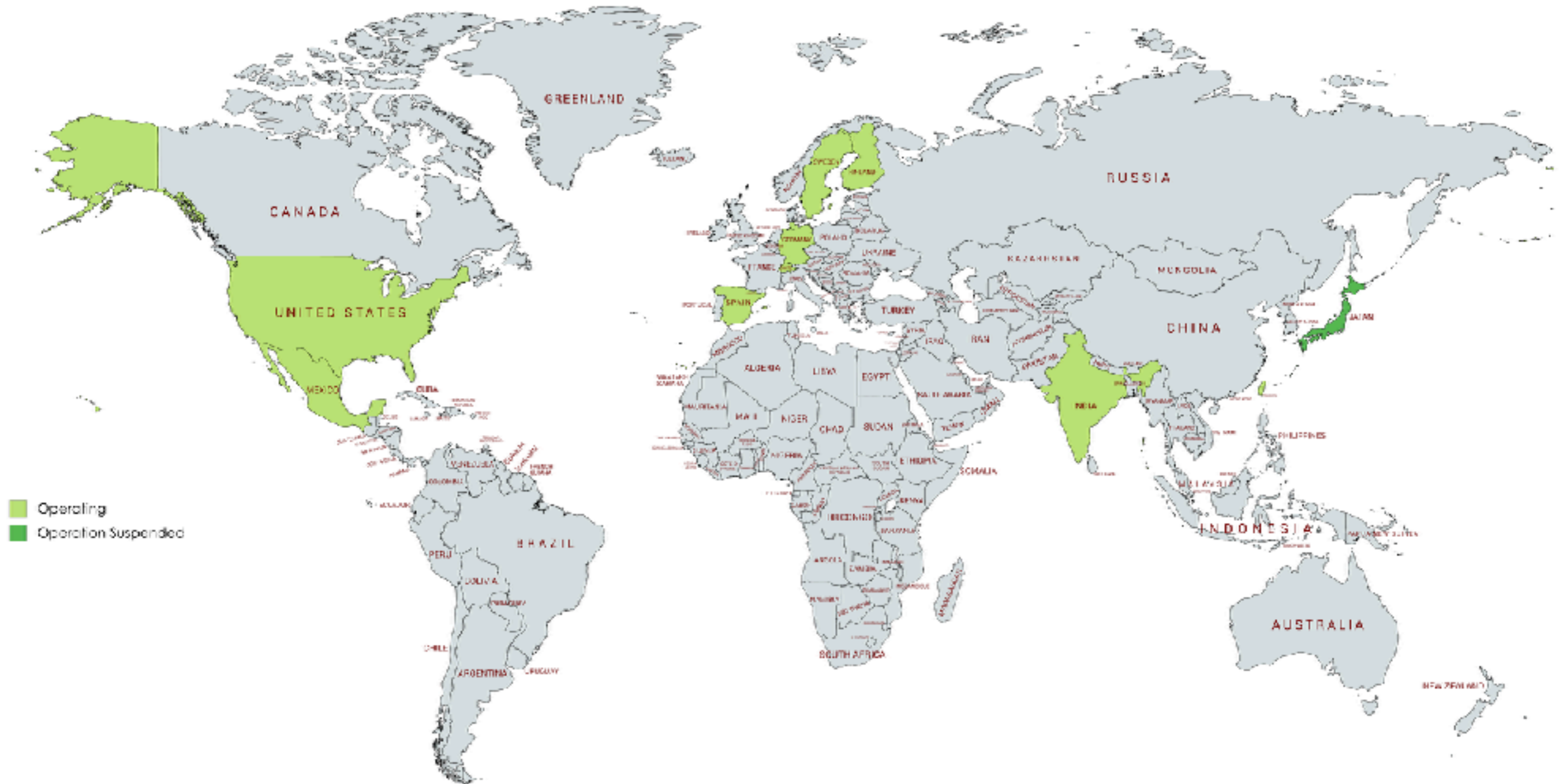
Disadvantages

- Harder to design and use complex structures and equipments to operate.
- ^{16}N contamination



2.2

Boiling water reactor (BWR)



Generated by mapchart.net

Data from https://en.wikipedia.org/wiki/List_of_nuclear_reactors

2.3 Pressurised heavy water reactor (PHWR)

Fuel Enriched/Natural Uranium dioxide (UO_2)

Gross Energy Produces 25 GW_e



▲ Wolsong Nuclear power plant

Source : en.wikipedia.org/wiki/Wolsong_Nuclear_Power_Plant

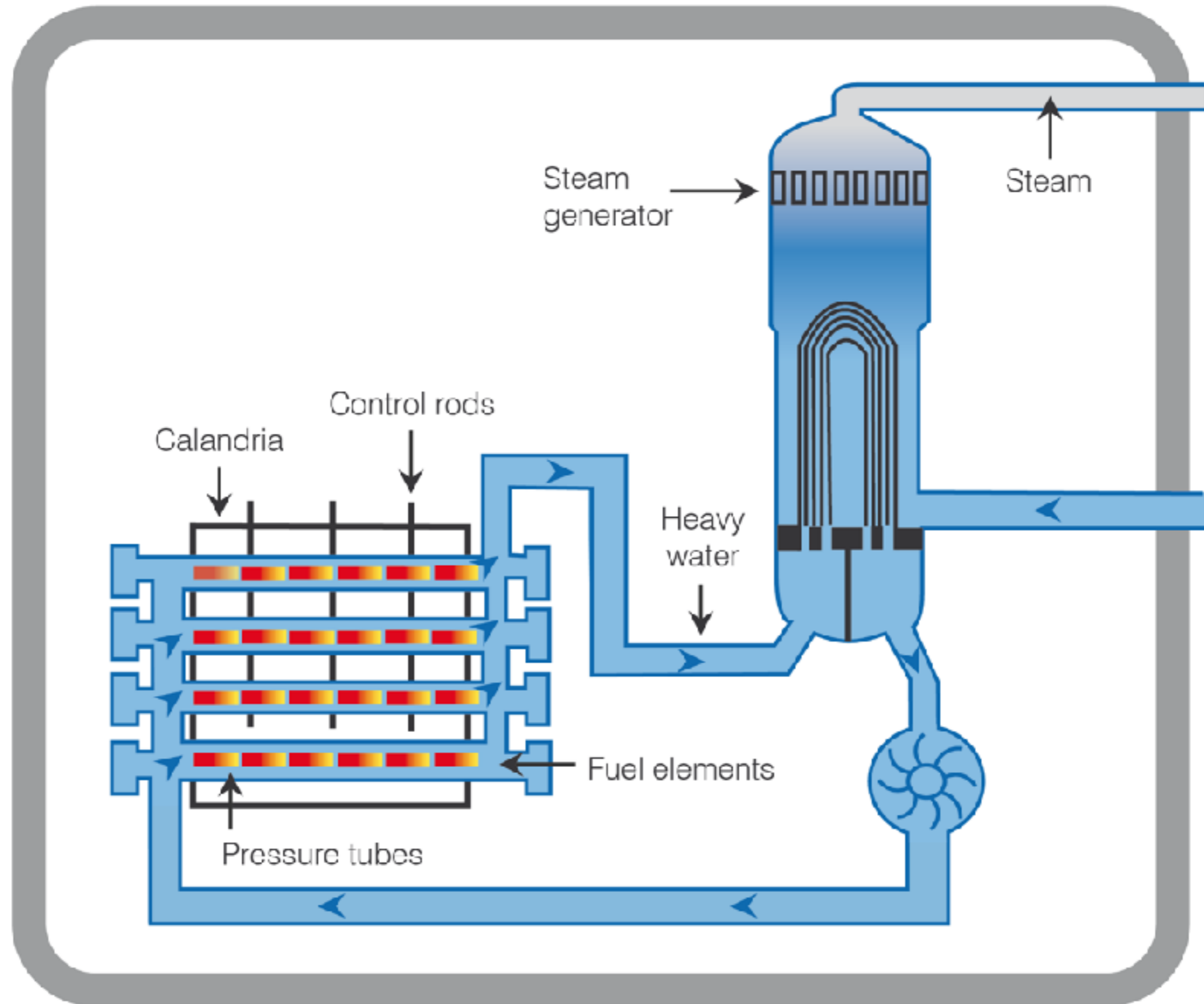
Advantages

- It can use natural Uranium as a fuel source.
- High efficiency.

Disadvantages

- Needs D_2O as a modulator (quite expensive).
- By product from reactor could be use for nuclear weapons.

A Pressurized Heavy Water Reactor (PHWR/Candu)



2.2

Pressurised heavy water reactor (PHWR)



2.4

Gas-cooled reactor (GCR)

Fuel Enriched/Natural Uranium dioxide (UO_2) and Natural Uranium

Gross Energy Produces 8 GW_e

Advantages

- It can use natural Uranium as a fuel source.
- Hard to explode.

Disadvantages

- Low energy output.
- Operating with high temperature.

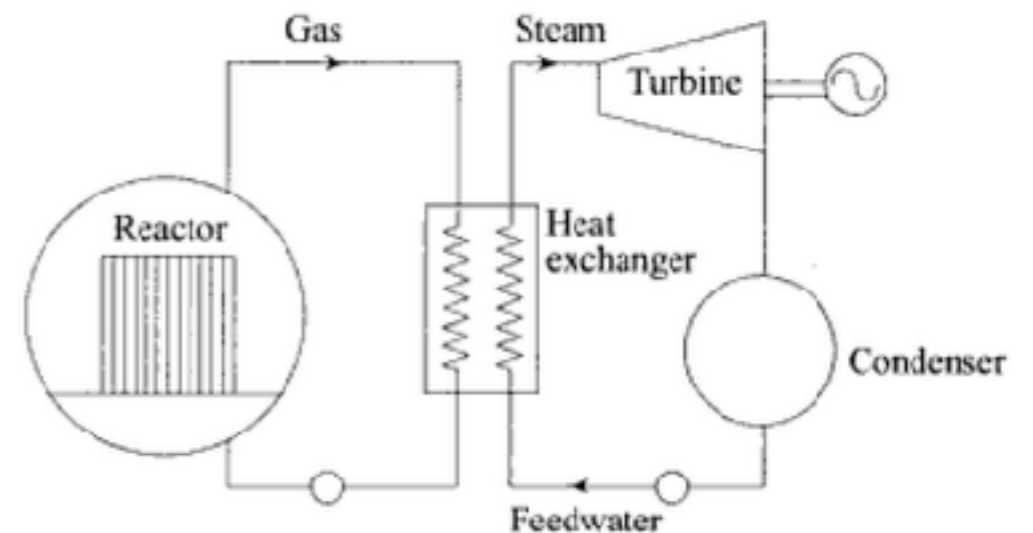


▲ Heysham Nuclear power station

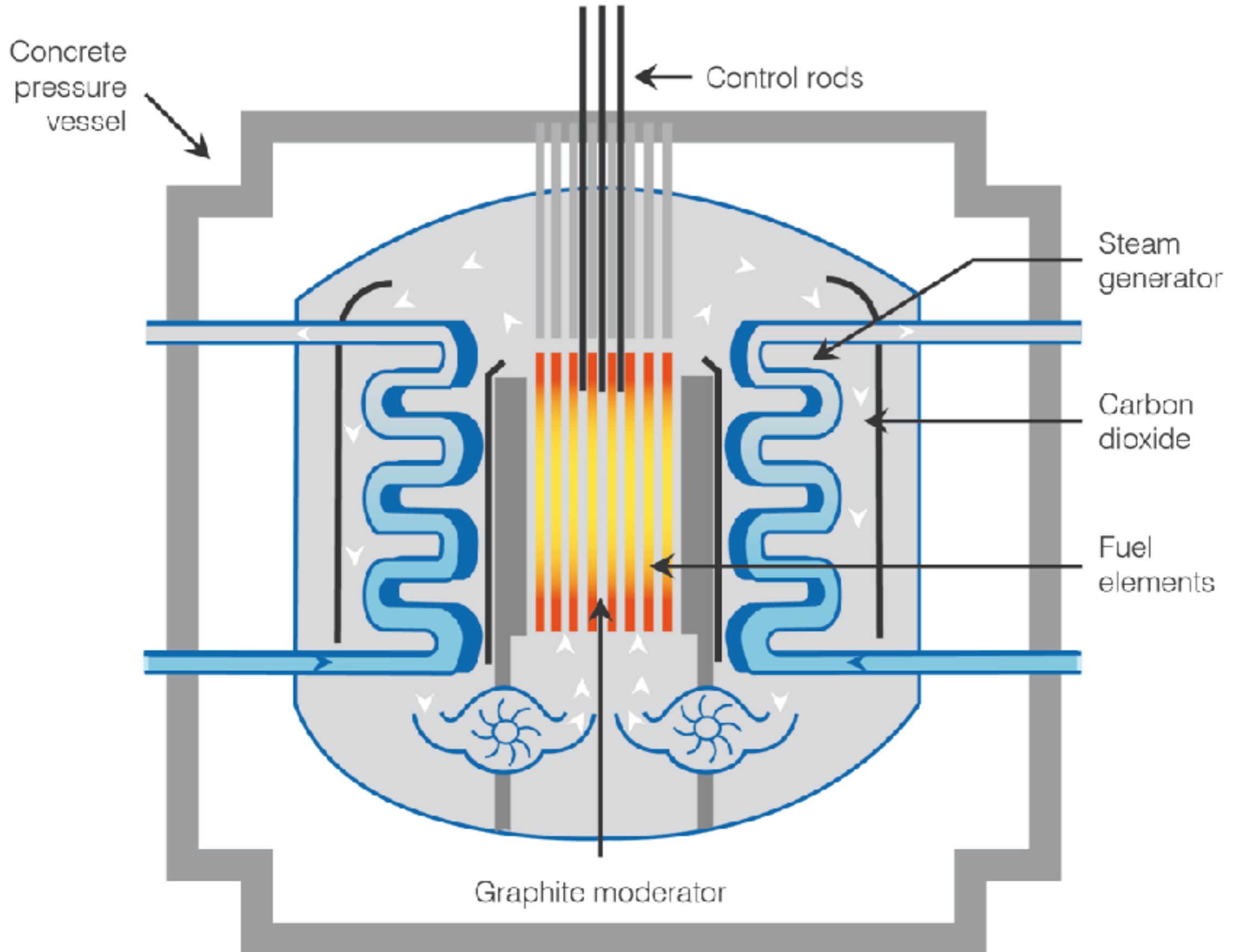
Source : en.wikipedia.org/wiki/Heysham_nuclear_power_station

Schematic diagram of Gas-cooled reactor plant ▶

Source : me-mechanicalengineering.com/gas-cooled-reactors/



An Advanced Gas-cooled Reactor (AGR)



2.4

Gas-cooled reactor (GCR)



2.5

Light water graphite reactor (LWGR)

Fuel Enriched/Natural Uranium dioxide (UO_2)

Gross Energy Produces 10 GW_e



▲ Bilibino Nuclear power plant

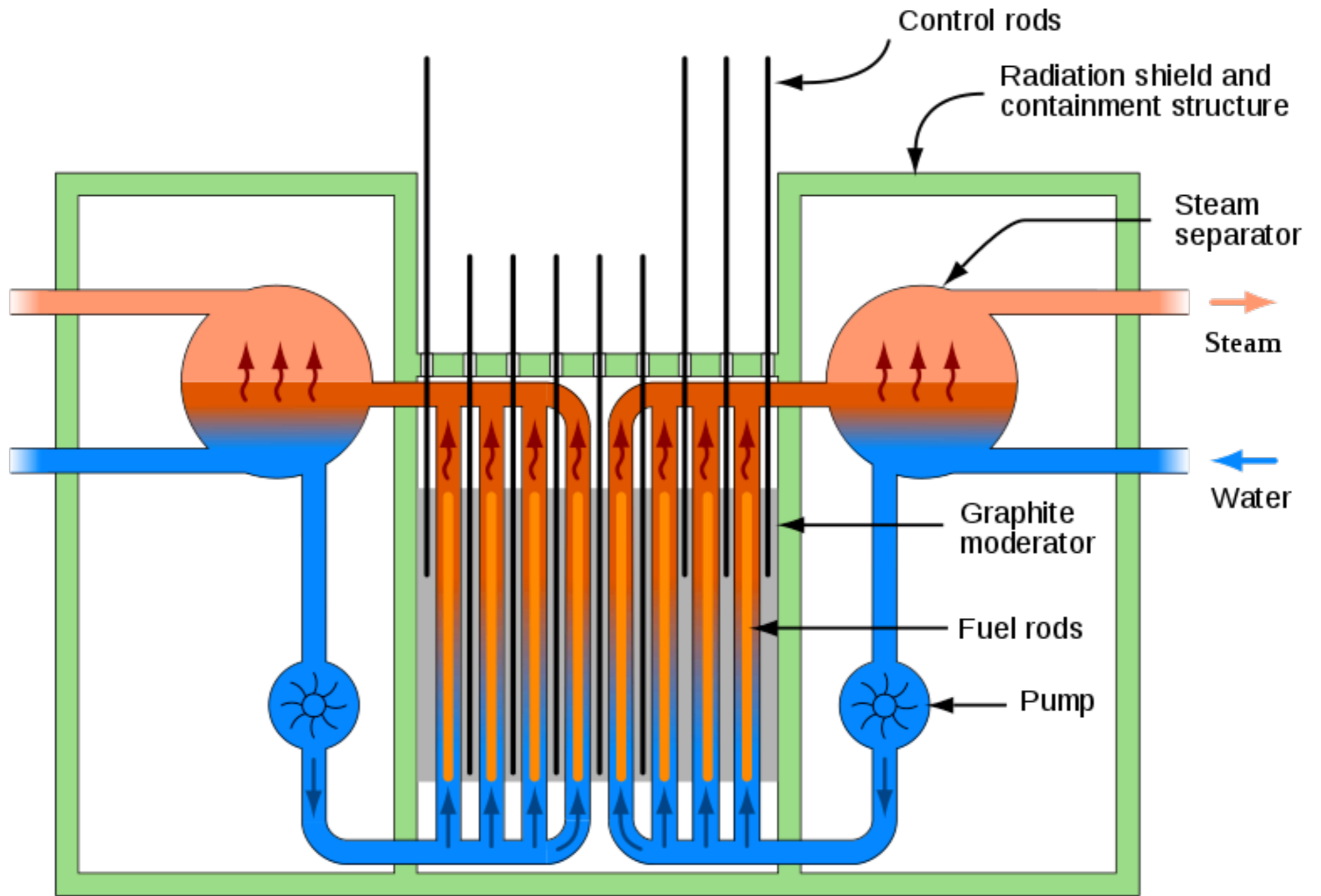
Source : en.wikipedia.org/wiki/Bilibino_Nuclear_Power_Plant

Advantages

- It can use natural Uranium as a fuel source.
- Can change fuel rod without suspending operation.

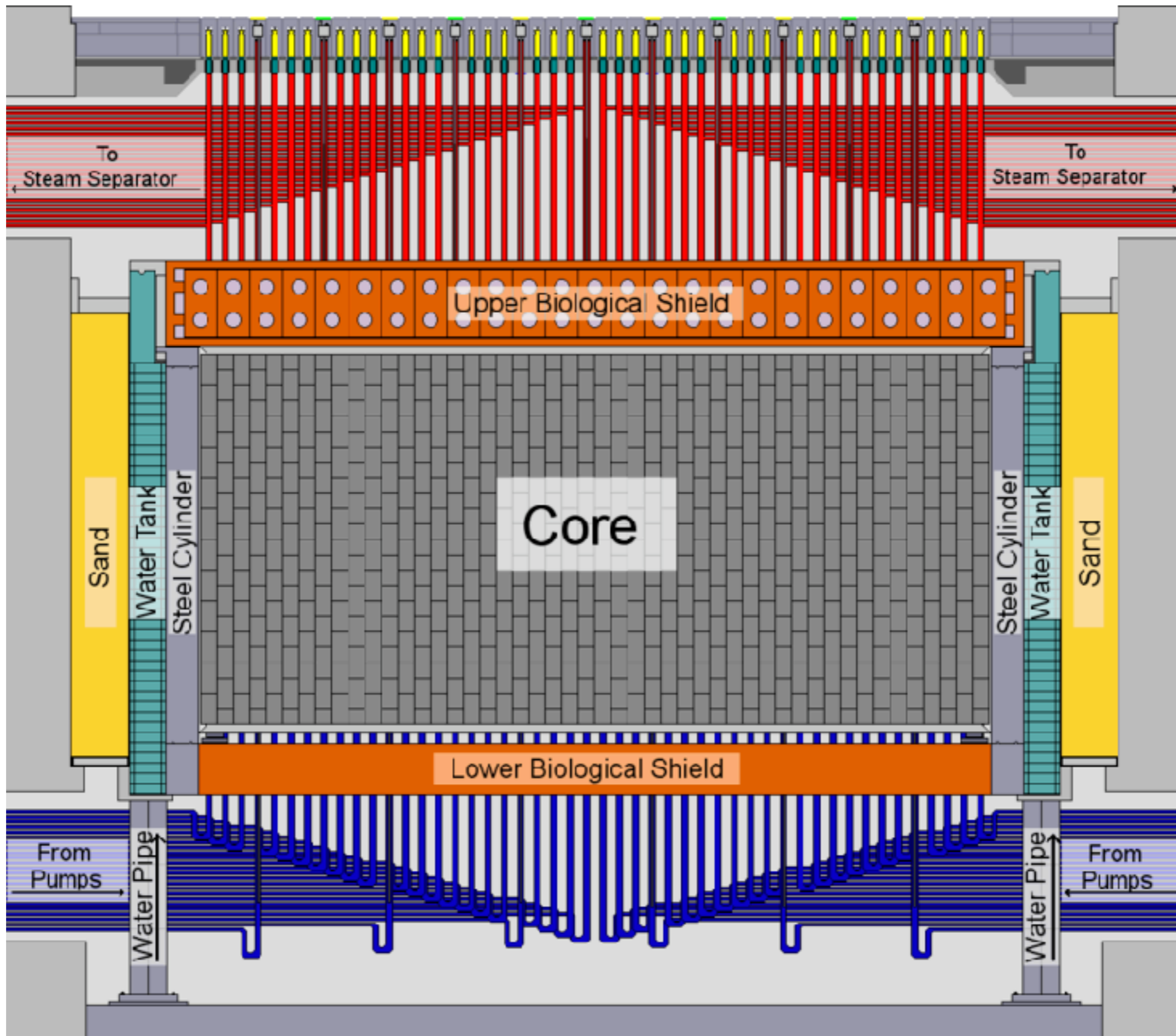
Disadvantages

- Easy to explode.



Reactor vessel, moderator and shielding

en.wikipedia.org/wiki/RBMK



Schematic side view of the layout of a RBMK reactor core.

2.5

Light water graphite reactor (LWGR)



2.6

Fast neutron reactor (FBR)

Fuel Uranium dioxide (UO_2) and Plutonium dioxide (PuO_2) **Gross Energy Produces** 1.4 GW_e



▲ Beloyarsk Nuclear Power Station

Source : en.wikipedia.org/wiki/Beloyarsk_Nuclear_Power_Station

Schematic diagram of LMFBR ▶

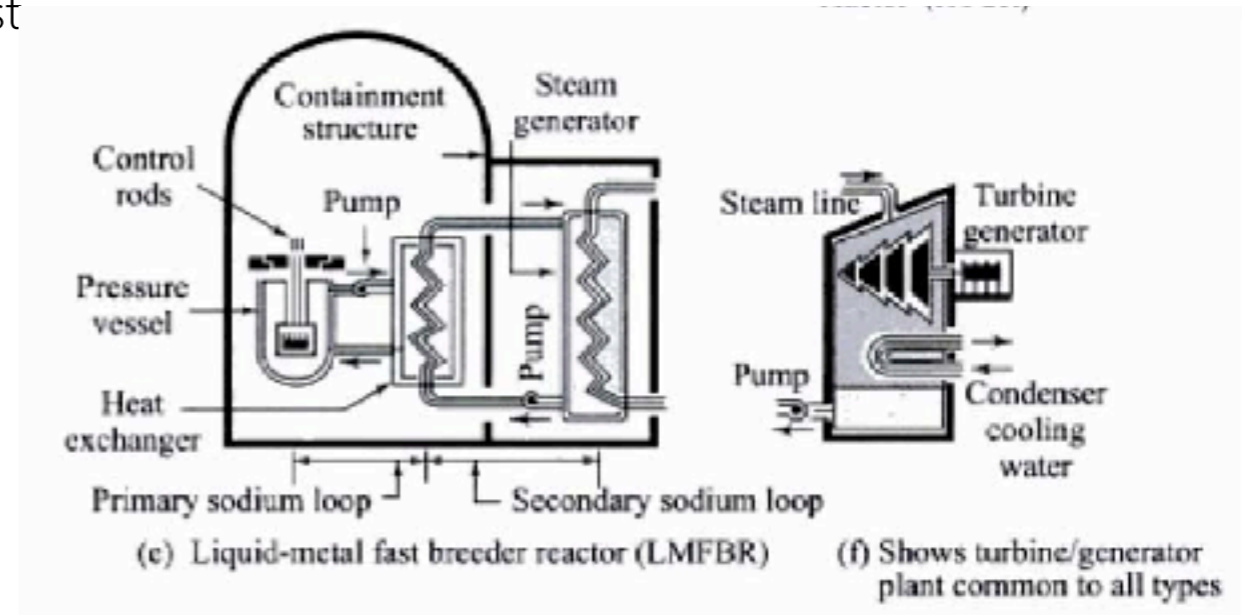
Source : me-mechanicalengineering.com/power-reactors/

Advantages

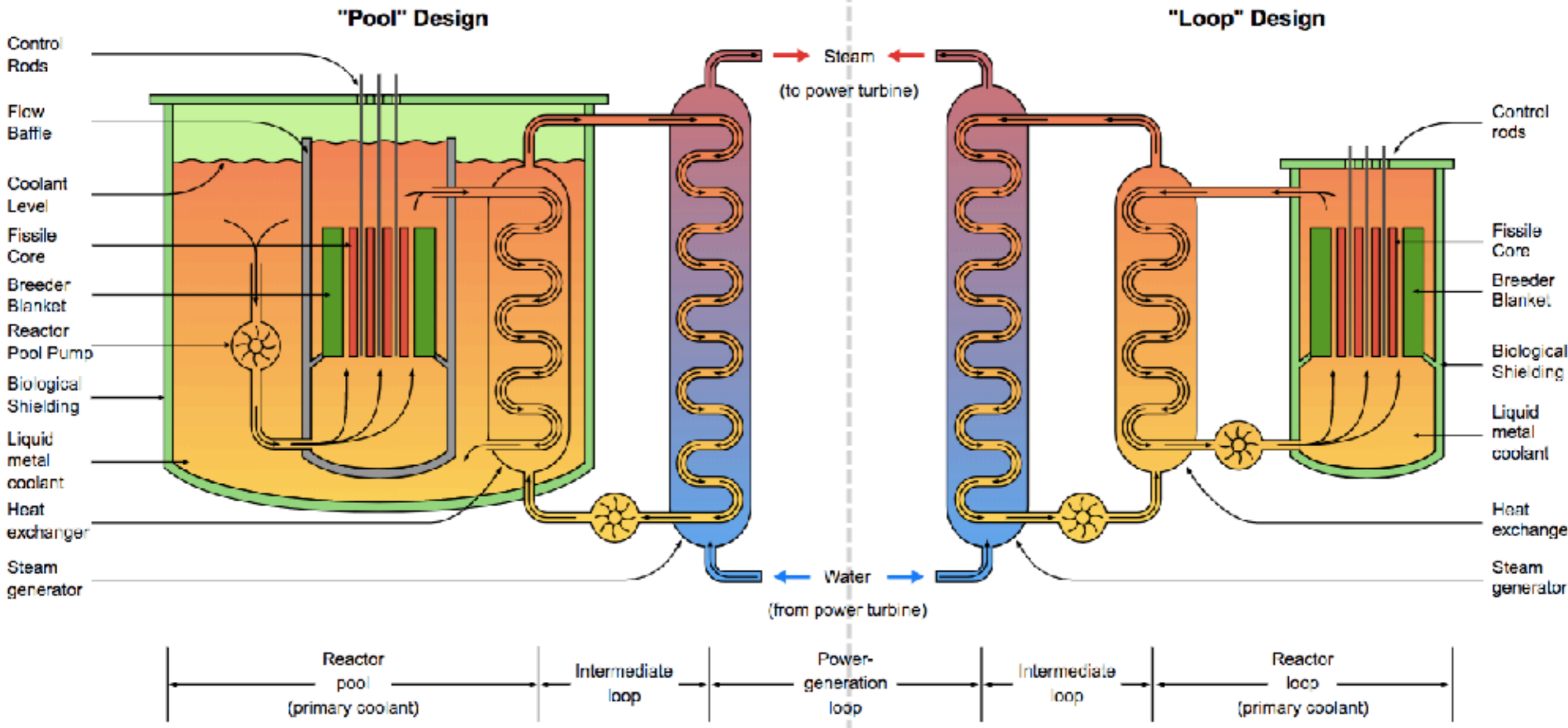
- Waste management
- Secure

Disadvantages

- Low energy output
- Cost



Liquid Metal cooled Fast Breeder Reactors (LMFBR)



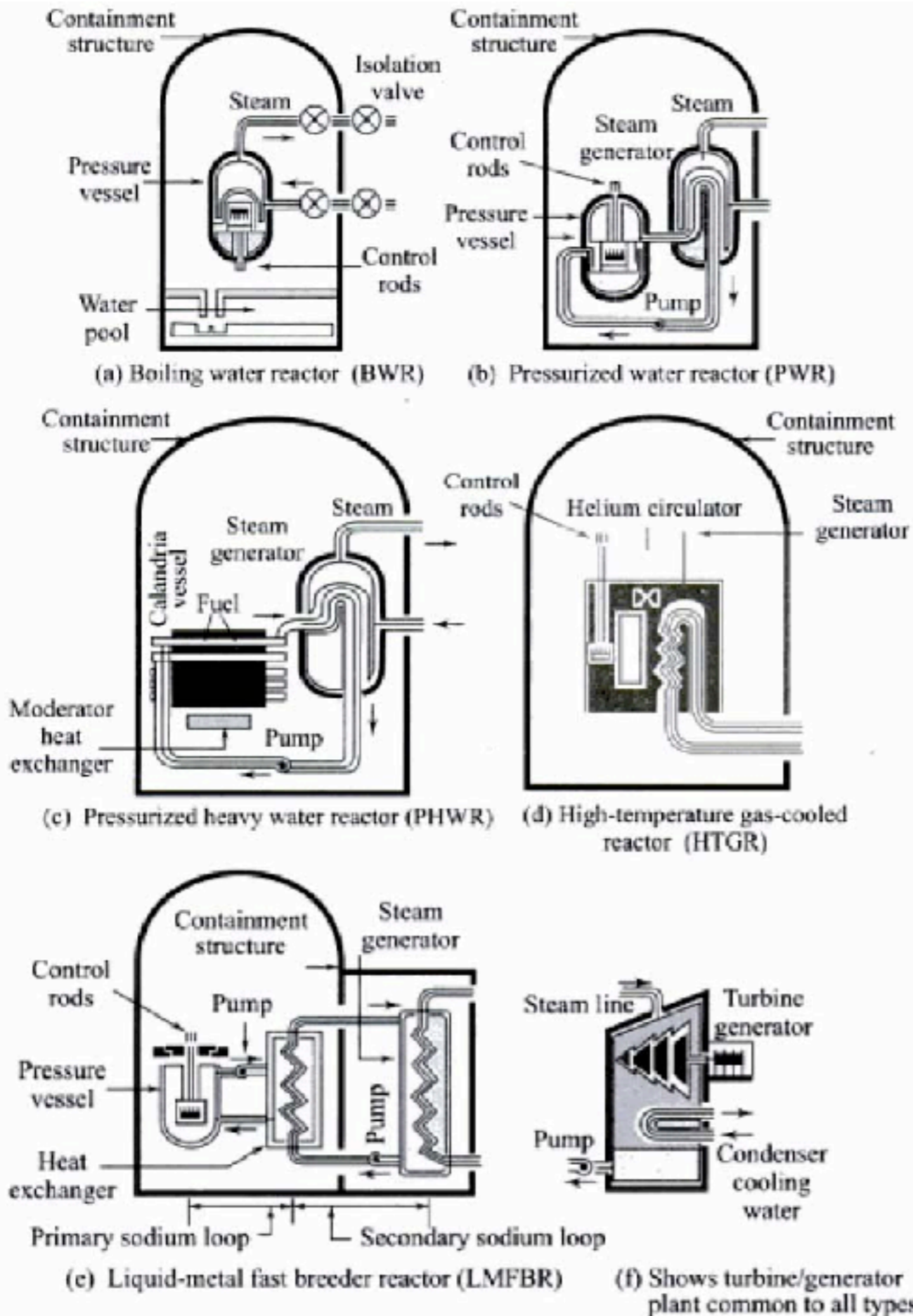
Schematic diagram showing the difference between the Loop and Pool types of LMFBR.

en.wikipedia.org/wiki/Breeder_reactor

2.6

Fast neutron reactor (FBR)





Characters	PWR	BWR	LMFBR	HTGR
Electric Power (MW_e)	1300	1050	1000	330
Thermal Power (MW_{th})	3800	3000	2750	842
Specific Power (kW_{th}/kg)	33	26	575	50
Power Density (kW_{th}/m^3)	100	60	300	10
Inlet Temperature ($^{\circ}C$)	280	275	330	400
Outlet Temperature ($^{\circ}C$)	310	285	500	770

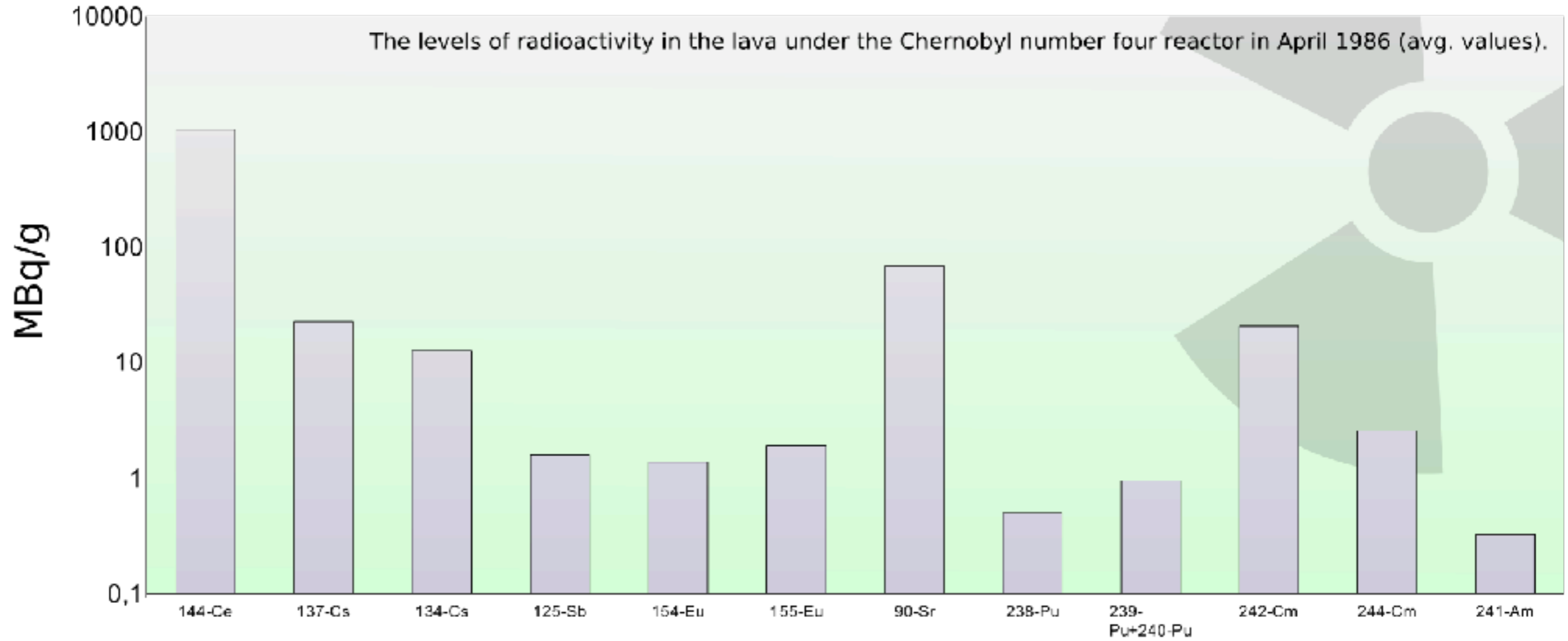
◀ Schematics diagram of different nuclear power reactors ²³

Source : me-mechanicalengineering.com/power-reactors/

Chernobyl disaster

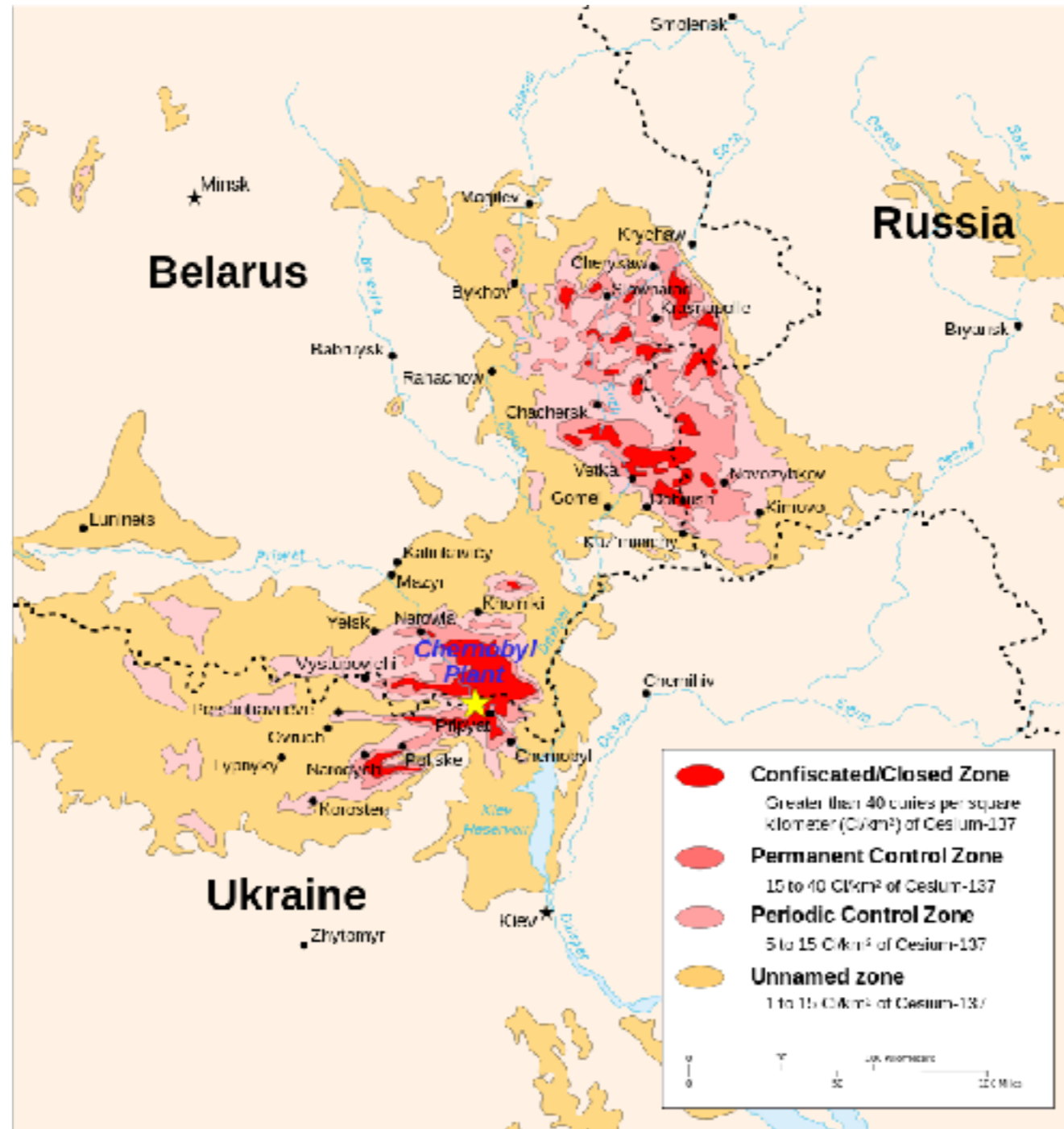


Chernobyl disaster



Source: http://www.kiae.ru/rus/inf/chnpp/pr_fcm.htm

Chernobyl disaster



Chernobyl disaster



Thyroid Cancer

Incidence per 100,000 in Belarus

