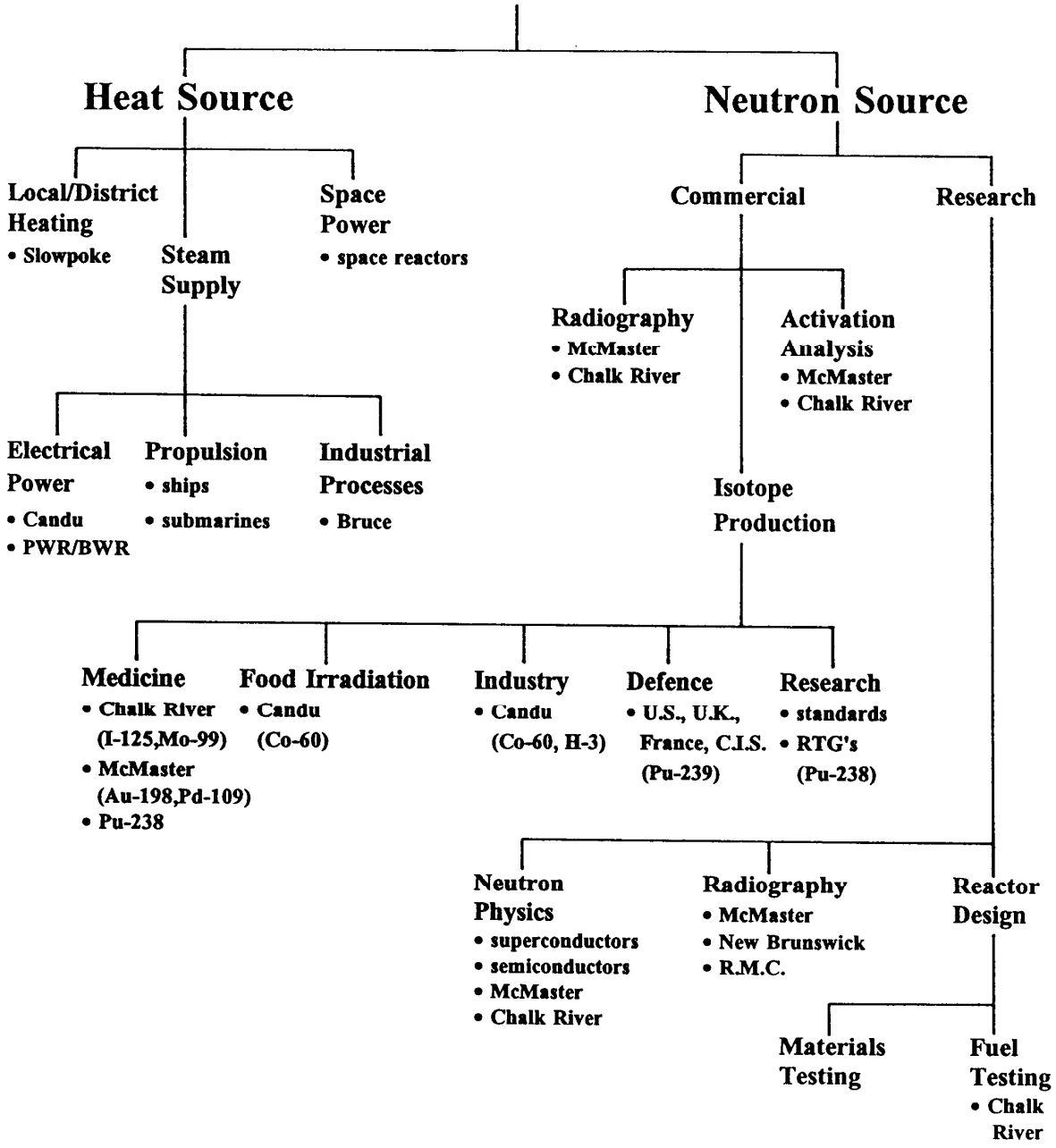
USES FOR REACTORS



Fissile Fuel:

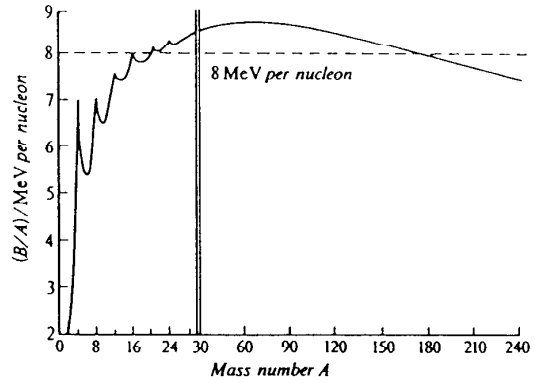


Fig. 6.3 Average binding energy per nucleon of the stable nuclei as a function of mass number (Ref. 2.1).

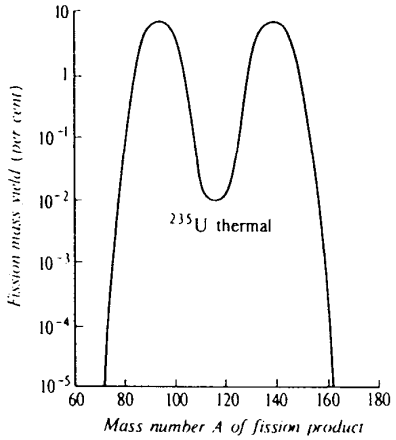


Fig. 11.21 Mass distribution of fission fragments.

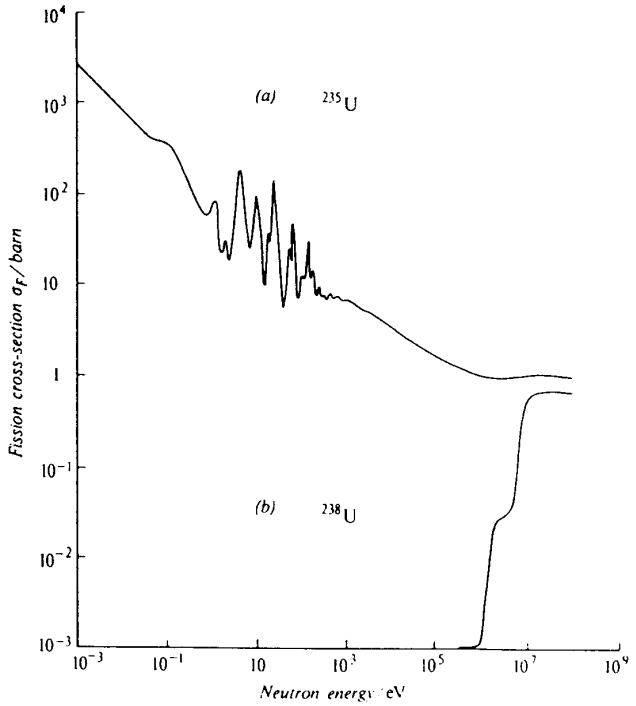


Fig. 11.20 Fission cross-sections, schematic, as a function of neutron energy. (*a*) ^{235}U, (*b*) ^{238}U.

Nuclear Reactor =

Fissile Fuel +

Neutron Moderator +

Coolant +

Control Mechanisms +

Neutron Reflector +

Support Structure +

Radiation Shielding +

Containment.

$$
{}_{92}U^{235} + n \rightarrow ({}_{92}U^{236})^* \begin{cases} \nearrow\ {}_{92}U^{236} + \gamma \\ \searrow\ {}_{54}Xe^{140} + {}_{38}Sr^{94} + 2n + 200\ MeV \end{cases}
$$

$$
{}_{92}U^{238} + n \rightarrow ({}_{92}U^{239})^* \rightarrow {}_{92}U^{239} + \gamma
$$

$$
{}_{92}U^{239} \rightarrow {}_{93}Np^{239} + e^- + \upsilon^+
$$

$$
{}_{93}Np^{239} \rightarrow {}_{94}Pu^{239} + e^- + \upsilon^+
$$

$$
{}_{94}Pu^{239} + n \rightarrow ({}_{94}Pu^{240})^* \begin{cases} \nearrow\ {}_{94}Pu^{240} + \gamma \\ \searrow\ {}_{56}Ba^{141} + {}_{38}Sr^{97} + 2n + 200\ MeV \end{cases}
$$

Moderator & Coolant:

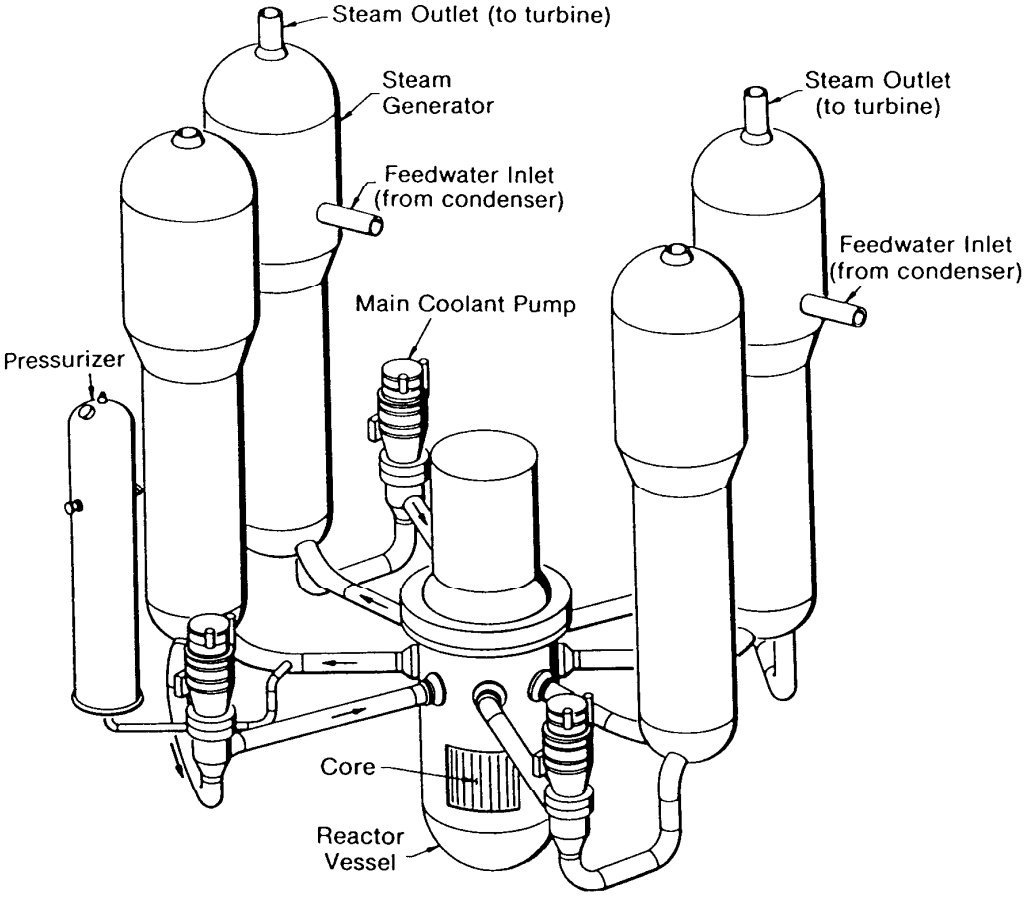
Slowing Down Parameters of Typical Moderators

Moderator	A	α	ξ	$\rho[g/cm^3]$	Number of collisions from 2 MeV to 1 eV	$\xi\Sigma_s[cm^{-1}]$	$\xi\Sigma_s/\Sigma_a$
H	1	0	1	gas	14	—	—
D	2	.111	.725	gas	20	—	—
H_2O	—	—	.920	1.0	16	1.35	71
D_2O	—	—	.509	1.1	29	0.176	5670
He	4	.360	.425	gas	43	1.6×10^{-5}	83
Be	9	.640	.209	1.85	69	0.158	143
C	12	.716	.158	1.60	91	0.060	192
^{238}U	238	.983	.008	19.1	1730	0.003	.0092

PWR-Type Reactor

Fuel: 2-3% enriched UO_2

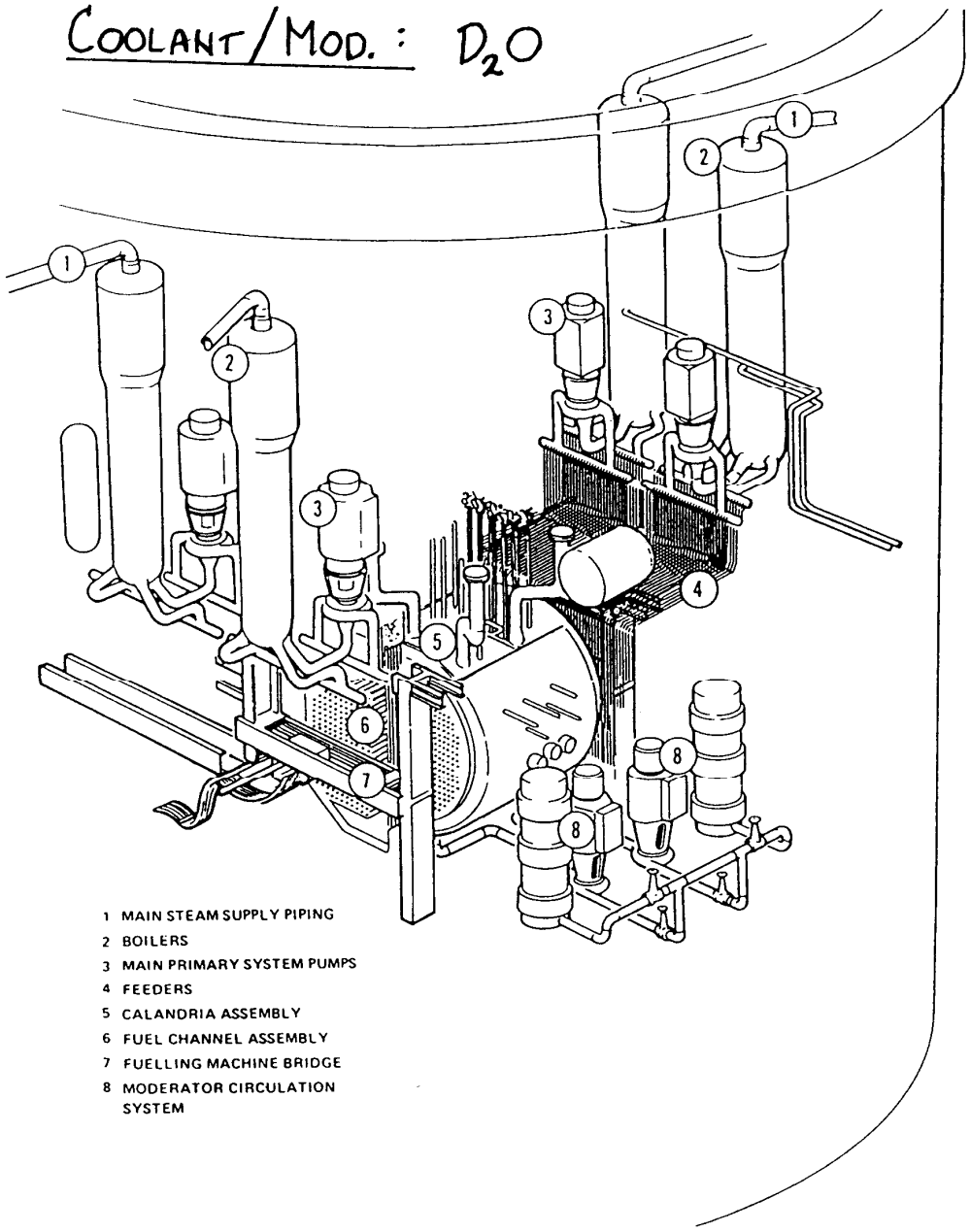
Coolant/Mod.: H_2O



CANDU-Type Reactor

Fuel: Natural UO_2

Coolant/Mod.: D_2O

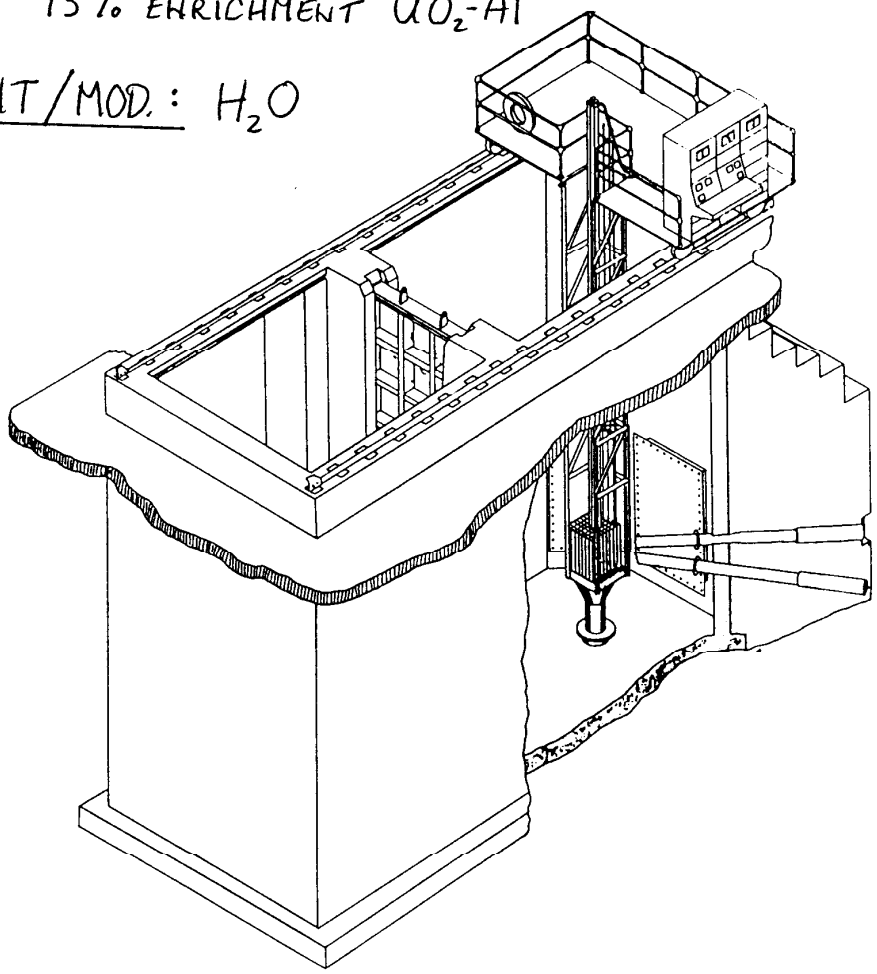


1 MAIN STEAM SUPPLY PIPING
2 BOILERS
3 MAIN PRIMARY SYSTEM PUMPS
4 FEEDERS
5 CALANDRIA ASSEMBLY
6 FUEL CHANNEL ASSEMBLY
7 FUELLING MACHINE BRIDGE
8 MODERATOR CIRCULATION SYSTEM

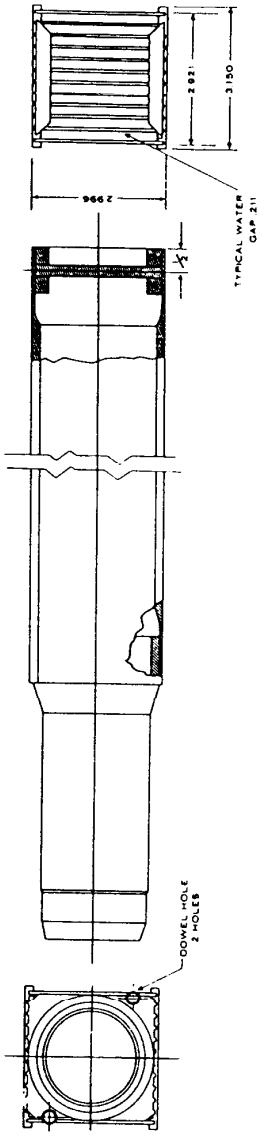
MNR - Type Reactor

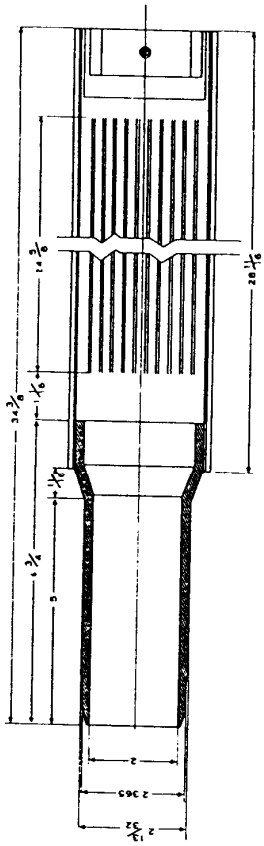
FUEL: 93% enrichment UO_2-Al

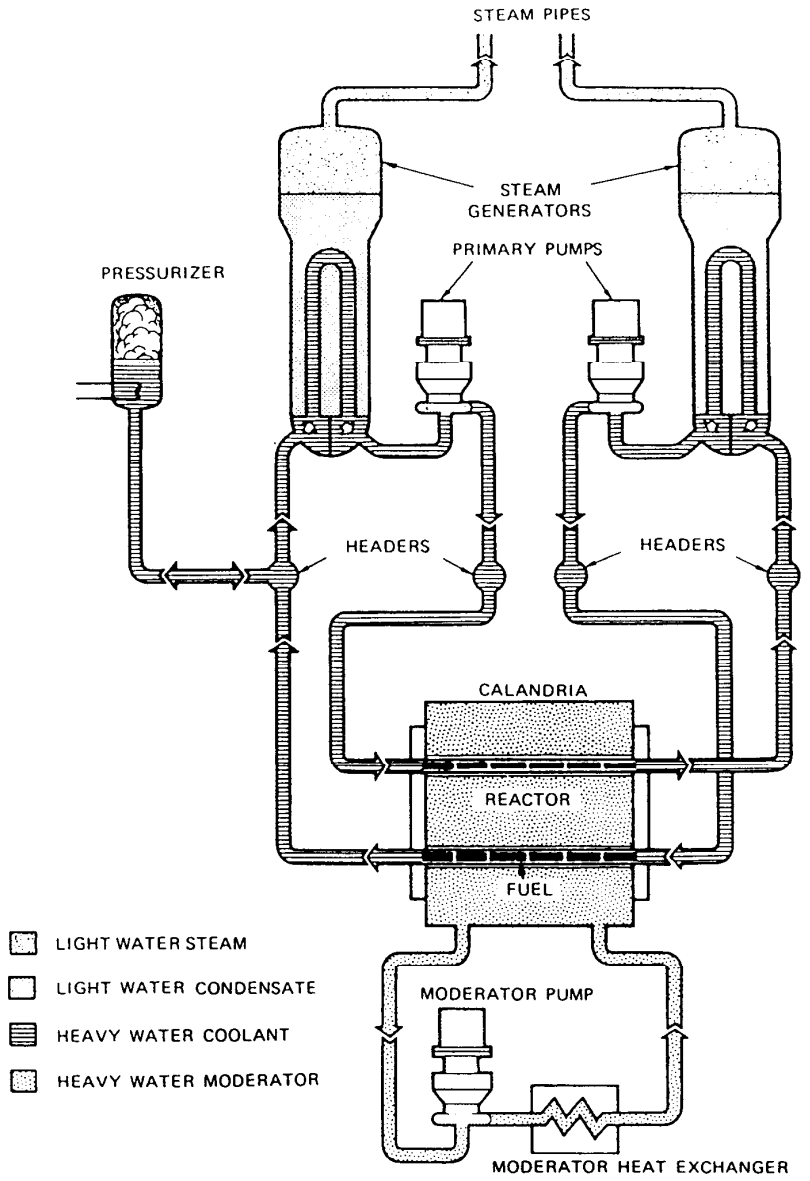
COOLANT/MOD.: H_2O

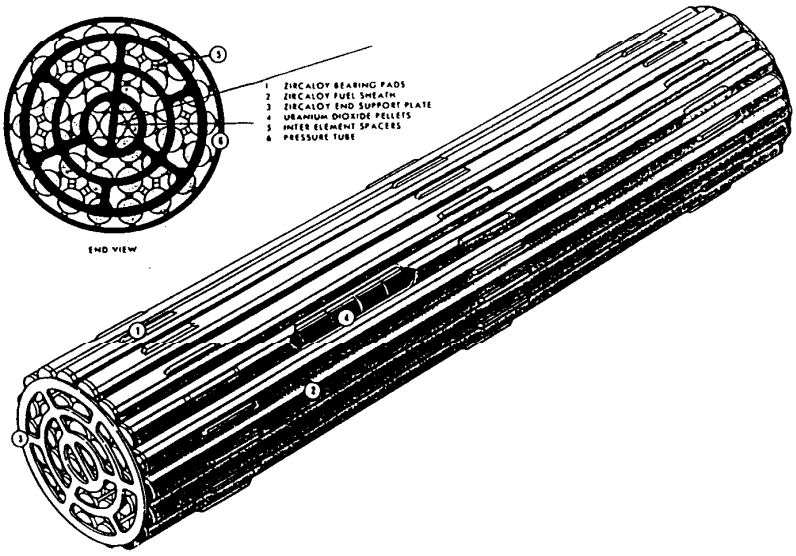


MNR - Type Fuel






STEAM PIPES
STEAM GENERATORS
PRIMARY PUMPS
PRESSURIZER
HEADERS
HEADERS
CALANDRIA
REACTOR
FUEL
LIGHT WATER STEAM
LIGHT WATER CONDENSATE
HEAVY WATER COOLANT
HEAVY WATER MODERATOR
MODERATOR PUMP
MODERATOR HEAT EXCHANGER

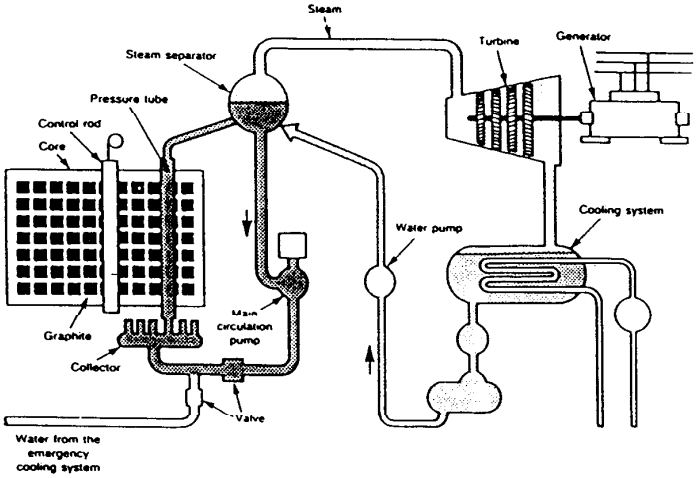

1 ZIRCALOY BEARING PADS
2 ZIRCALOY FUEL SHEATH
3 ZIRCALOY END SUPPORT PLATE
4 URANIUM DIOXIDE PELLETS
5 INTER ELEMENT SPACERS
6 PRESSURE TUBE
END VIEW

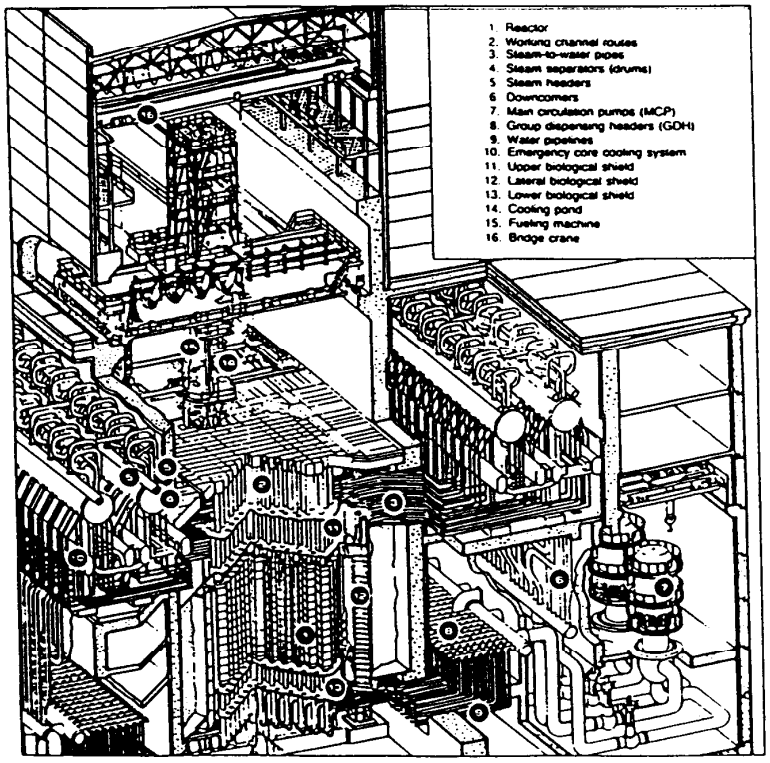
CHERNOBYL-TYPE REACTOR

FUEL: 2% ENRICHMENT UO_2

COOLANT: H_2O

MODERATOR: GRAPHITE

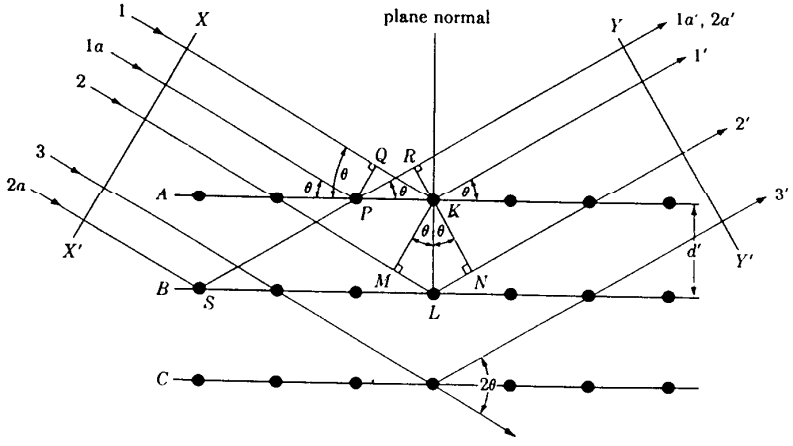




All Things Great and Small...

Detection Method	Object Size	Typical Objects
Light Microscopy	10^{-7} m	groups of cells
Electron Microscopy	$10^{-6} \rightarrow 10^{-9}$ m	individual cells, large molecules, grain structure
X-ray Diffraction	$10^{-8} \rightarrow 10^{-9}$ m	crystal structure
Neutron Diffraction	10^{-10} m	crystal structure
Nuclear & Particle Physics	$\leq 10^{-14}$ m	nuclei, subatomic particle

Neutron (and X-Ray) Diffraction



Careers in the Nuclear Area

General Area	Undergraduate Area of Study	Graduate School
Reactor Engineering:		
Thermalhydraulics	**Mech. Engineering** **Engineering Science**	**McMaster**
Materials	**Materials Engineering** **Physics** **Chemistry**	**Toronto, McMaster**
Core Physics	**Engineering Science** **Physics**	**McMaster, Toronto, Ecole Polytechnique, New Brunswick**
Materials Science	**Physics** **Chemistry**	**McMaster, Toronto**
Nuclear Medicine	**Engineering Science** **Physics** **Biology**	**McMaster, Toronto, New Brunswick, McGill, B.C.**
Health and Radiation Physics	**Physics** **Biophysics** **Chemistry** **Engineering Science**	**McMaster**
Nuclear and Particle Physics	**Physics**	**Toronto, B.C., Carleton, Queens, McMaster, McGill**