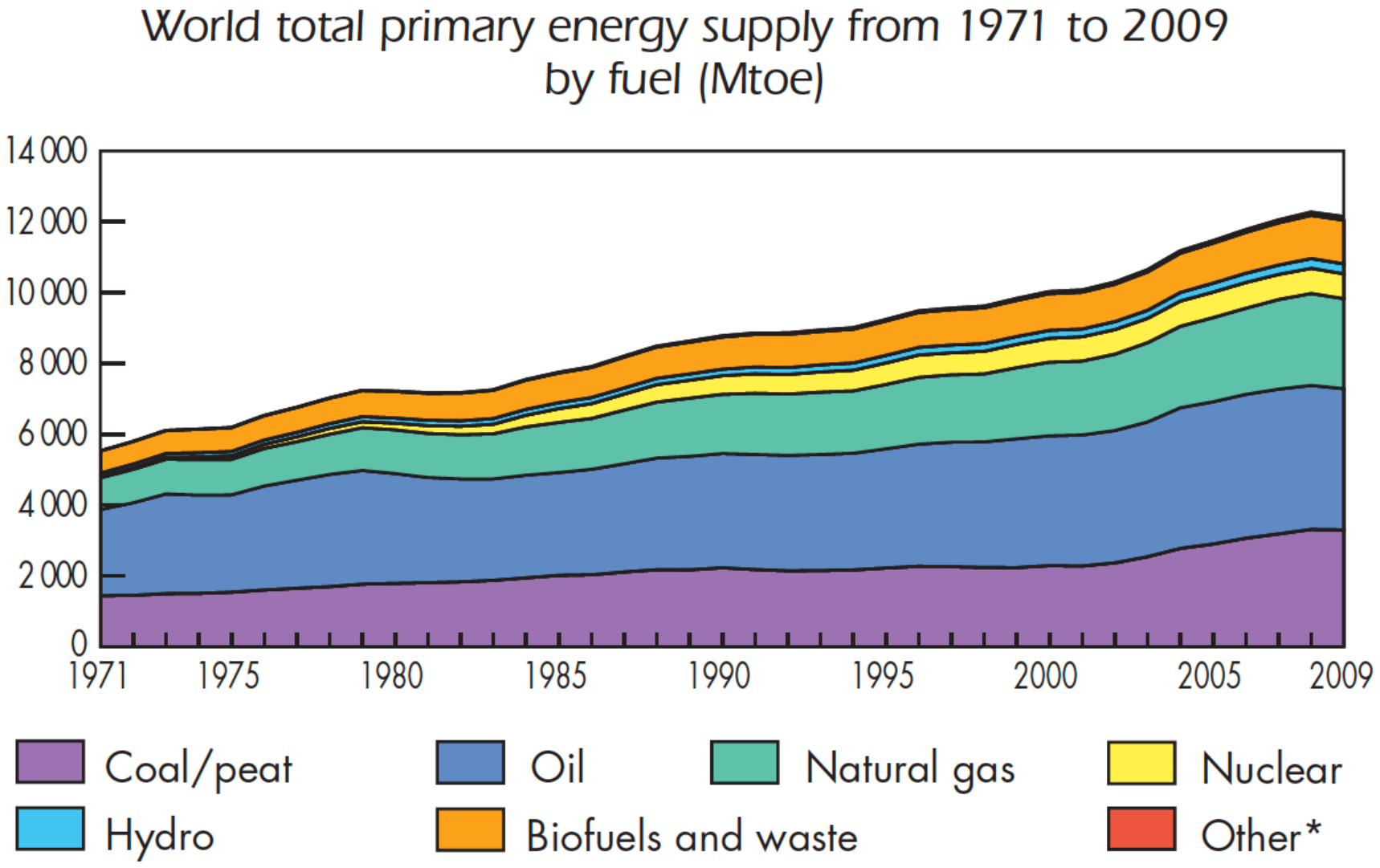
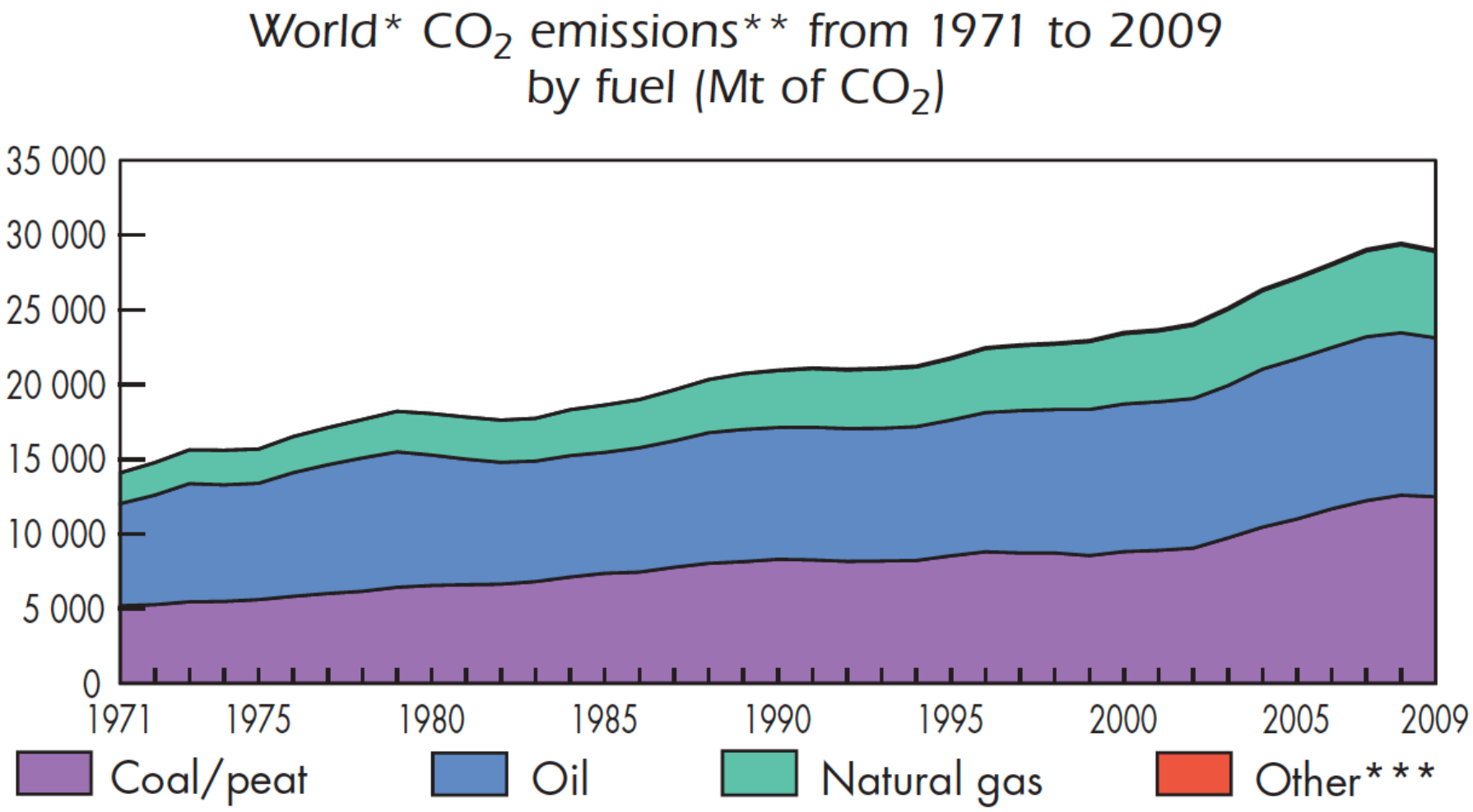


-IEA Key World Energy Stats 2011



-IEA Key World Energy Stats 2011

Th

90

232.04

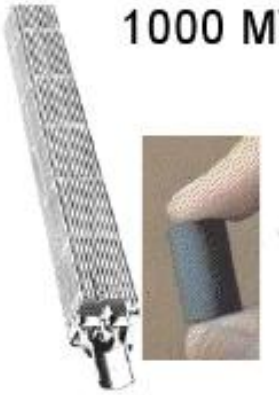
Thorium

Uranium Fuel Cycle vs. Thorium

1000 MW of electricity for one year

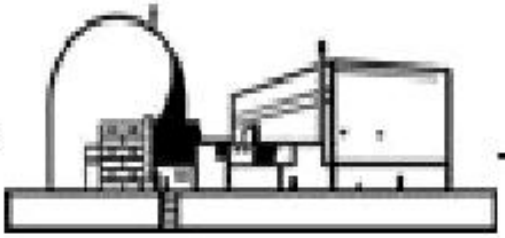
800,000 tons Ore

250 tons
Natural uranium



35 tons
Enriched Uranium
(Costly Process)

215 tons
depleted uranium
-disposal plans uncertain



Uranium-235 content is
"burned" out of the fuel;
some plutonium is formed
and burned

35 tons Spent Fuel
Yucca Mountain (~10,
000 years)

- 33.4 t uranium-238
- 0.3 t uranium-235
- 0.3 t plutonium
- 1.0 t fission products

200 tons Ore

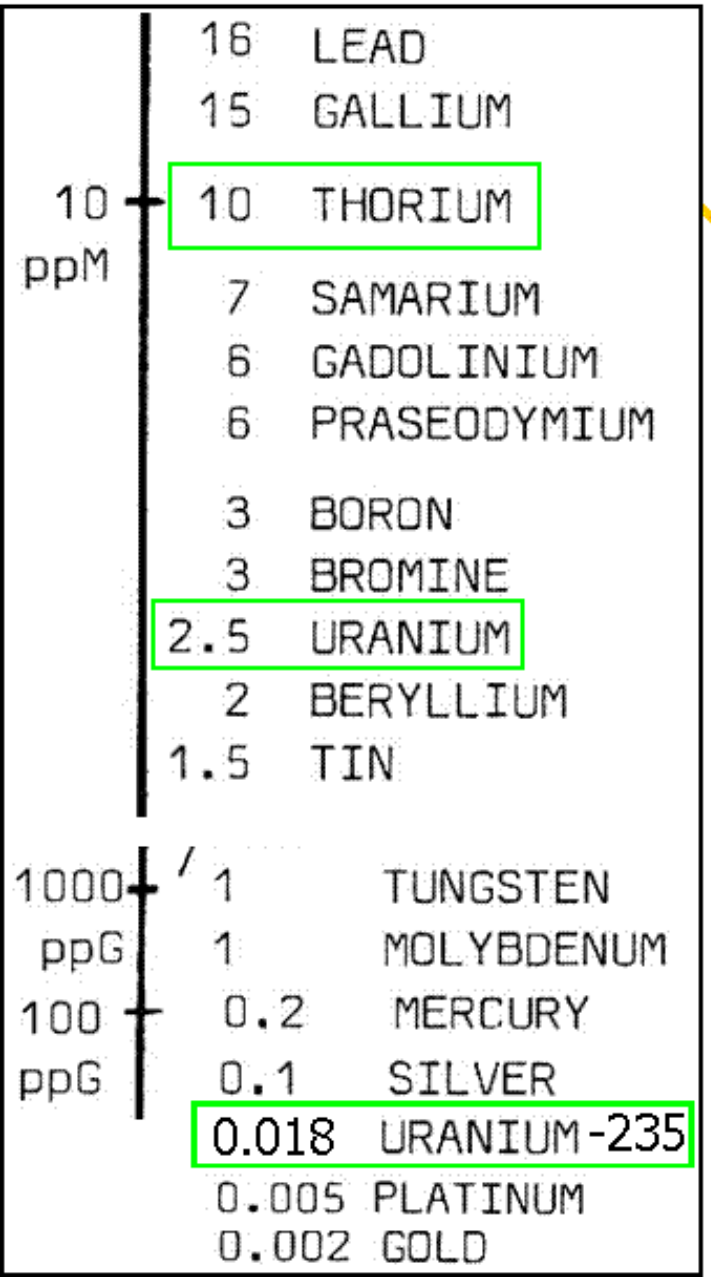
1 ton
Natural Thorium

Thorium introduced into
blanket of fluoride reactor;
completely converted to
uranium-233 and "burned"

1 Ton
Fission products;
no uranium,
plutonium, or
other actinides

Within 10 years, 83%
of fission products are
stable and can be
partitioned and sold.

The remaining 17%
fission products go to
geologic isolation for
~300 years.



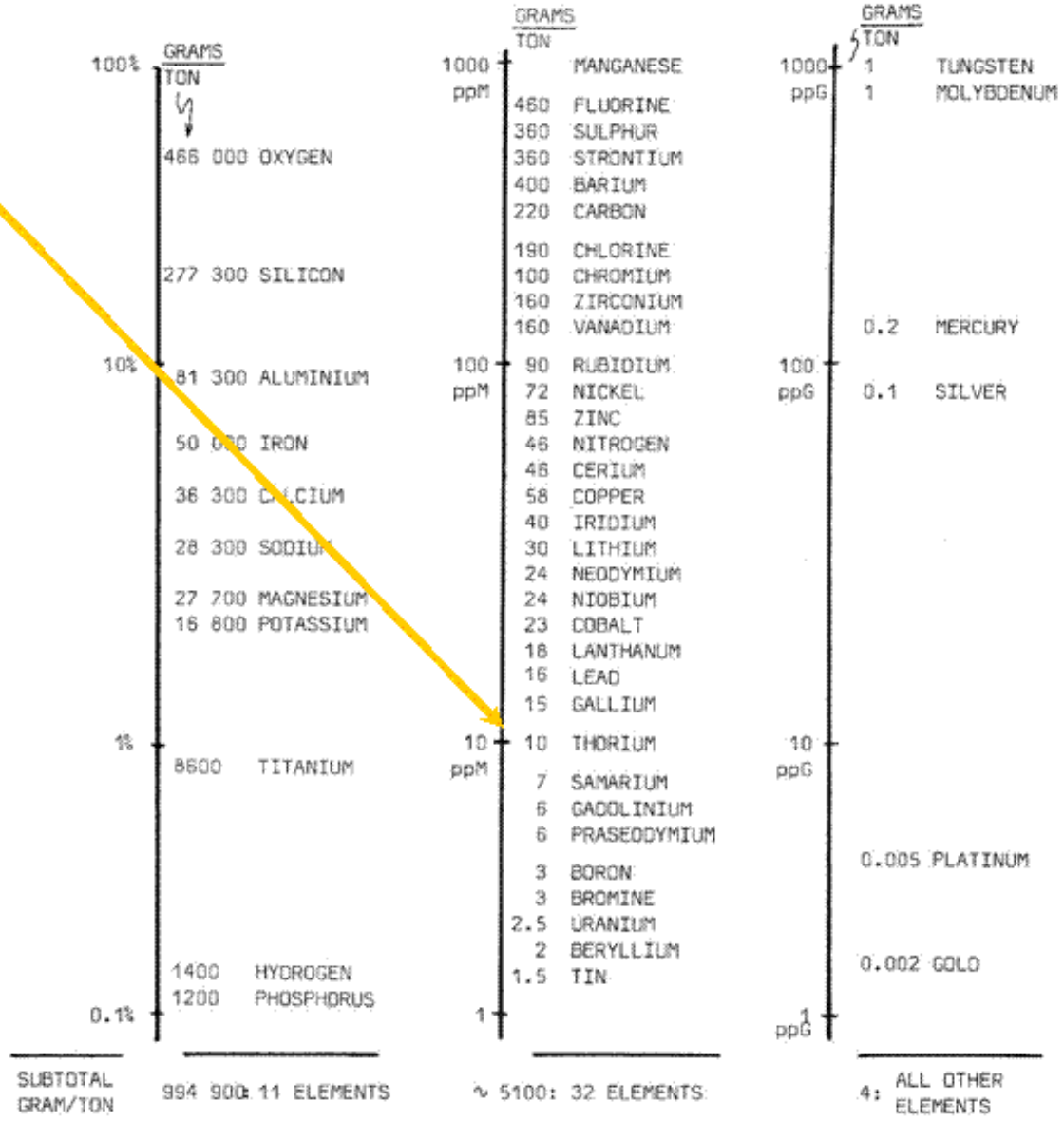
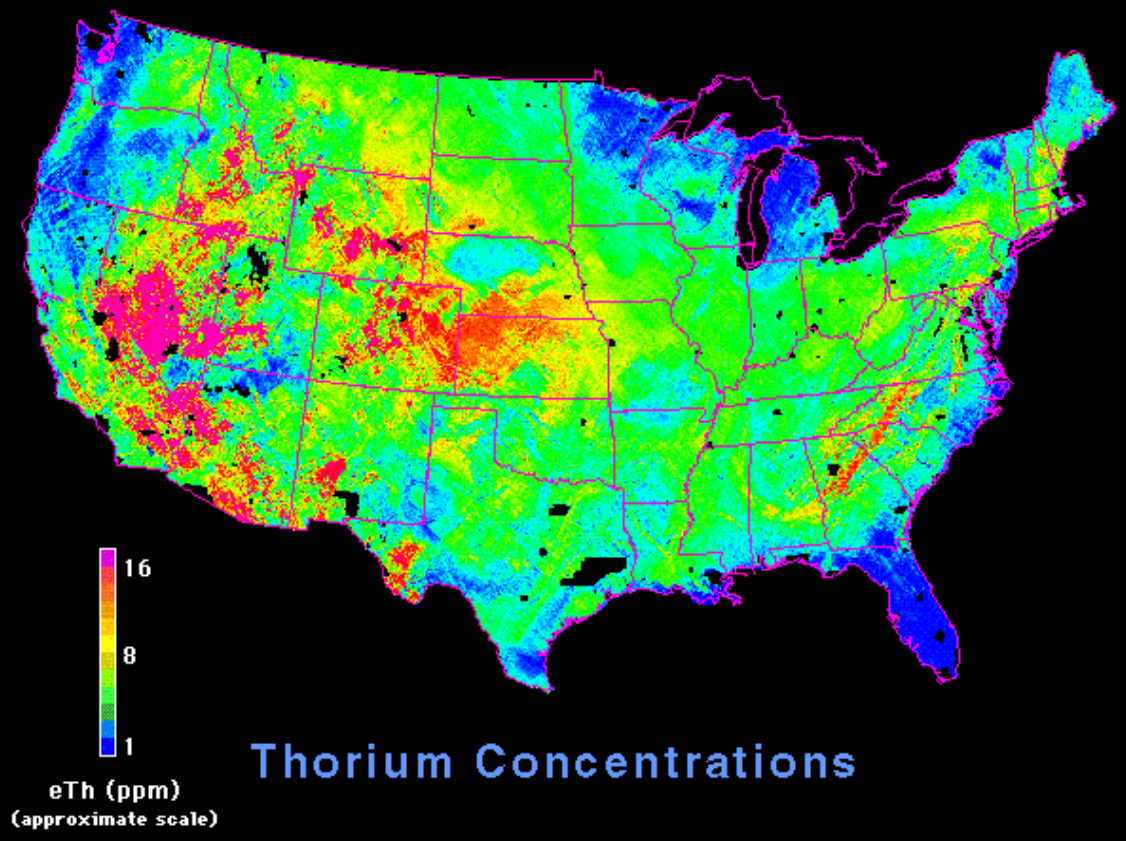


Fig. 5.13. The chemical composition of the Earth's crust.

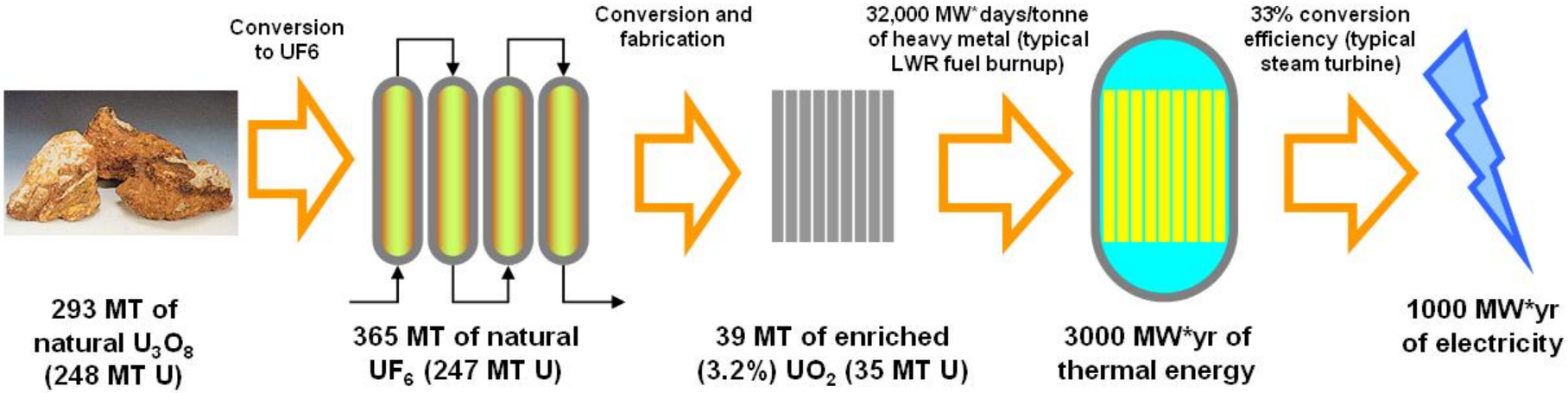


IAEA Estimates in tonnes (2005)

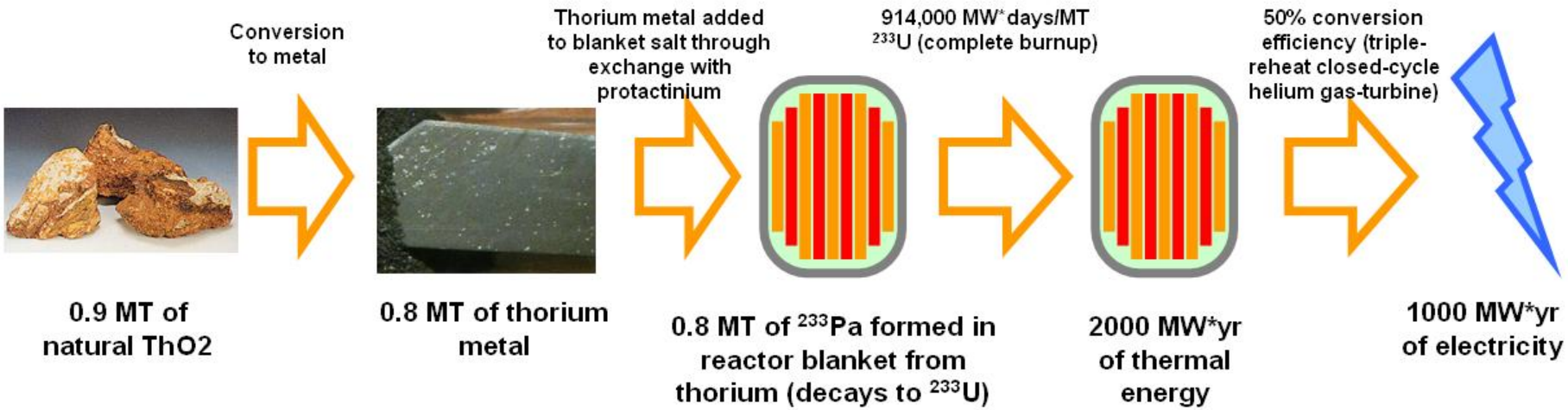
Country	RAR Th	EAR Th
Australia	489,000	19%
USA	400,000	15%
Turkey	344,000	13%
India	319,000	12%
Venezuela	300,000	12%
Brazil	302,000	12%
Norway	132,000	5%
Egypt	100,000	4%
Russia	75,000	3%
Greenland	54,000	2%
Canada	44,000	2%
South Africa	18,000	1%
"Other countries"	33,000	1%
"World total"	2,610,000	

Energy Extraction Comparison

Uranium-fueled light-water reactor: 35 GW*hr/MT of natural uranium

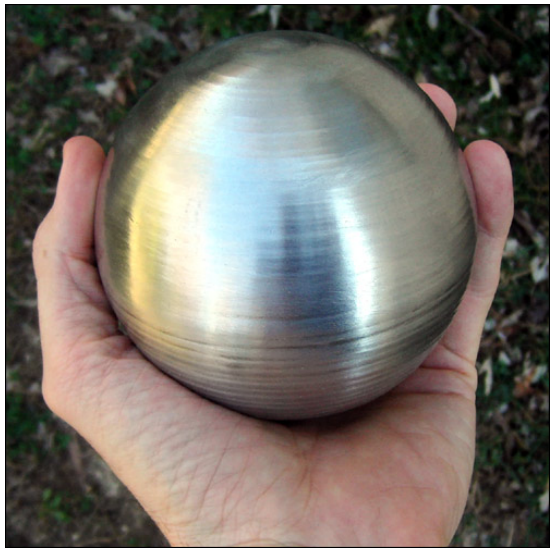


Thorium-fueled liquid-fluoride reactor: 11,000 GW*hr/MT of natural thorium



Uranium fuel cycle calculations done using WISE nuclear fuel material calculator: http://www.wise-uranium.org/nfcm.html

Energy Generation Comparison



6 kg of thorium metal in a liquid-fluoride reactor has the energy equivalent (66,000 MW*hr electrical*) of:

***Each ounce of thorium can therefore produce $14,000-24,000 of electricity (at $0.04-0.07/kW*hr)**

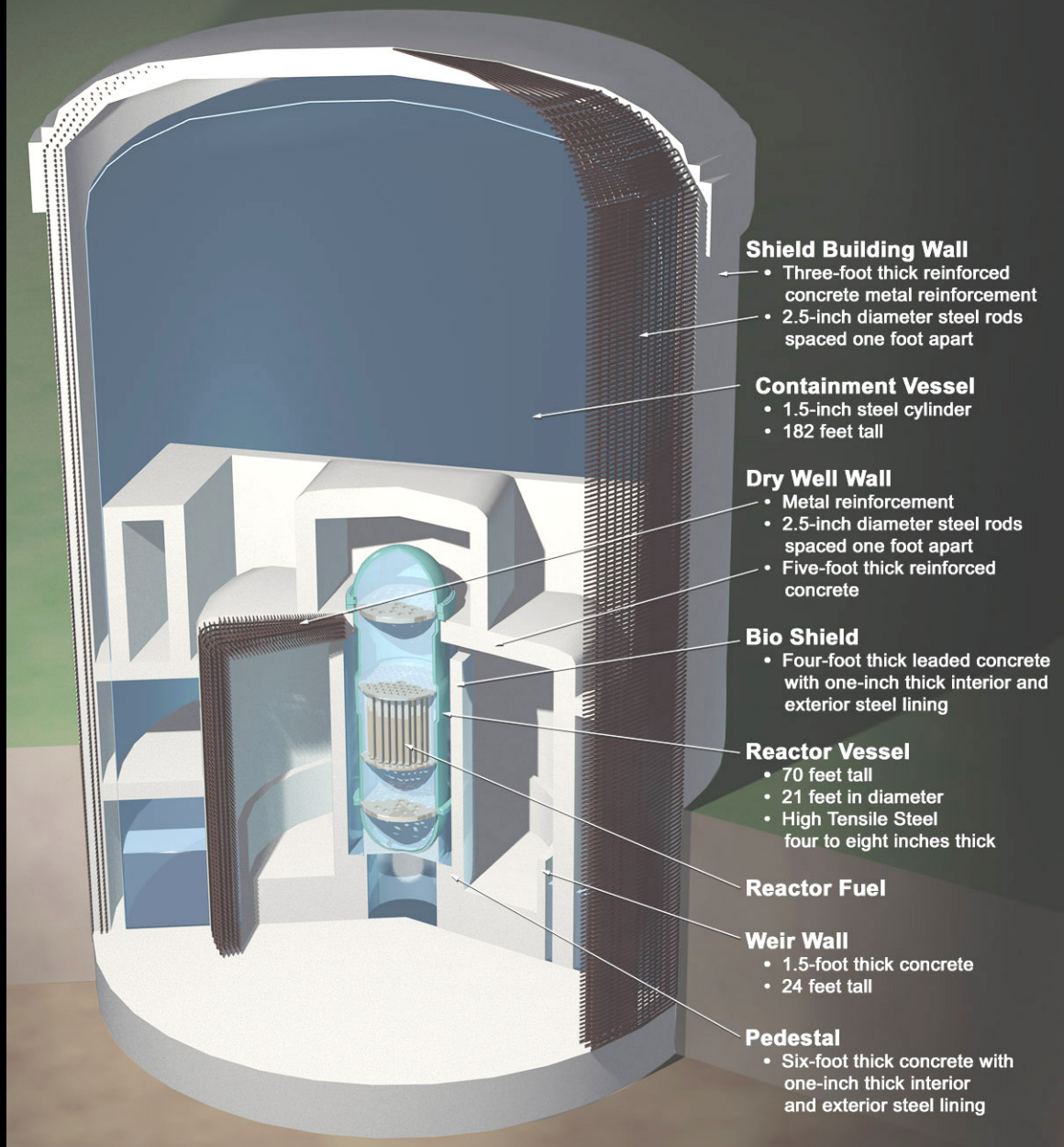
=

230 train cars (25,000 MT) of bituminous coal or 600 train cars (66,000 MT) of brown coal,

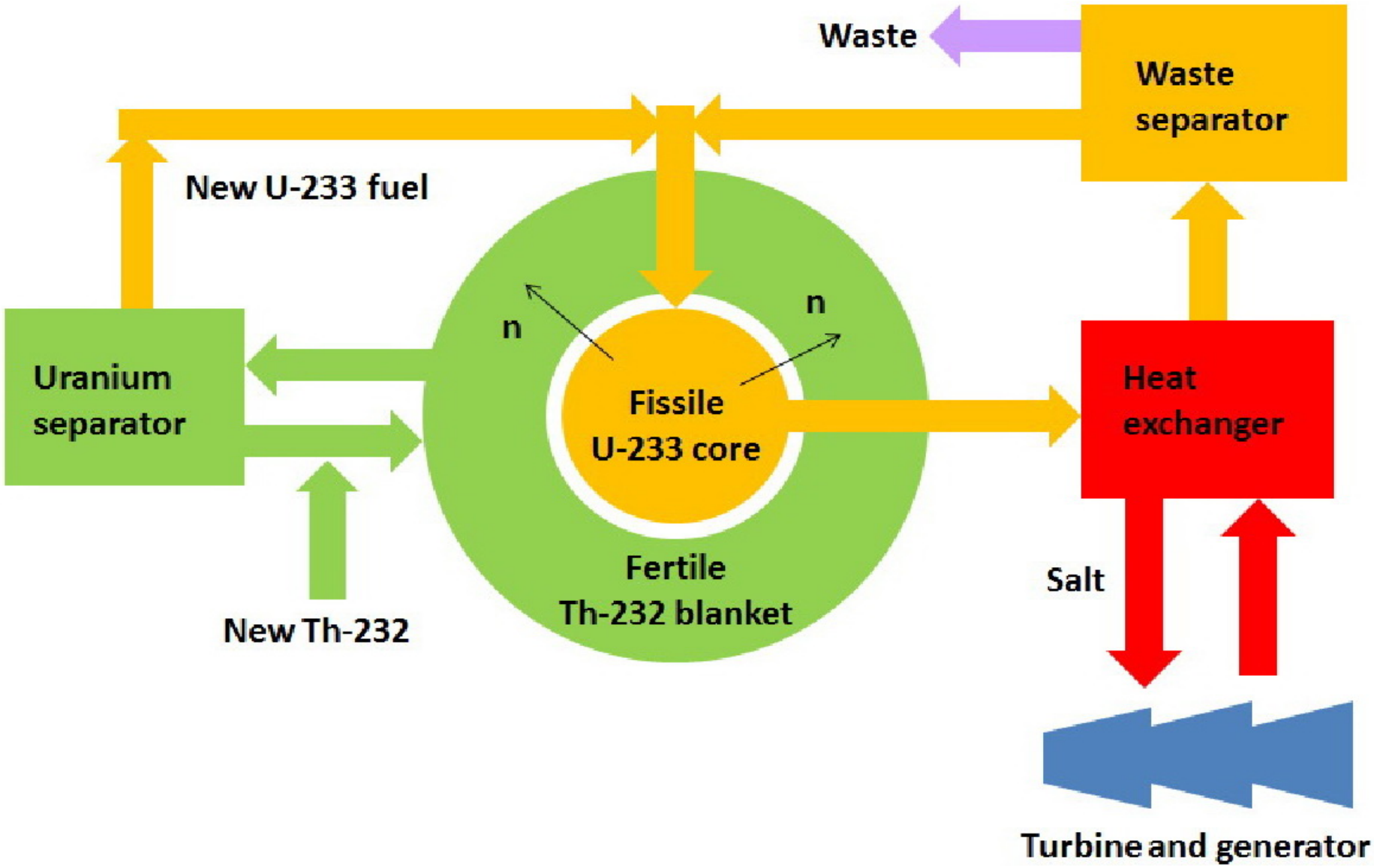
or, 440 million cubic feet of natural gas (15% of a 125,000 cubic meter LNG tanker),

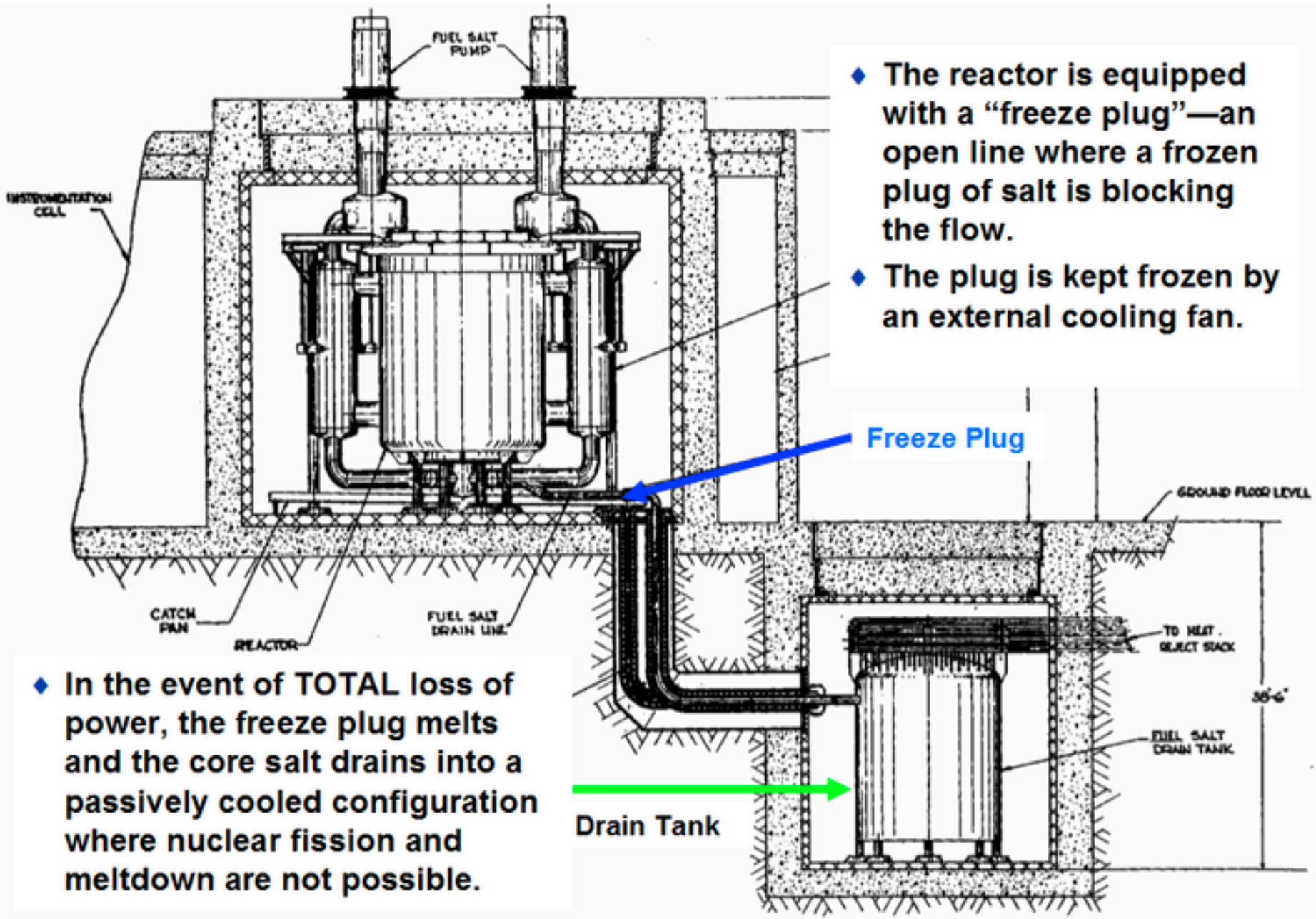
or, 300 kg of enriched (3%) uranium in a pressurized water reactor.

Multiple Layers of Safety at Nuclear Power Plants



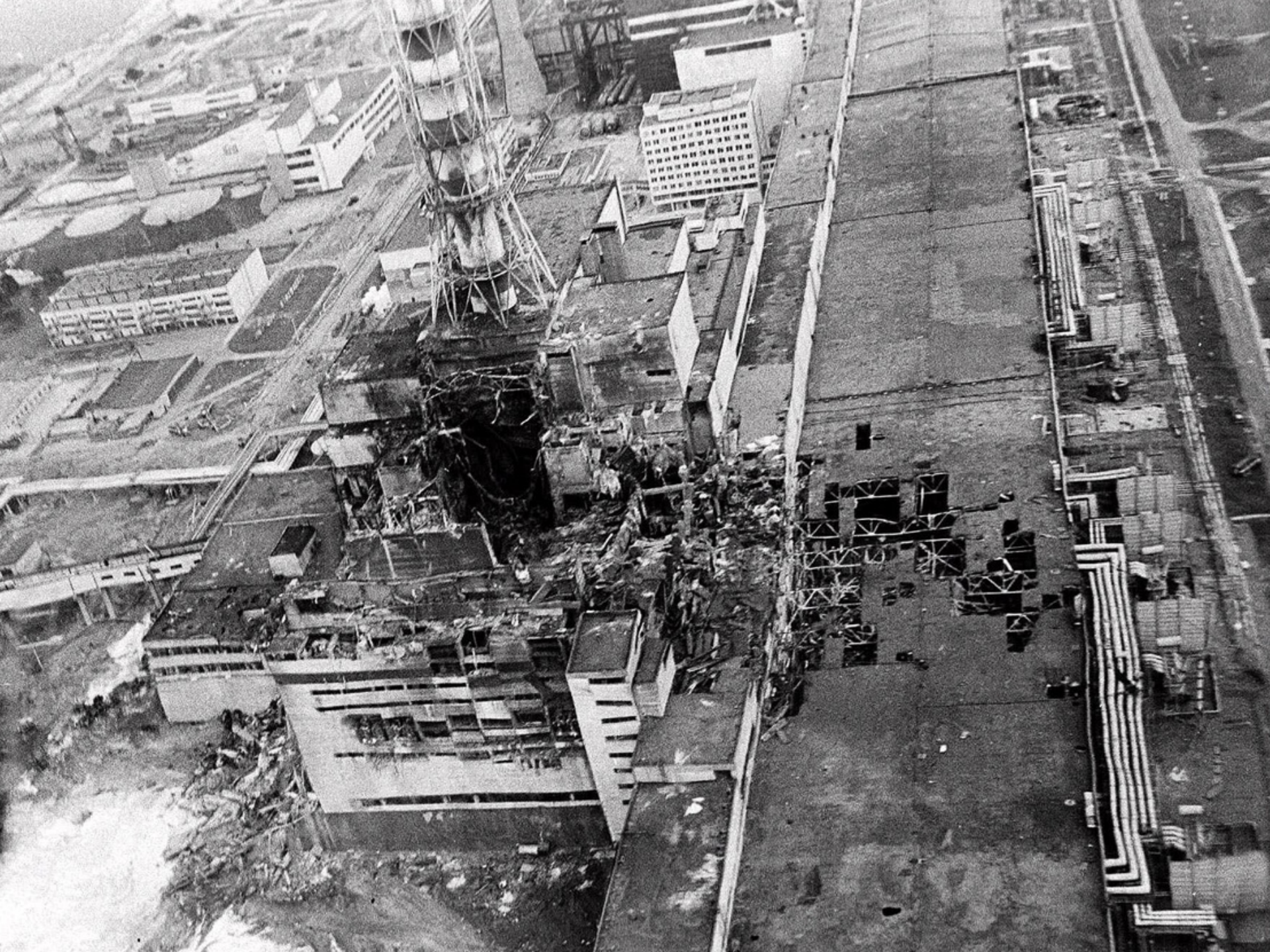
Boiling Water Reactor


Waste
Waste separator
New U-233 fuel
n
n
Uranium separator
Fissile U-233 core
Heat exchanger
Fertile Th-232 blanket
Salt
New Th-232
Turbine and generator



- The reactor is equipped with a "freeze plug"—an open line where a frozen plug of salt is blocking the flow.
- The plug is kept frozen by an external cooling fan.

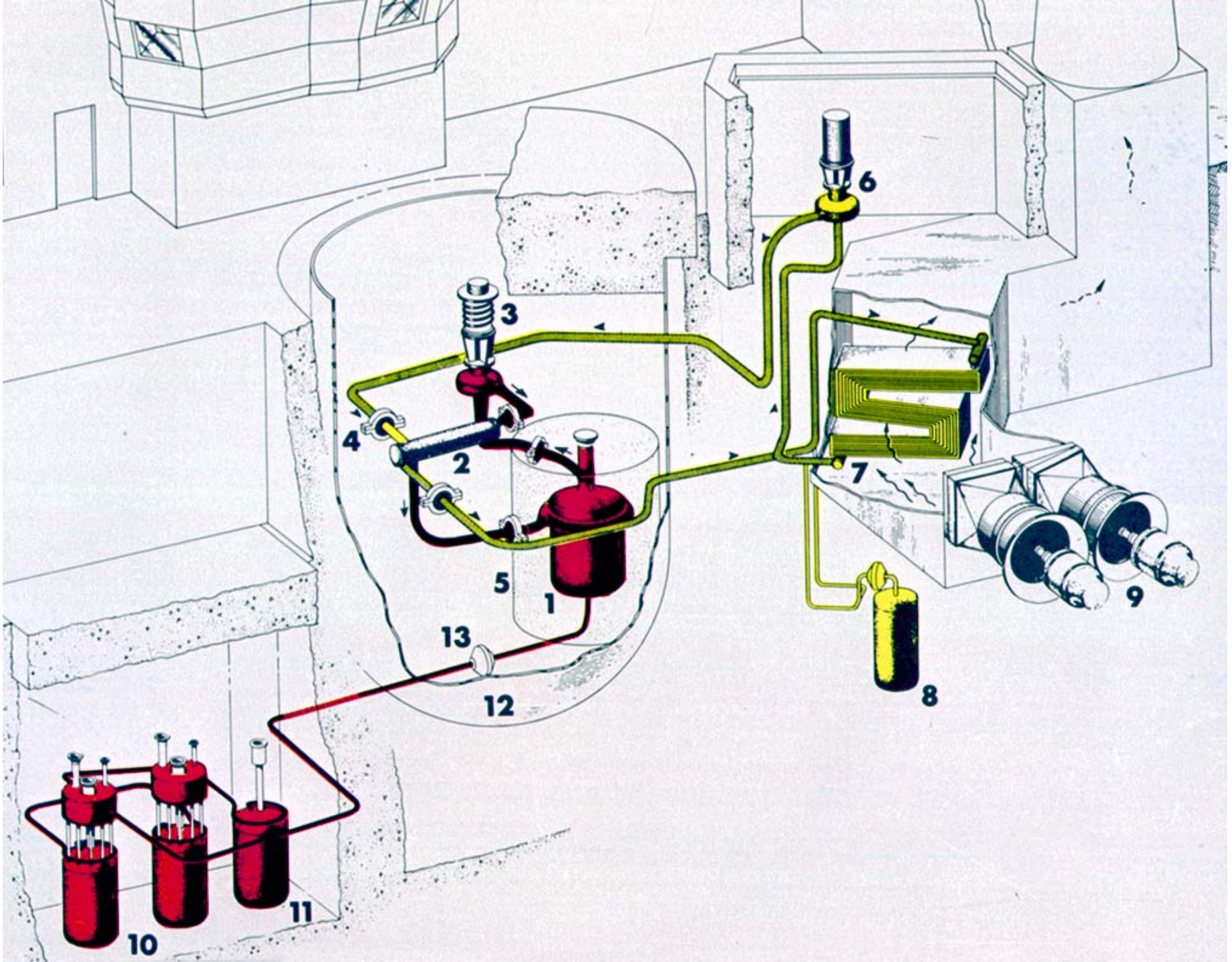
- In the event of TOTAL loss of power, the freeze plug melts and the core salt drains into a passively cooled configuration where nuclear fission and meltdown are not possible.




NUCLEAR
NO
THANKS

Molten Salt Reactor Experiment

Bldg. 7303, Oak Ridge National Laboratory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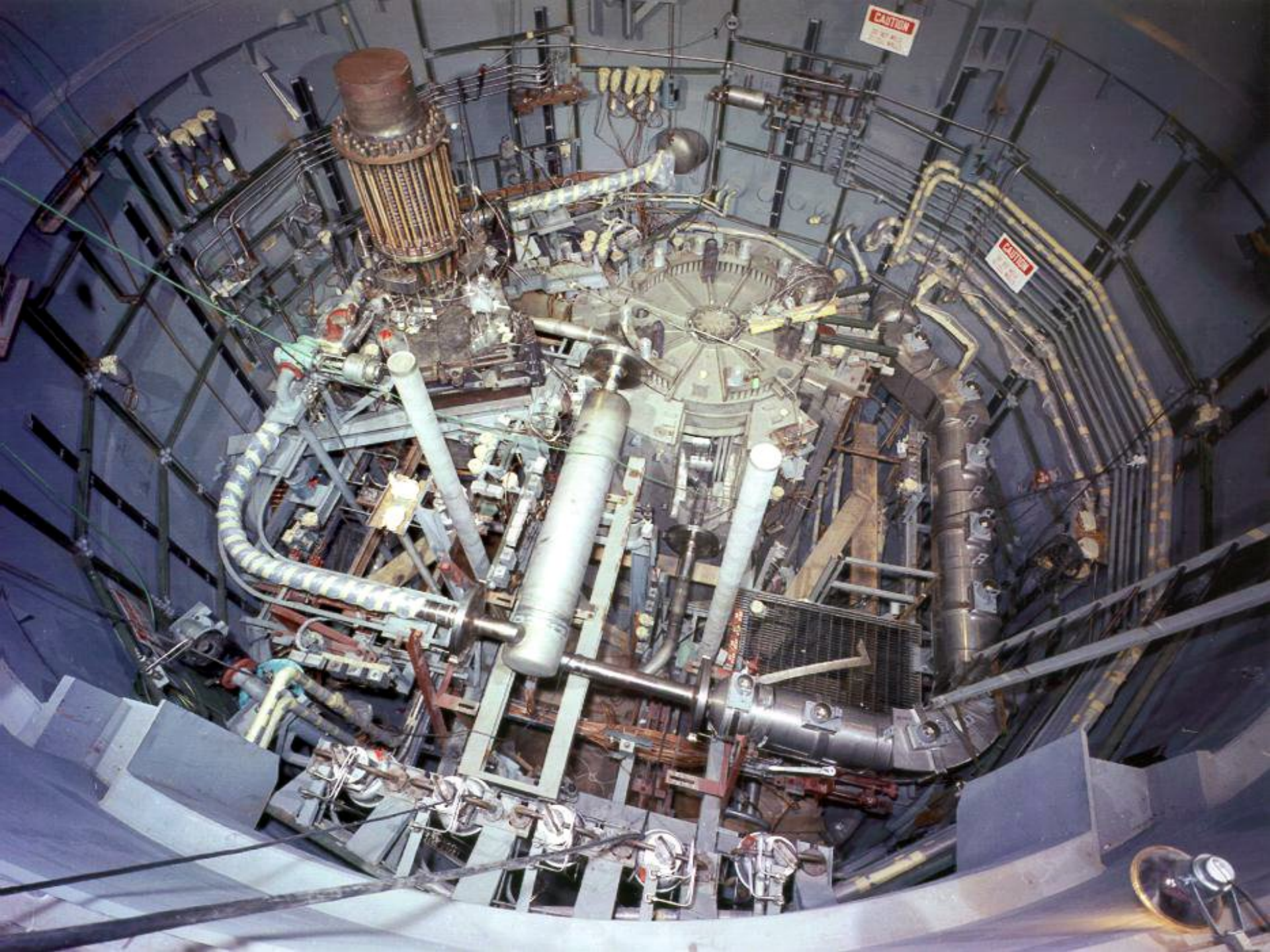
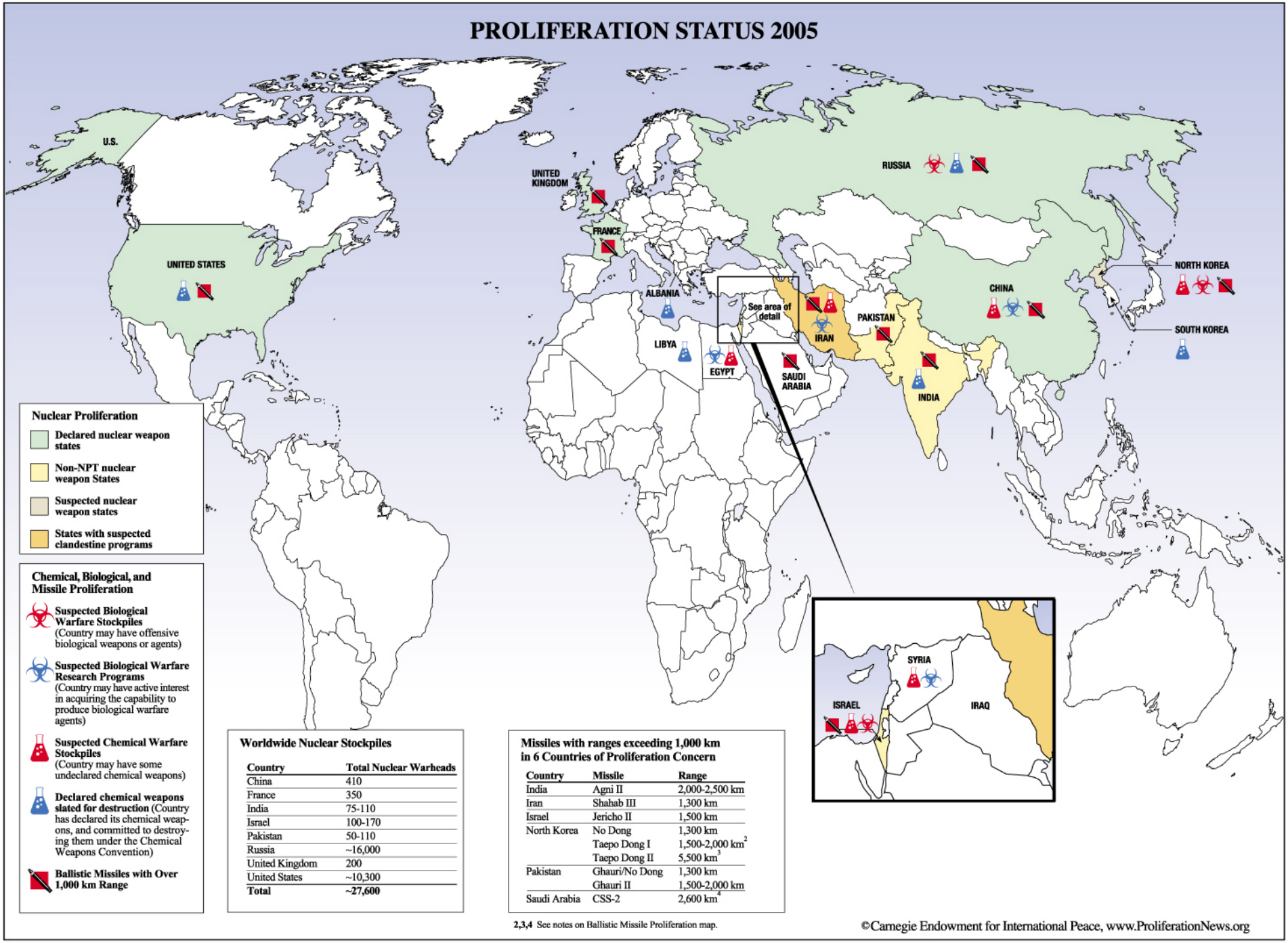

CAUTION
CAUTION

PROLIFERATION STATUS 2005



Nuclear Proliferation

- **Declared nuclear weapon states**
- **Non-NPT nuclear weapon States**
- **Suspected nuclear weapon states**
- **States with suspected clandestine programs**

Chemical, Biological, and Missile Proliferation

- **Suspected Biological Warfare Stockpiles** (Country may have offensive biological weapons or agents)
- **Suspected Biological Warfare Research Programs** (Country may have active interest in acquiring the capability to produce biological warfare agents)
- **Suspected Chemical Warfare Stockpiles** (Country may have some undeclared chemical weapons)
- **Declared chemical weapons slated for destruction** (Country has declared its chemical weapons, and committed to destroying them under the Chemical Weapons Convention)
- **Ballistic Missiles with Over 1,000 km Range**

Worldwide Nuclear Stockpiles

Country	Total Nuclear Warheads
China	410
France	350
India	75-110
Israel	100-170
Pakistan	50-110
Russia	~16,000
United Kingdom	200
United States	~10,300
Total	**~27,600**

Missiles with ranges exceeding 1,000 km in 6 Countries of Proliferation Concern

Country	Missile	Range
India	Agni II	2,000-2,500 km
Iran	Shahab III	1,300 km
Israel	Jericho II	1,500 km
North Korea	No Dong	1,300 km
	Taepo Dong I	1,500-2,000 km[2]
	Taepo Dong II	5,500 km[3]
Pakistan	Ghauri/No Dong	1,300 km
	Ghauri II	1,500-2,000 km
Saudi Arabia	CSS-2	2,600 km[4]

2,3,4 See notes on Ballistic Missile Proliferation map.