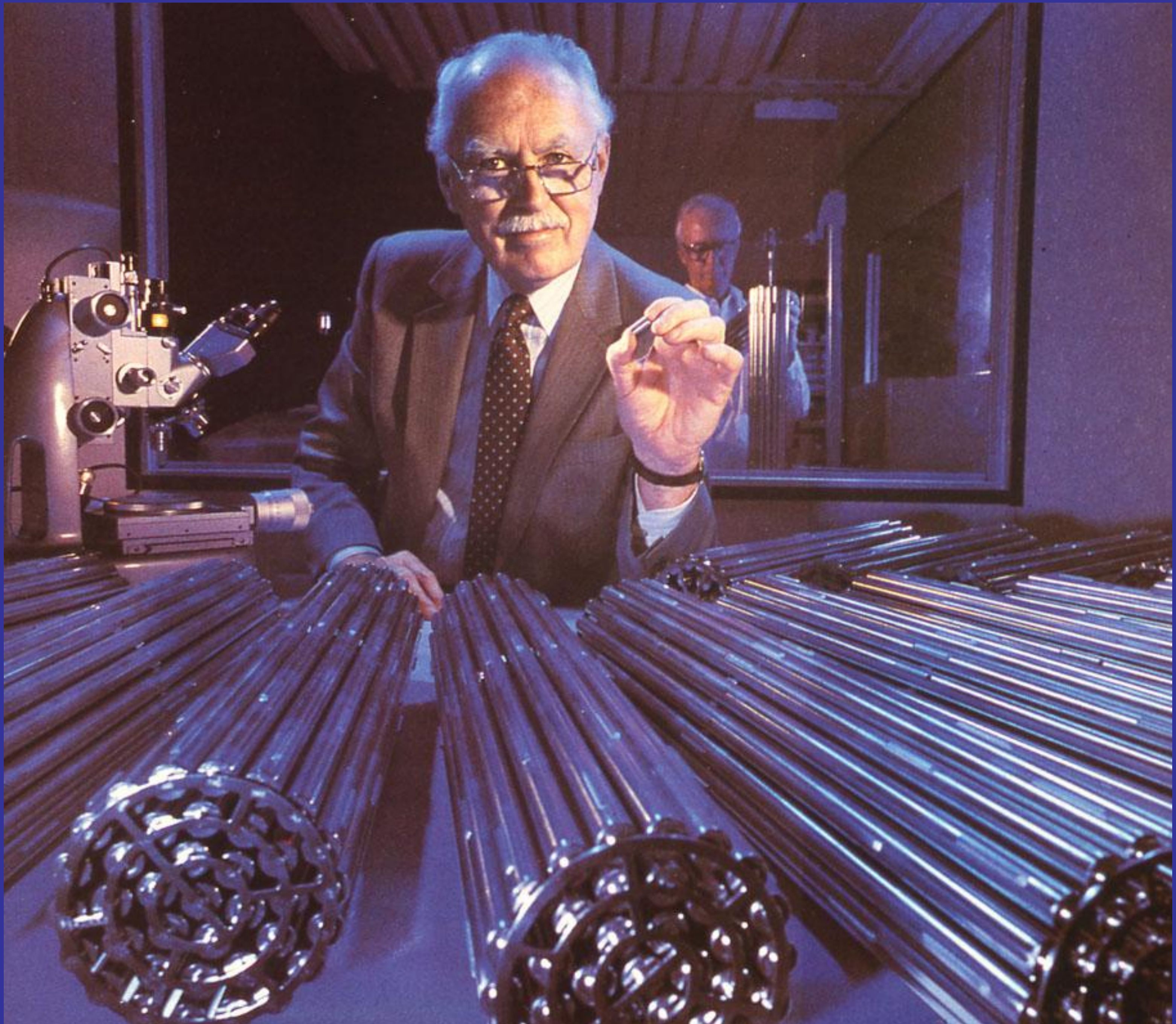
Nuclear Renaissance = Nuclear Proliferation

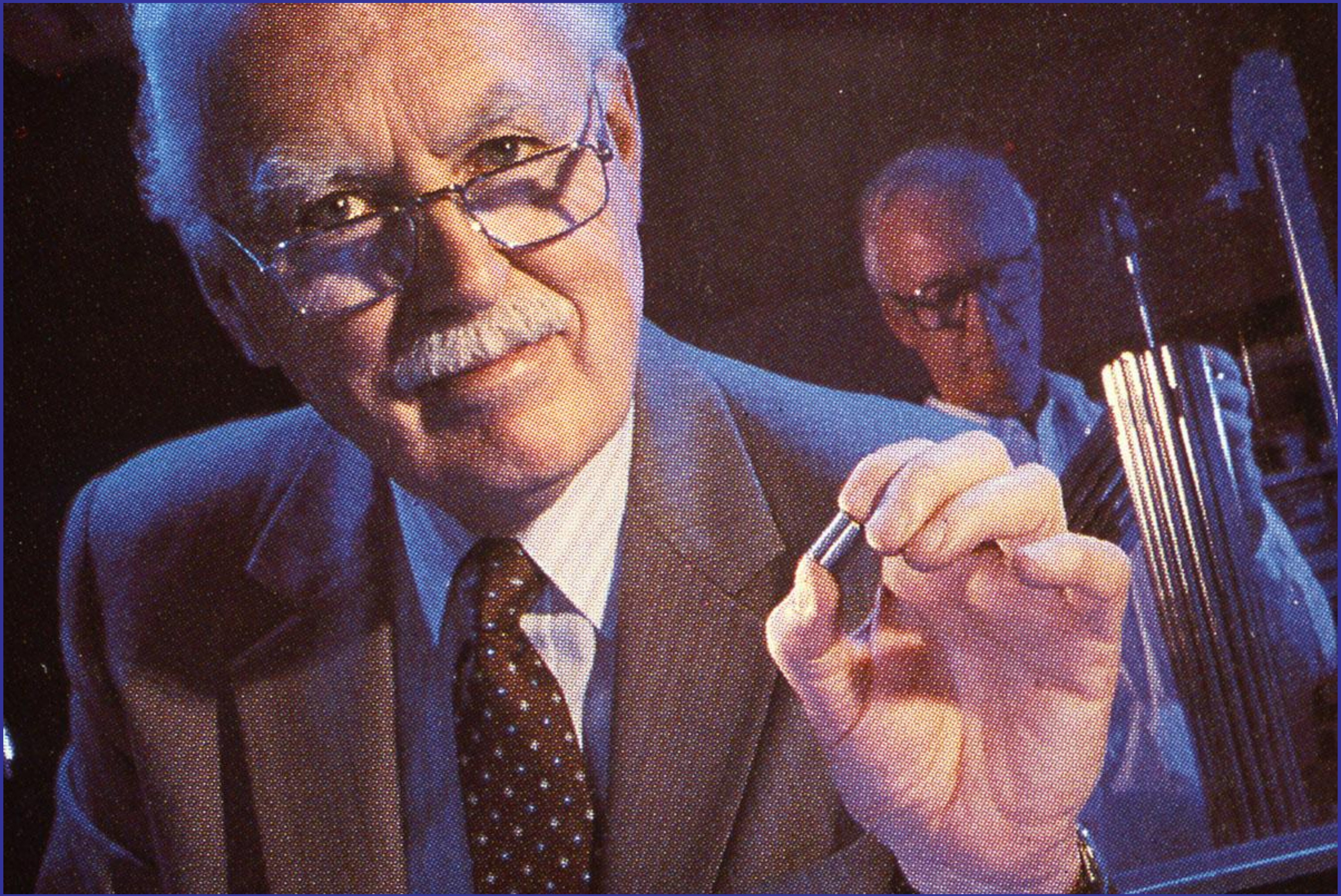
a presentation by
Gordon Edwards Ph.D.
and Robert Del Tredici

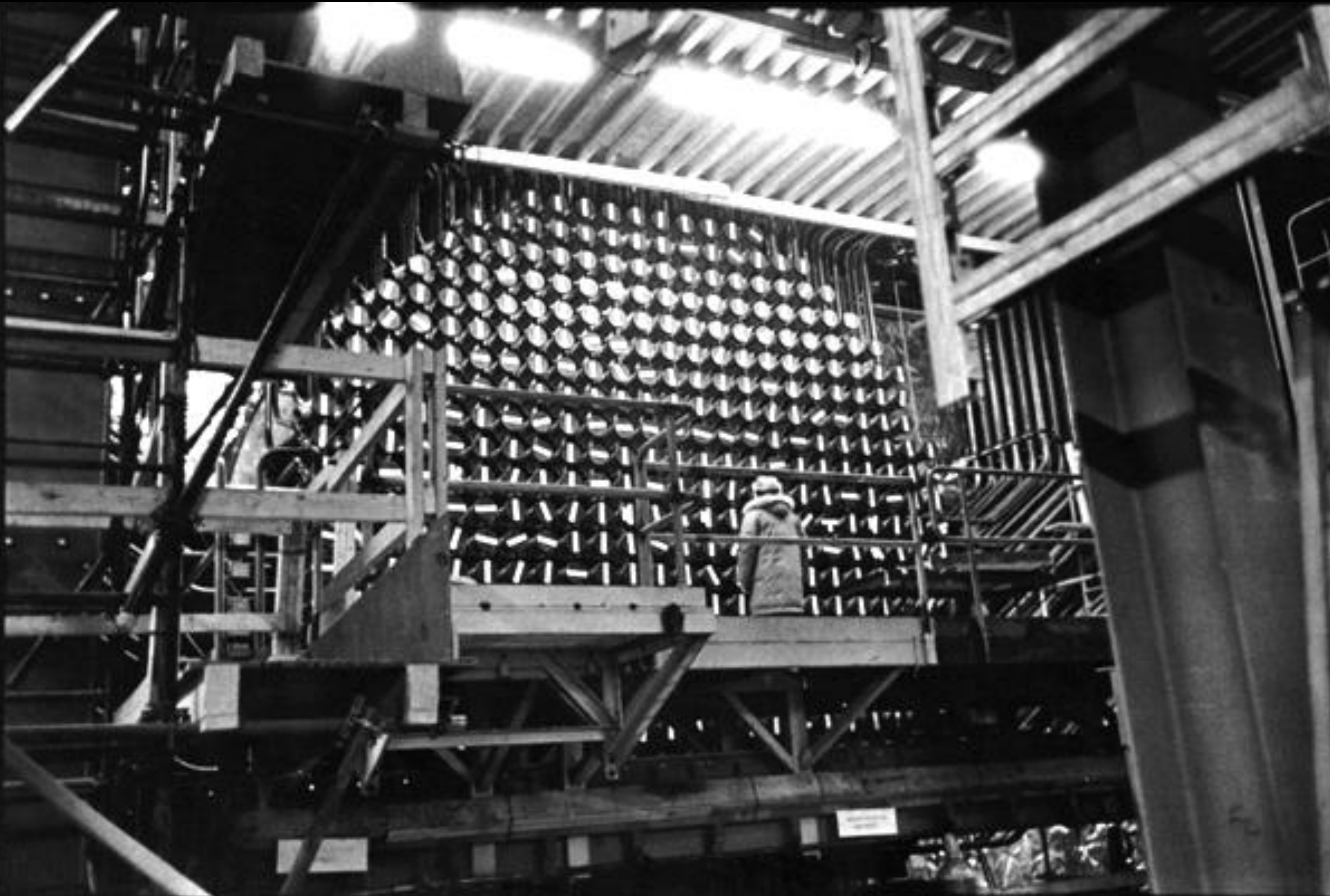
featuring the photographs of Robert Del Tredici

Canadian Coalition for Nuclear Responsibility
www.ccnr.org

Part 1.
The Nuclear Renaissance







INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO

UNEP

IPCC: Working Group III report

"Given costs relative to other supply options,

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of the electricity supply in 2005,

WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE UNEP

IPCC: Working Group III report

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of the electricity supply in 2005,

2.7 % of total energy

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

can have an 18% share of the total

electricity supply in 2030

3 % of total energy

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

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"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

can have an 18% share of the total

electricity supply in 2030

3 % of total energy

but **safety, weapons proliferation**

and waste remain as constraints"

Prognos Institute Report (Switzerland, 2010)

- The world-wide renaissance of nuclear power that has so often been predicted will not take place in the next few decades. Nuclear energy will be on the decline till the year 2030, and will continue to decline in importance globally.

WIEN INTERNATIONAL , January 10, 2010

Federal Energy Regulatory Commission (FERC, US, 2009)

- The new chairman of the Federal Energy Regulatory Commission (FERC) said the U.S. doesn't need to build any new nuclear or coal-fired plants. It could make do with renewable energy and natural gas.

Wall Street Journal, April 27, 2009

Fortune Magazine (US 2009)

- Don't expect more than three new nuclear plants to be built in the next 10 years, experts at a session on nukes at Fortune's *Brainstorm: Green* conference agree

Fortune Magazine, April 22 2009

Key Points

1. *Nuclear Power cannot solve the problem of greenhouse gas emissions.*
2. *Nuclear expansion exacerbates the problem of weapons proliferation.*
3. *Nuclear Renaissance: not happening.*

LESSON 1

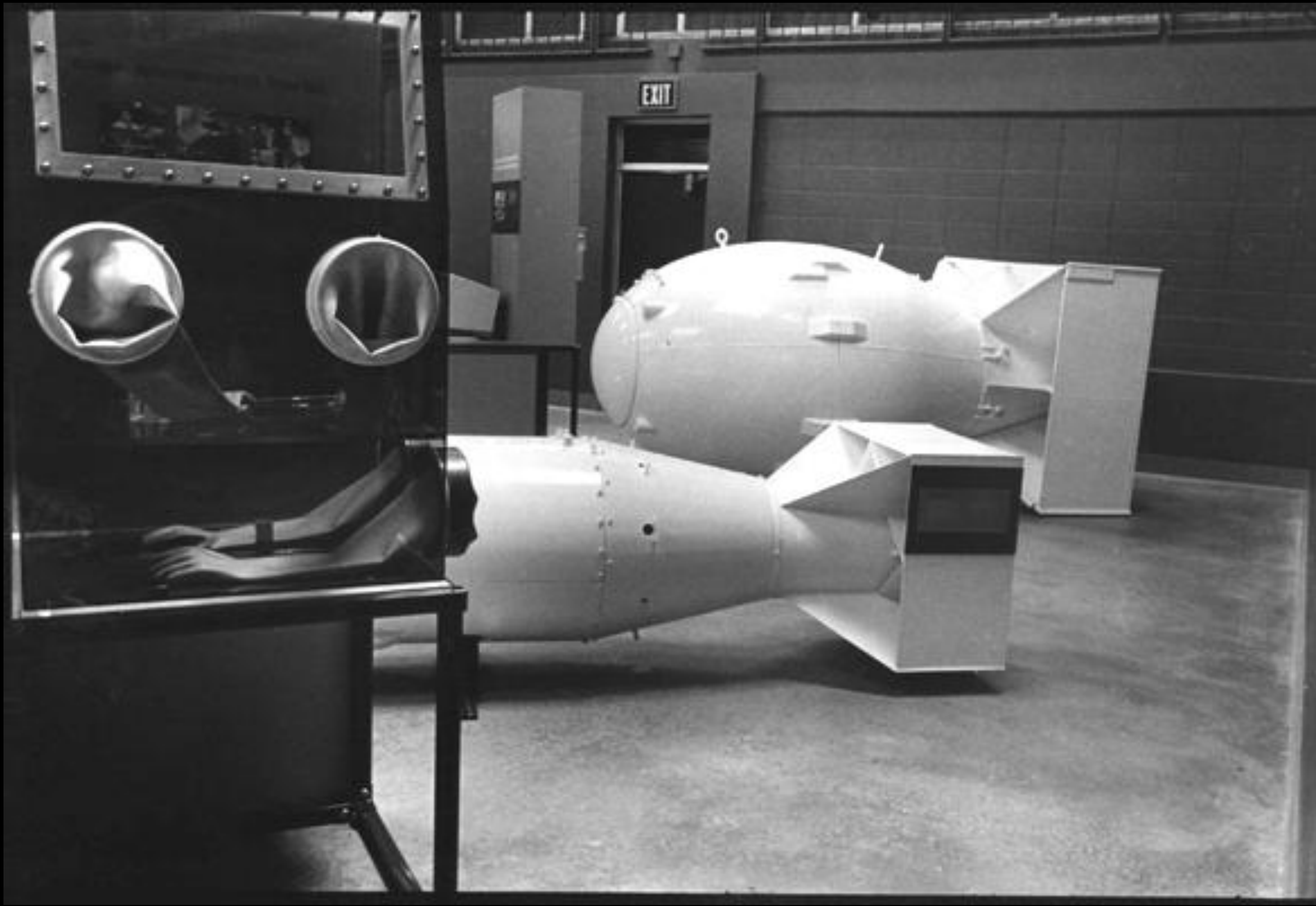
The problems posed by

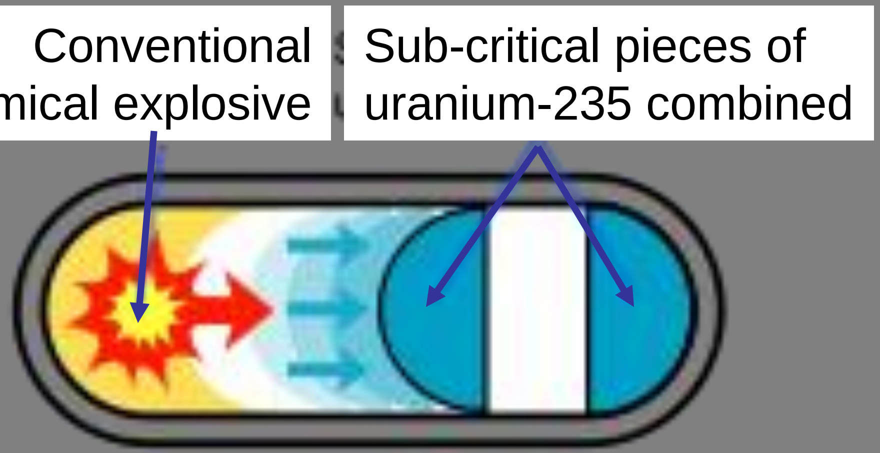
a nuclear renaissance

far exceed its benefits.

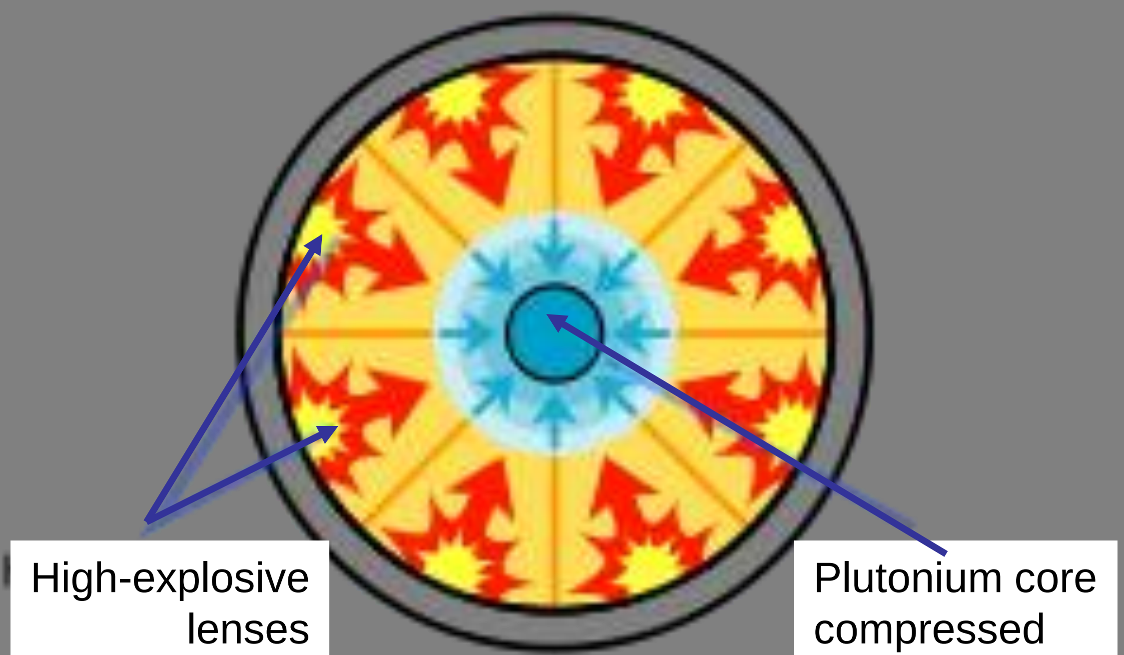
Part 2.
The Spread of
Nuclear Weapons


КУРЧАТОВ


EXIT

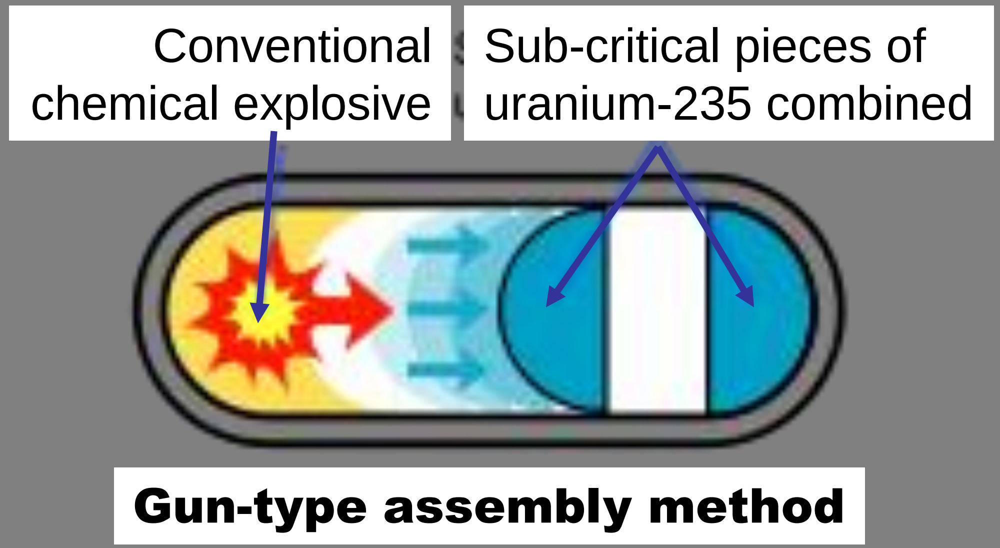


Gun-type assembly method

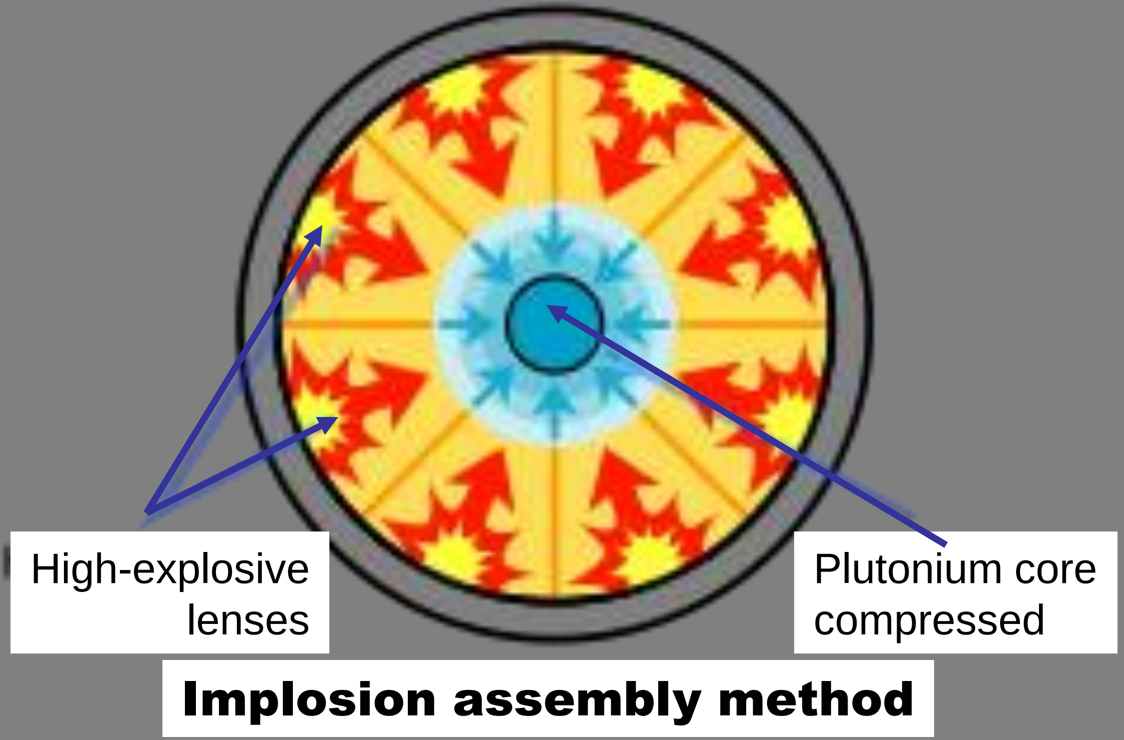


Implosion assembly method

Uses Highly Enriched Uranium



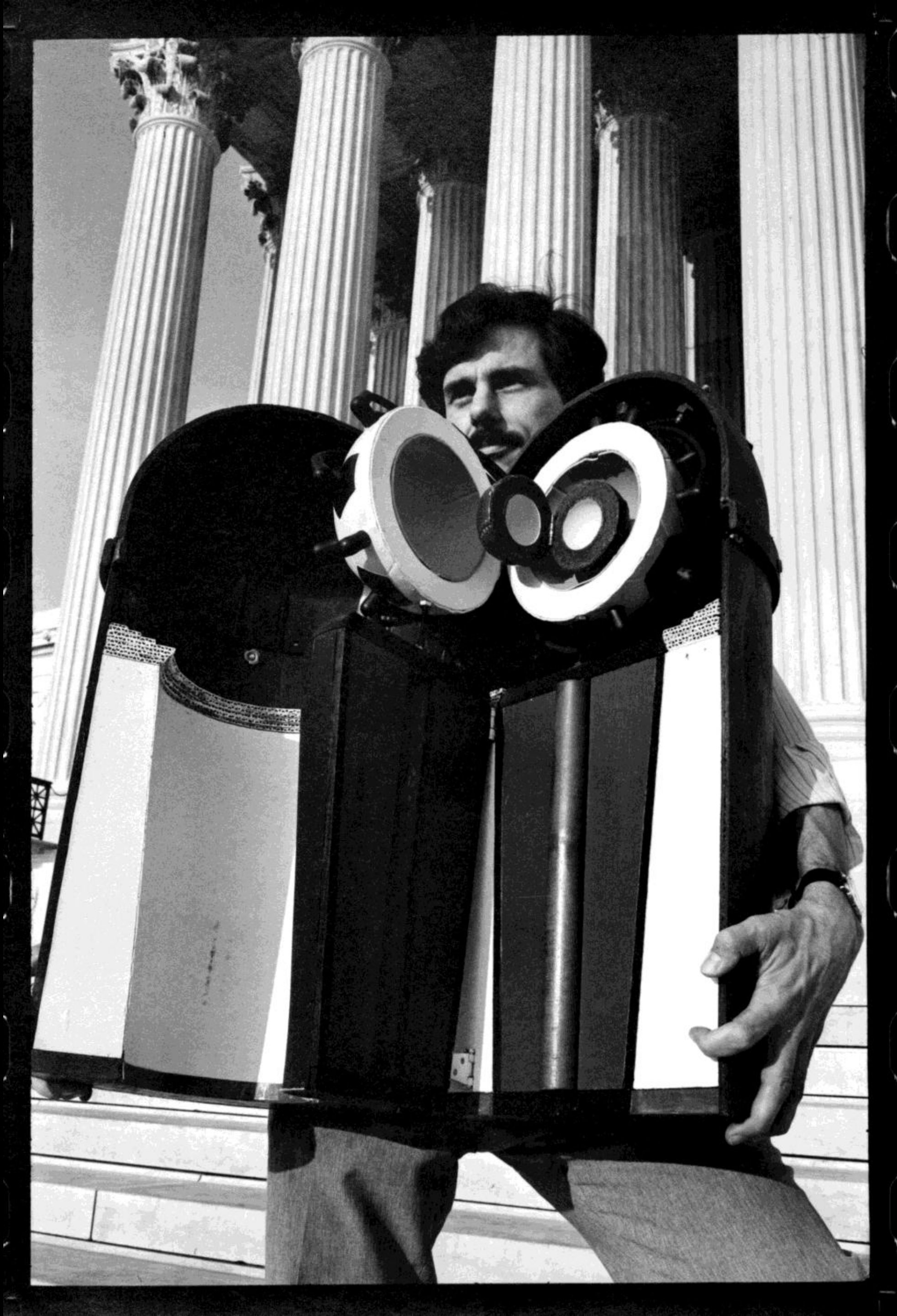
Uses Any Kind of Plutonium



When an atom of uranium-238 absorbs a neutron. . .

When an atom of uranium-238 absorbs a neutron. . .

. . . it is transformed into an atom of plutonium-239



On 15 November 1945 the U.S., U.K. and Canada issued a Joint Declaration with 3 prophetic insights.

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2. "no system of safeguards will of itself provide an effective guarantee against the production of atomic weapons";

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1. nuclear weapons provide "a means of destruction hitherto unknown, against which there can be no adequate military defence";

2. "no system of safeguards will of itself provide an effective guarantee against the production of atomic weapons";

3. atom bombs are weapons "in the employment of which no single nation can, in fact, have a monopoly."

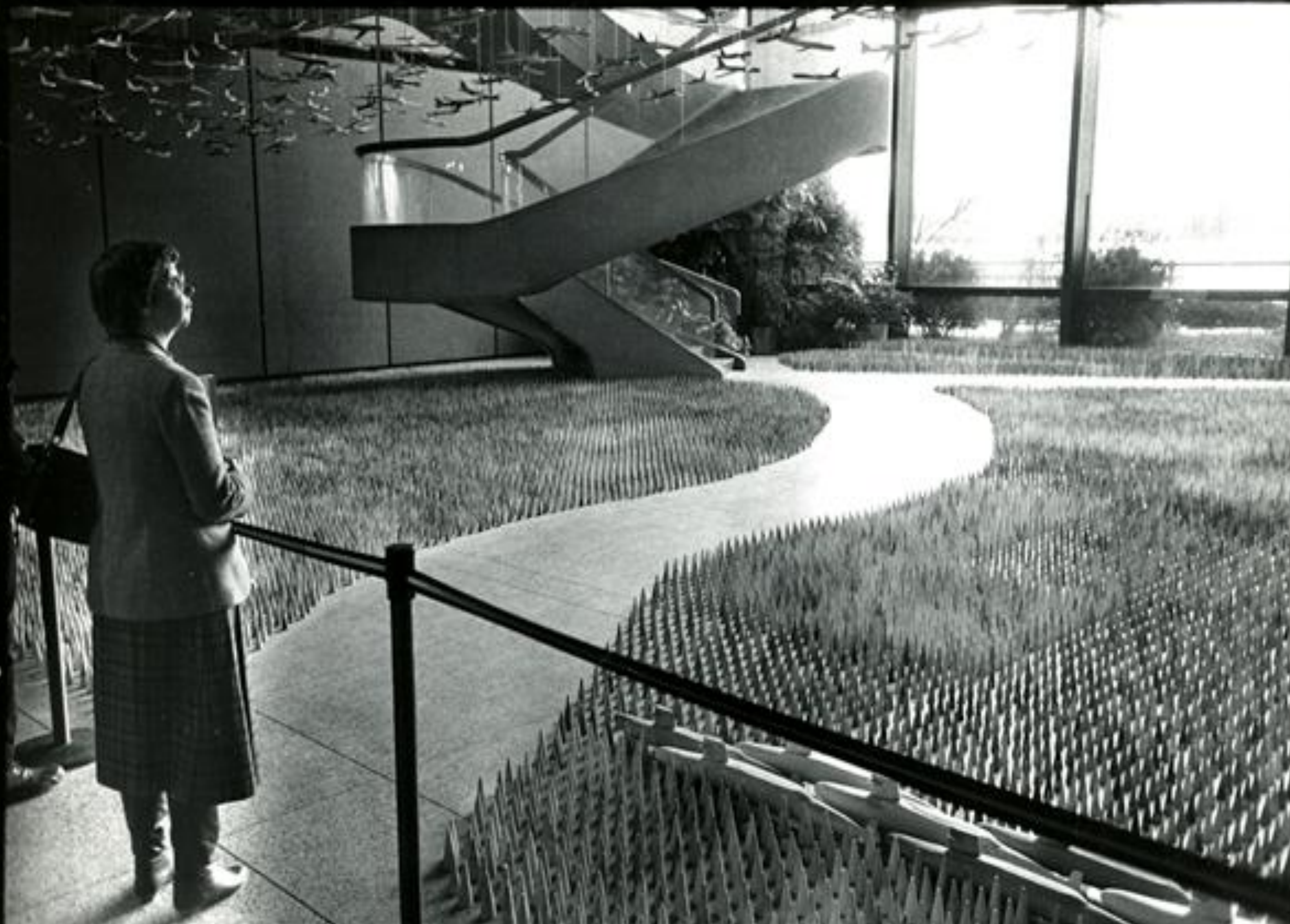
The 1945 Joint Declaration urged the United Nations to find a way of "entirely eliminating the use of atomic energy for destructive purposes and promoting its use for industrial and humanitarian purposes."

Acheson-Lilienthal Report (U.S. 1946)

. . . the development of atomic energy for peaceful purposes and . . . for bombs are, in much of their course, interchangeable and

interdependent.

We have concluded unanimously that there is no prospect for security against atomic warfare in a system of international agreements to outlaw such weapons controlled only by a system which relies on inspection and similar police-like methods.



Non-Proliferation Treaty (1968)
Preamble

Affirming the principle that the benefits of peaceful applications of nuclear technology, including . . . nuclear explosive devices should be available for peaceful purposes to all Parties of the Treaty, whether nuclear-weapon or non-nuclear weapon States . . .

Non-Proliferation Treaty (1968)
Article V

Each party to the Treaty undertakes . . . to ensure that . . . peaceful applications of nuclear explosions will be made available to non-nuclear-weapon States . . . and that the charge to such Parties for the explosive devices used will be as low as possible . . .

Key Points

1. *All nuclear weapons need a HEU (highly enriched uranium) or plutonium explosive.*

2. *All nuclear reactors need EU (enriched uranium) or plutonium as a fuel.*

3. *PNE (peaceful nuclear explosives) are allowed under the NPT but not accepted*

4. *Safeguards alone are not enough.*

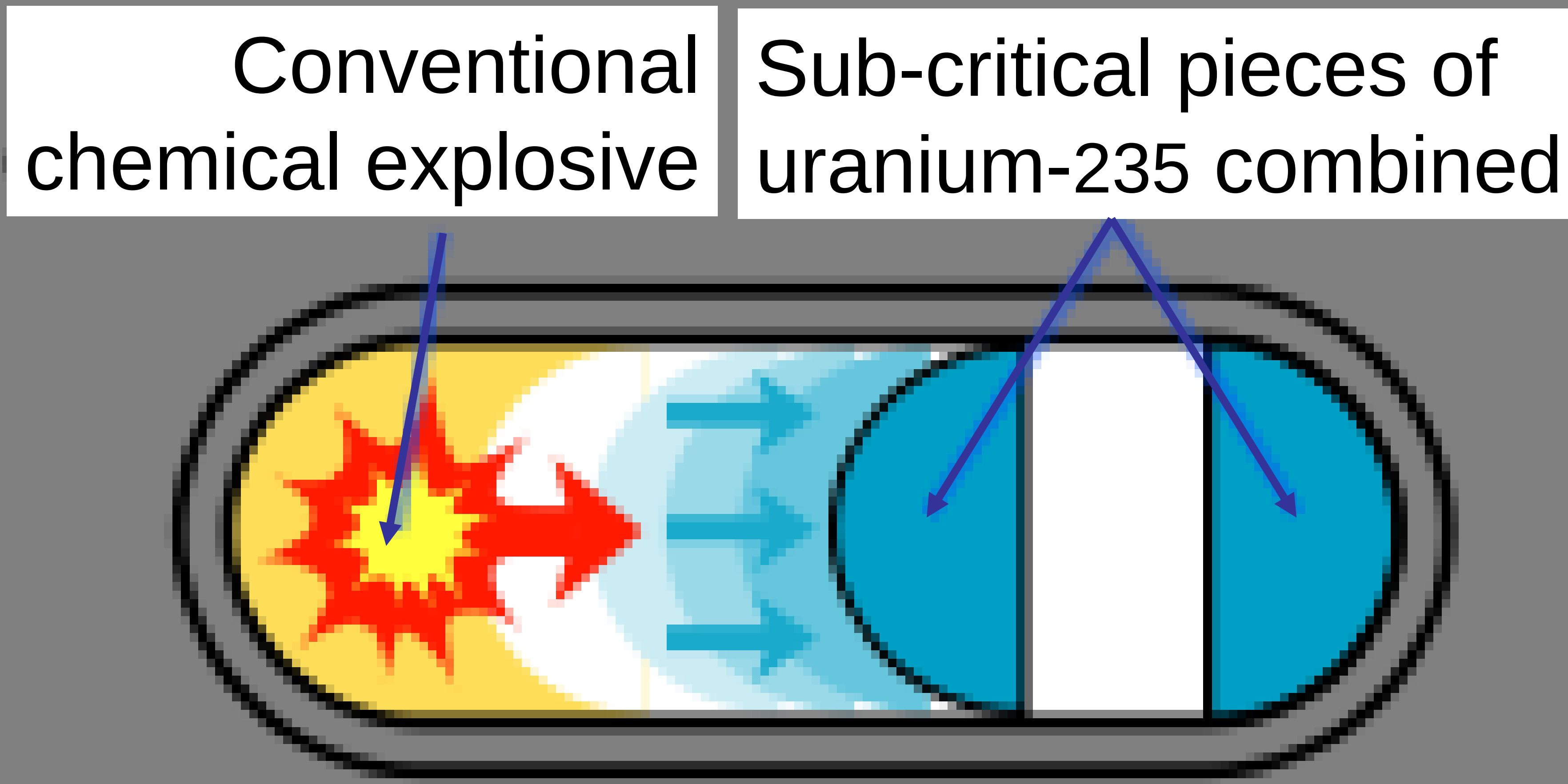
LESSON 2

A nuclear weapons free world is incompatible with stockpiles of peaceful nuclear explosives.

Part 2.
Nuclear Weapons Proliferation

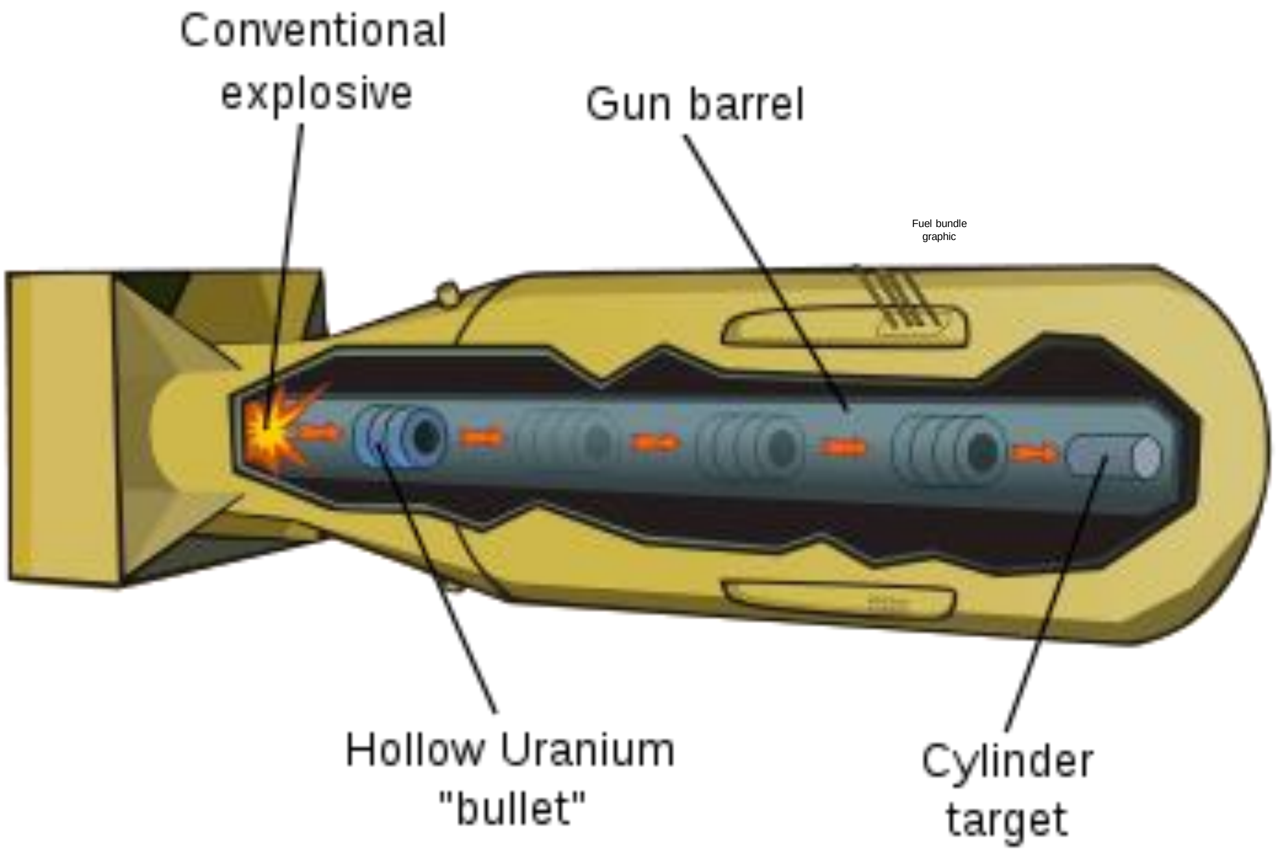
Paths to Proliferation . . .

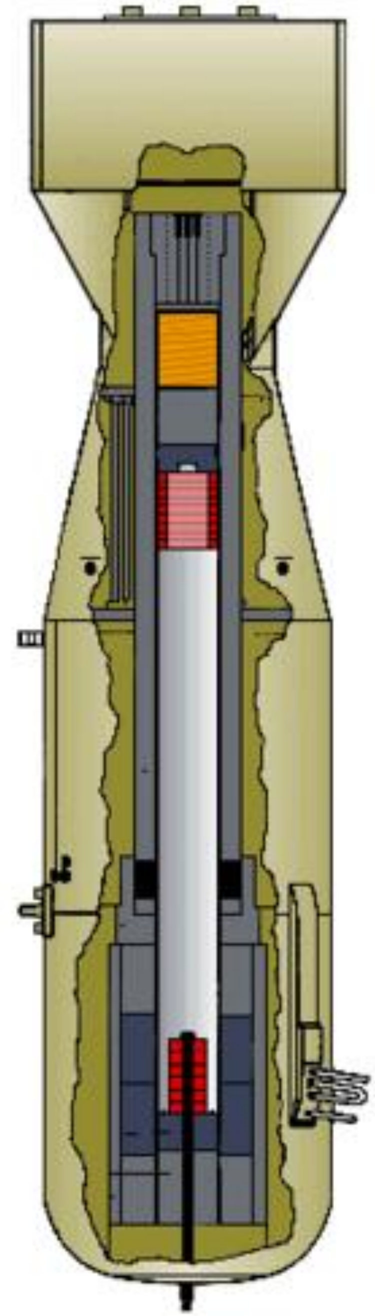
(a) Highly Enriched Uranium (HEU)



Gun-type assembly method

Fuel bundle graphic





Key Points

1. Gun-Type atomic bombs are relatively low-tech, but HEU is needed.

2. Obama´s April summit focused on HEU: “locking down” & eliminating civilian use.

3. Medical isotopes are made at Chalk River (NRU reactor) from HEU targets.

4. HEU can be denatured (just blend in DU).

LESSON

A nuclear weapons free world is incompatible with stockpiles of highly enriched uranium (HEU).

Paths to Proliferation . . .

(b) Depleted Uranium

DU = depleted uranium


6 cm

Key Points

1. *Depleted uranium (DU) has no significant commercial use – it is nuclear waste.*

2. *DU is mainly uranium-238; it is the raw material from which plutonium is made.*

3. *Metallic components of H-bombs are made from DU and contribute most of the radioactive fallout and most of the blast.*

4. *DU is not adequately safeguarded.*

LESSON

A nuclear weapons free world

is incompatible with stockpiles

of depleted uranium (DU) . . .

LESSON

A nuclear weapons free world

is incompatible with stockpiles

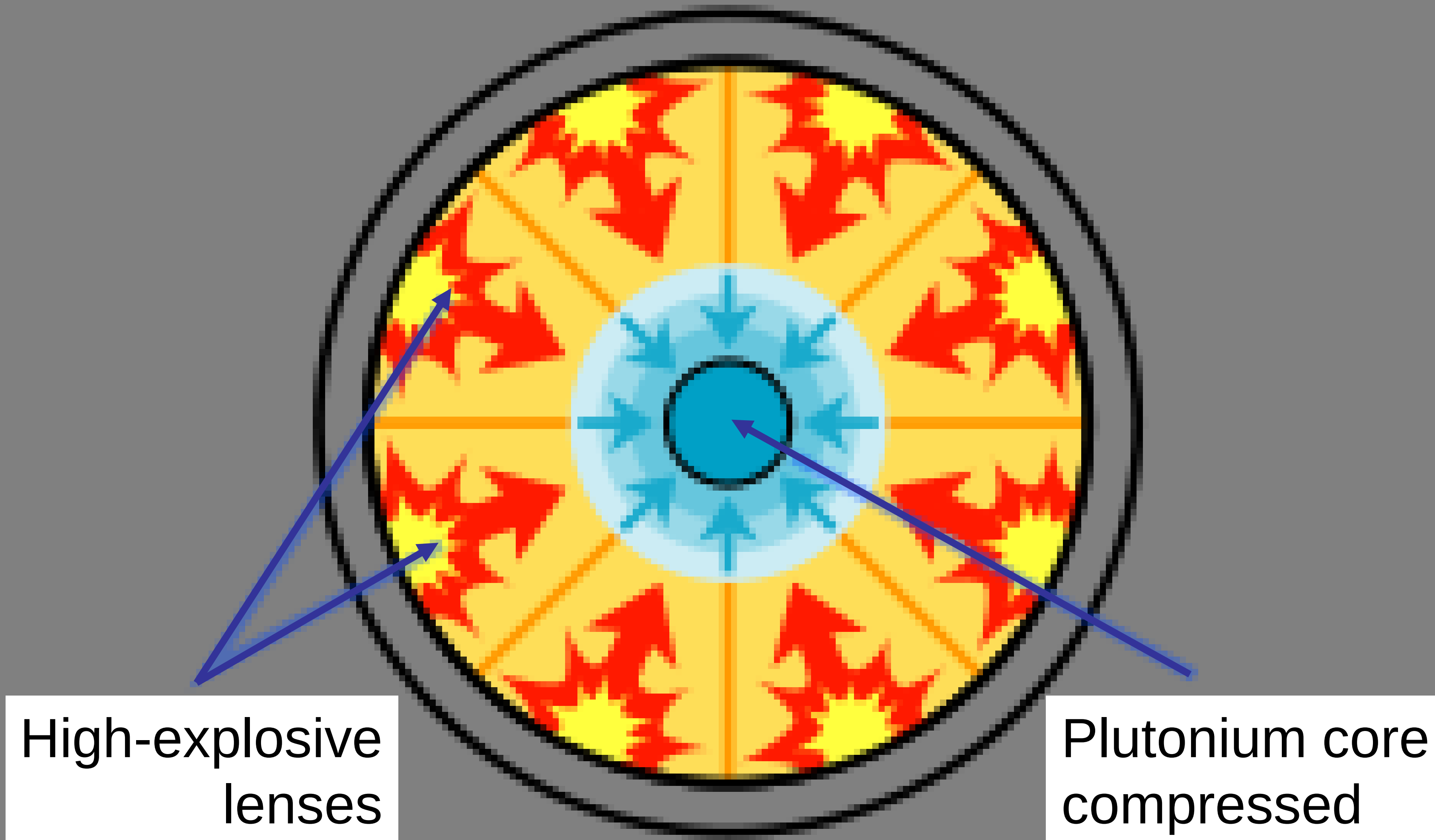
of depleted uranium (DU) . . .

as long as nuclear reactors exist.

Paths to Proliferation . . .

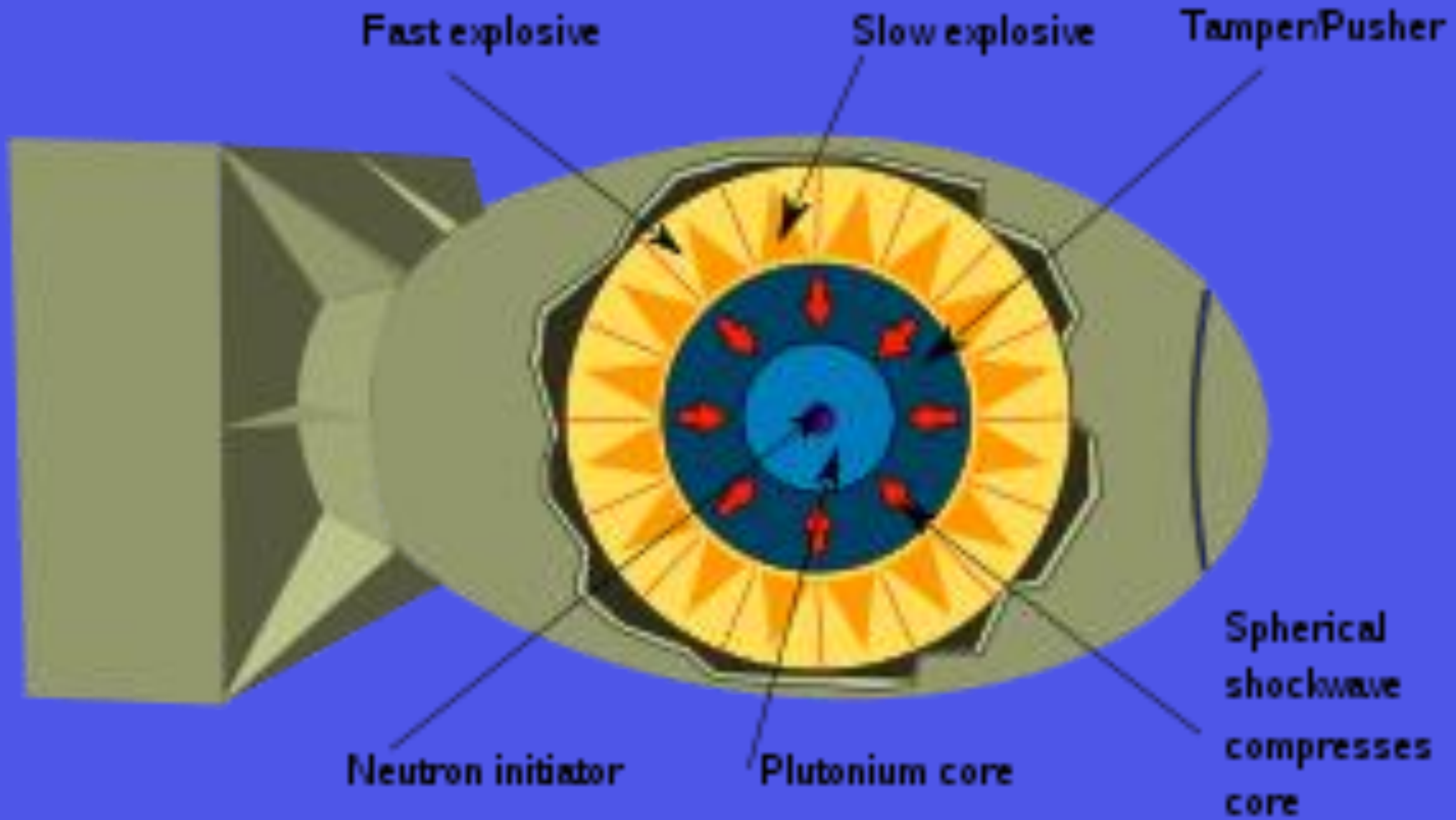
(c) Plutonium

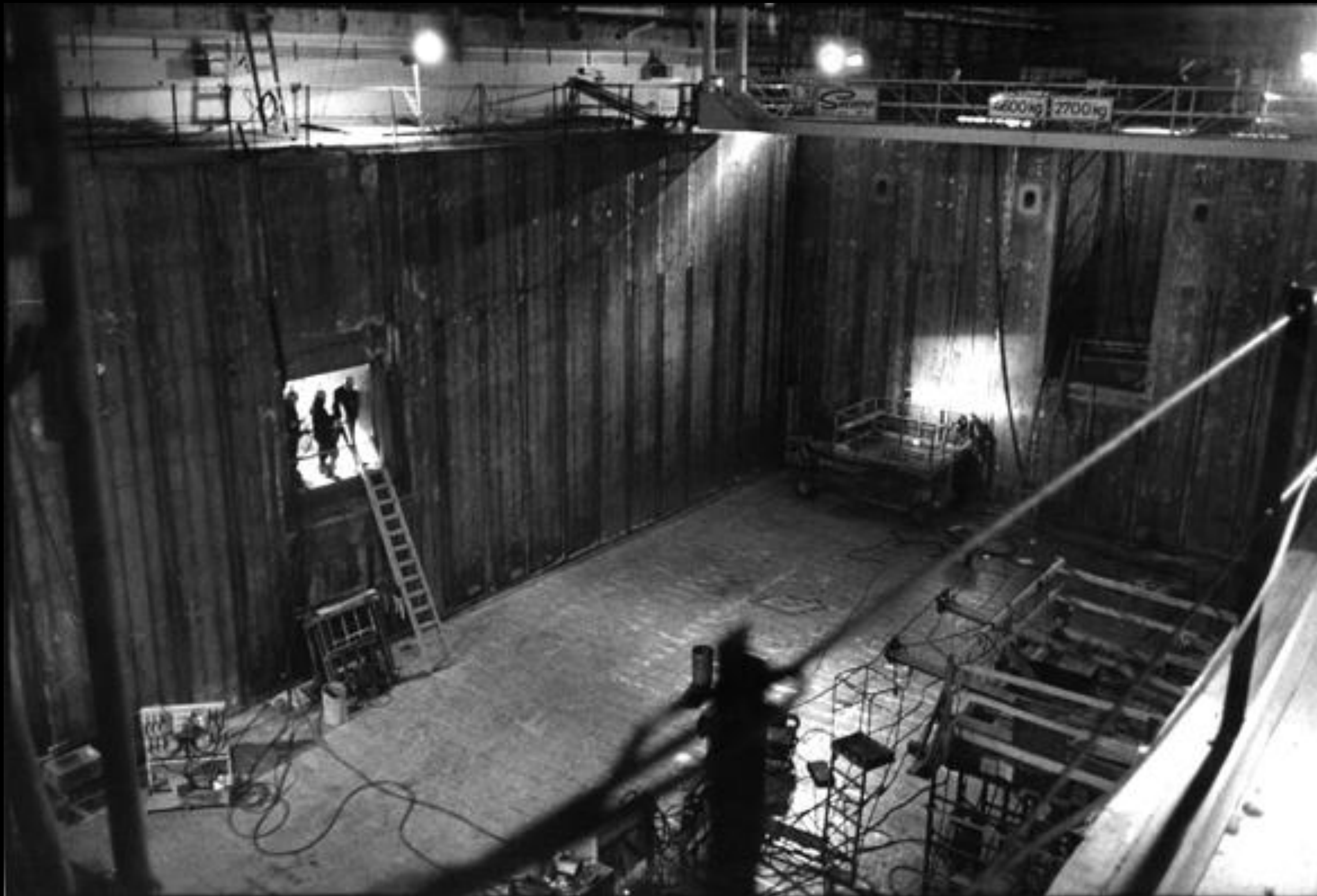

FAT MAN
TYPE
ATOMIC BOMB LIKE THE
BOMB EXPLODED OVER
JAPAN
IN WAR



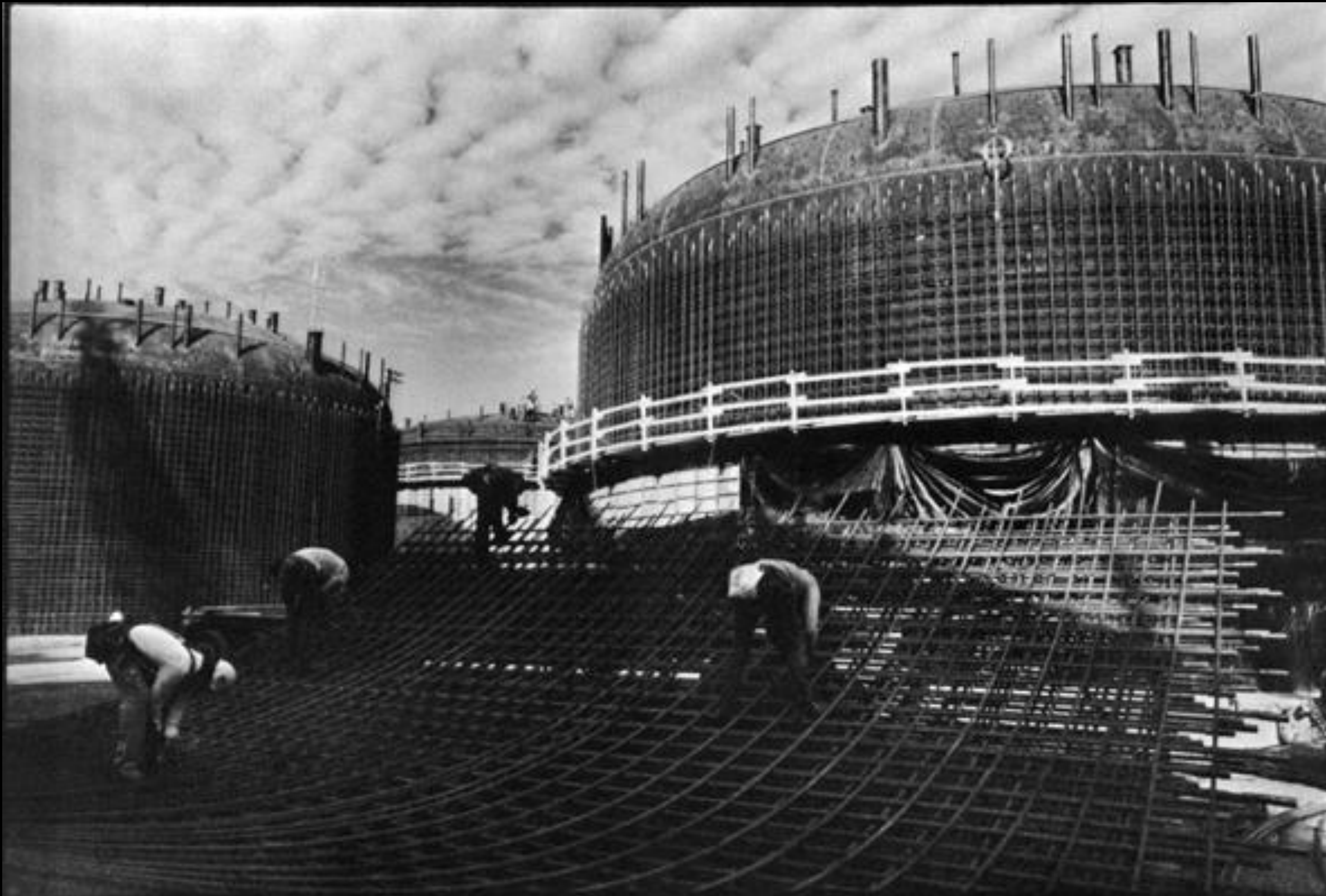
Implosion assembly method

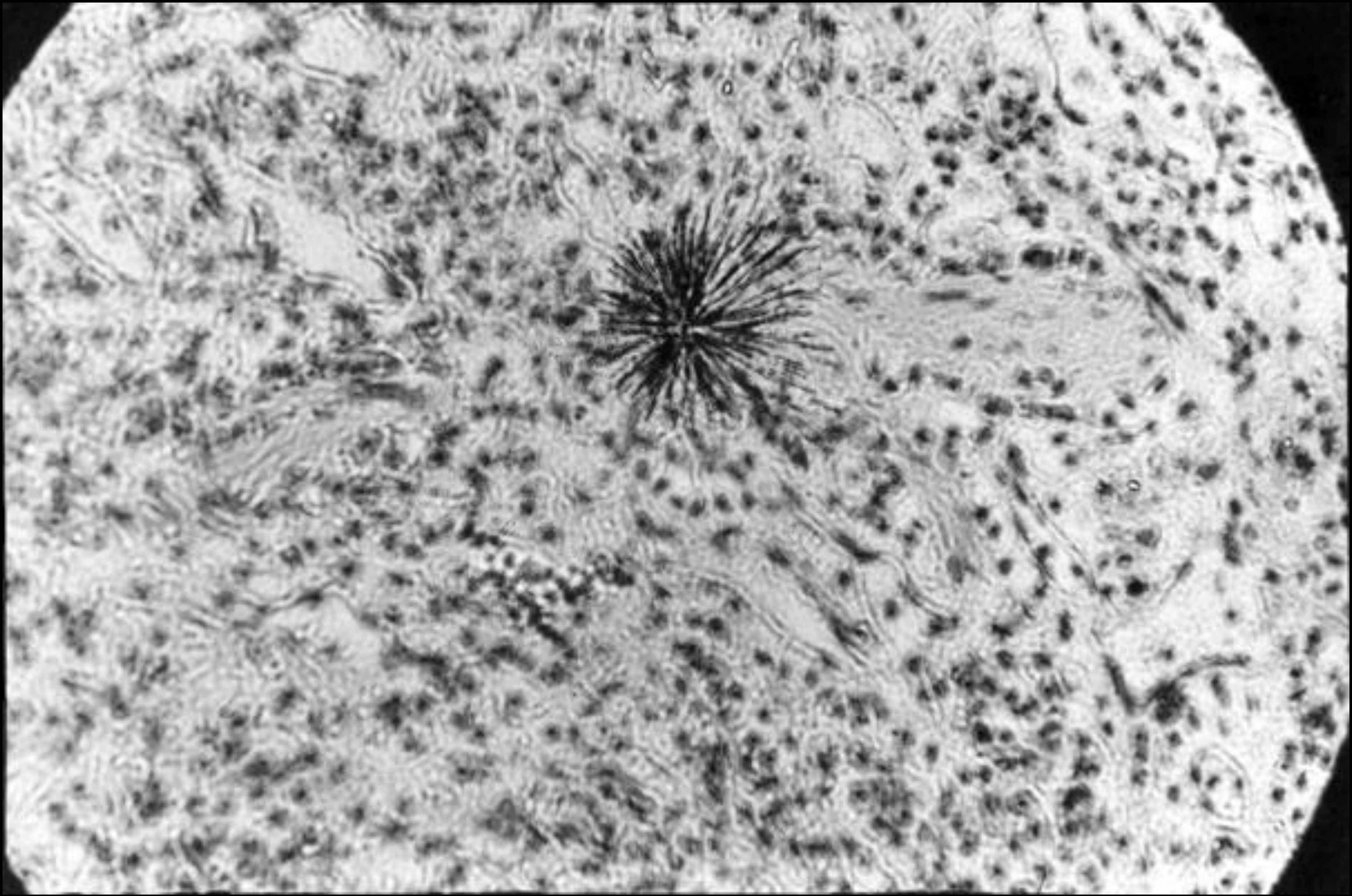
X-Ray motion picture frames
of implosion experiment

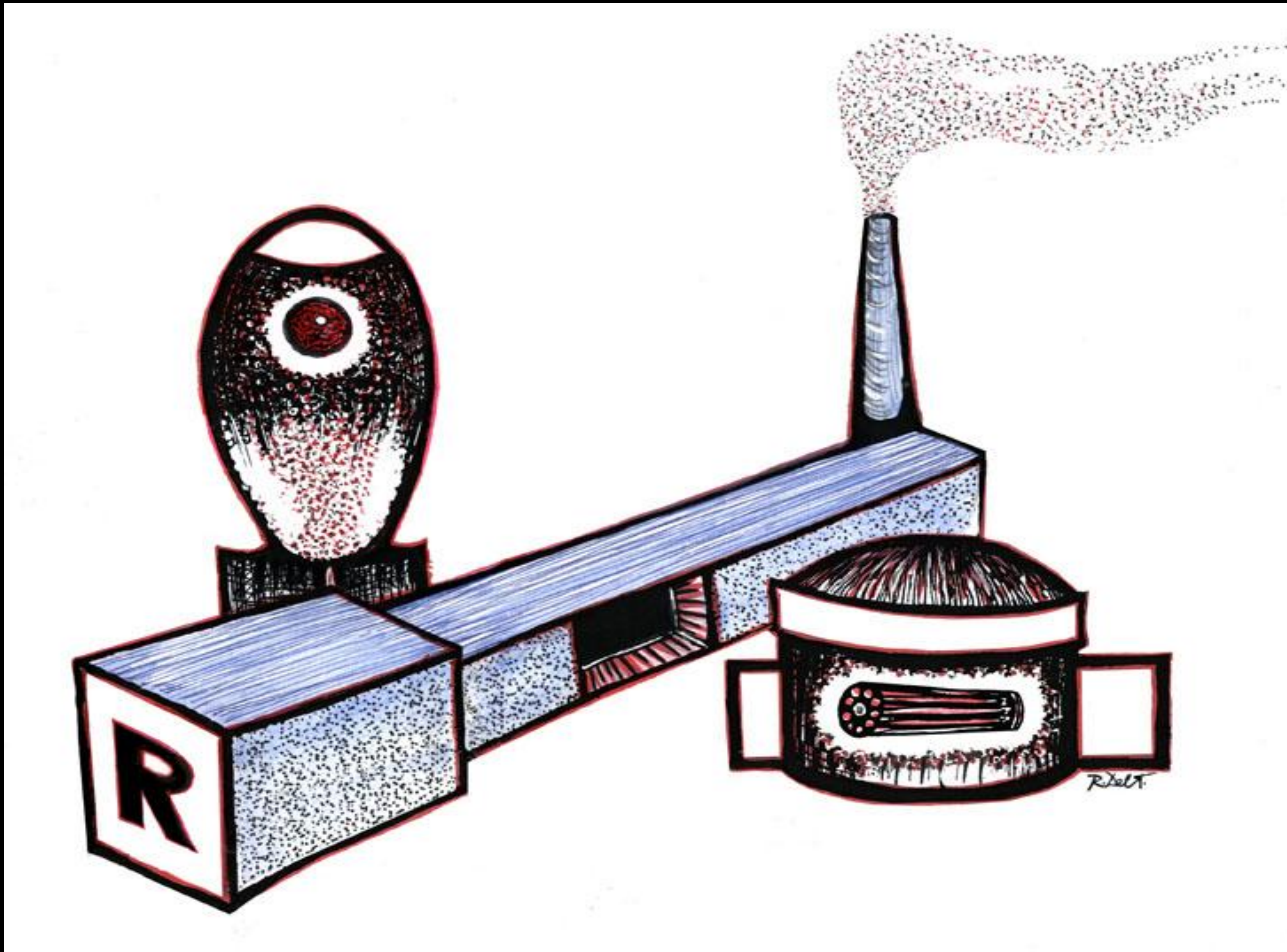

Fast explosive
Slow explosive
Tamper/Pusher
Spherical
shockwave
compresses
core
Neutron initiator
Plutonium core


2700 kg


DANGER






R

Key Points

1. *All kinds of reactor-produced plutonium can be used to make powerful bombs.*

2. *Plutonium cannot be denatured by any method known to science.*

3. *Thorium is not a nuclear fuel; it must be blended with plutonium to be used at all.*

4. *Thorium-232 is transformed into U-233 (uranium-233) -- excellent bomb material.*

LESSON

A nuclear weapons free world

is incompatible with stockpiles

of separated plutonium . . .

LESSON

A nuclear weapons free world

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of separated plutonium . . .

. . . even as reactor fuel (MOX).

Final Thoughts

1. The NPT can be read to mean that producing HEU and plutonium are not peaceful uses of nuclear energy . . .

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1. The NPT can be read to mean that producing HEU and plutonium are not peaceful uses of nuclear energy . . .

. . . as we have done with PNEs.

Final Conclusion

A nuclear weapons free world is not sustainable in the context of a nuclear power renaissance . . .

Final Conclusion

A nuclear weapons free world is not sustainable in the context of a nuclear power renaissance . . .

. . . for without HEU, DU or MOX, there is no future for nuclear power.

The End

Canadian Coalition for Nuclear Responsibility

www.ccnr.org

un char de combat endommagé par des munitions à U.A.

Uranium
and its Dangers

featuring the photographs of Robert Del Tredici

Canadian Coalition for Nuclear Responsibility
www.ccnr.org


THE ZEEP REACTOR
LE RÉACTEUR ZEEP

La diffusion des armements nucléaires

les États-Unis

le Canada

l'Angleterre

(la France)

[la Russie]

l'Inde

le Pakistan

le Taiwan

l'Argentine

la Corée du Sud

[l'Israël]

THE ZEEP REACTOR

A nuclear chain reaction was first initiated in Canada on September 5, 1945, when the ZEEP reactor went into operation here at Chalk River. Originally part of an effort to produce plutonium for nuclear weapons, the reactor was designed by a team of Canadian, British and French scientists and engineers assembled in Montreal and in Ottawa in 1942-43 under the administration of the National Research Council. Named Zero Energy Experimental Pile because it was developed to produce only one watt of heat, the ZEEP reactor was used to provide data for the design of the powerful NRX (National Research Experimental) reactor. In 1952 the project was transferred from NRC to Atomic Energy of Canada Limited.

IONIZING RADIATION

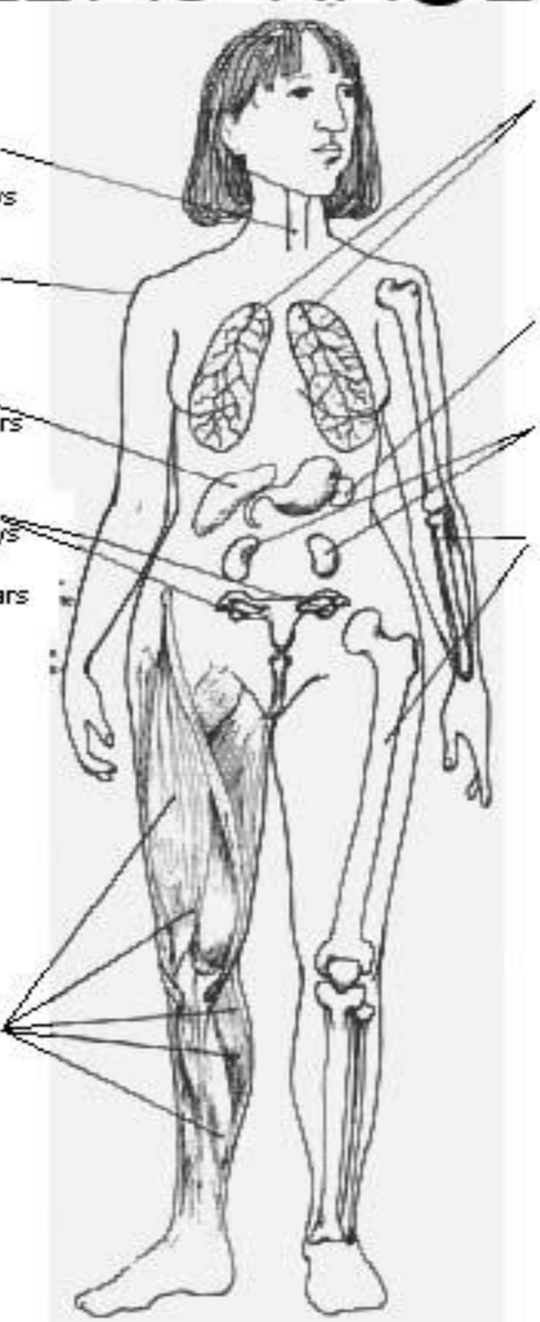
THYROID
iodine–131
beta (gamma) ; 8 days

SKIN
sulphur–35
beta ; 87 days

LIVER
cobalt–60
beta (gamma) ; 5 years

OVARIES
iodine–131
beta (gamma) ; 8 days
cobalt–60
beta (gamma) ; 5 years
krypton-85
gamma ; 10 years
ruthenium–106
gamma ; 1 year
zinc–65
gamma ; 245 days
barium–140
gamma ; 13 days
potassium–42
gamma ; 12 hours
cesium–137
gamma ; 30 years
plutonium–239
alpha ; 24 000 years

MUSCLE
potassium–42
gamma ; 12 hours
cesium–137
gamma ; 30 years

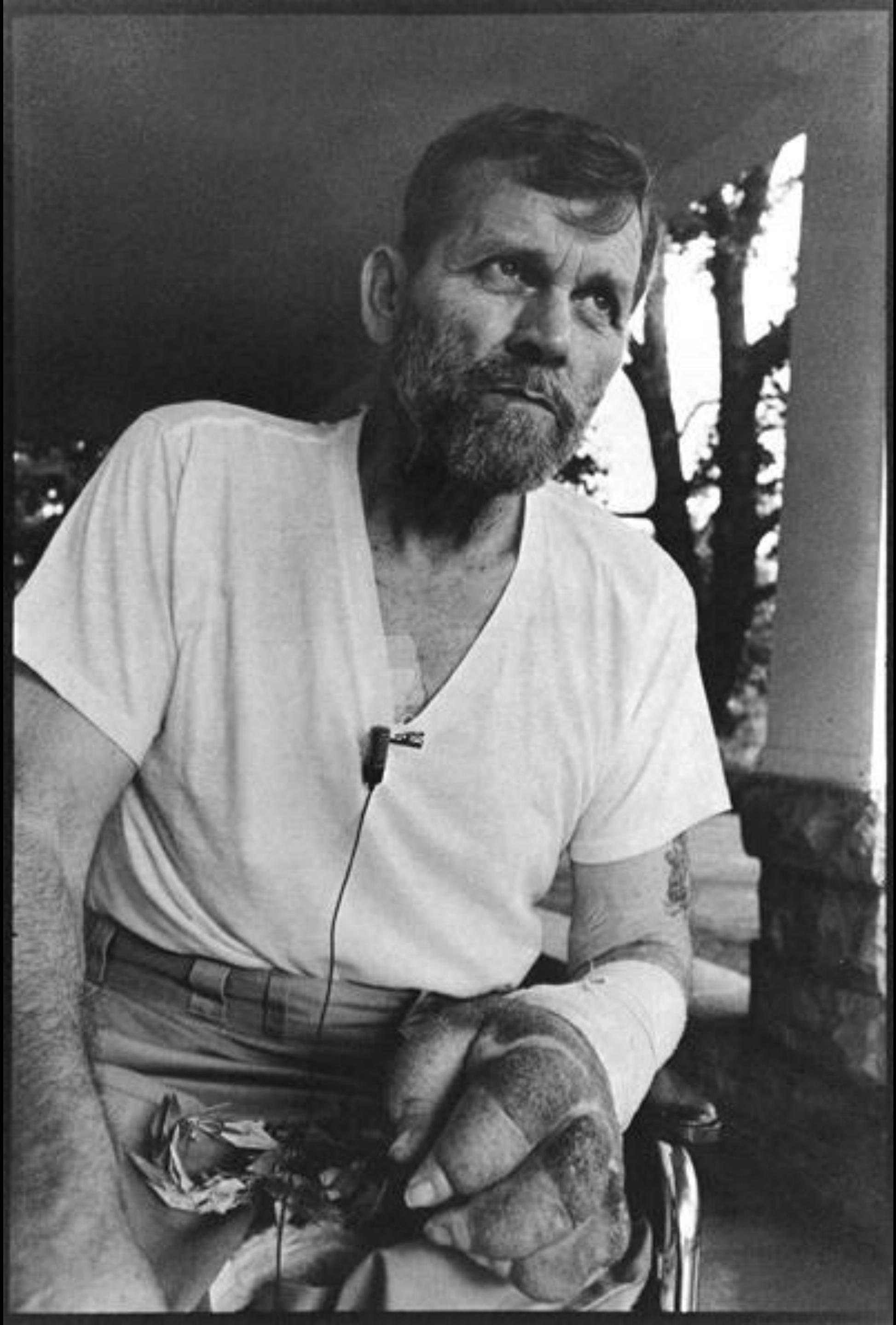


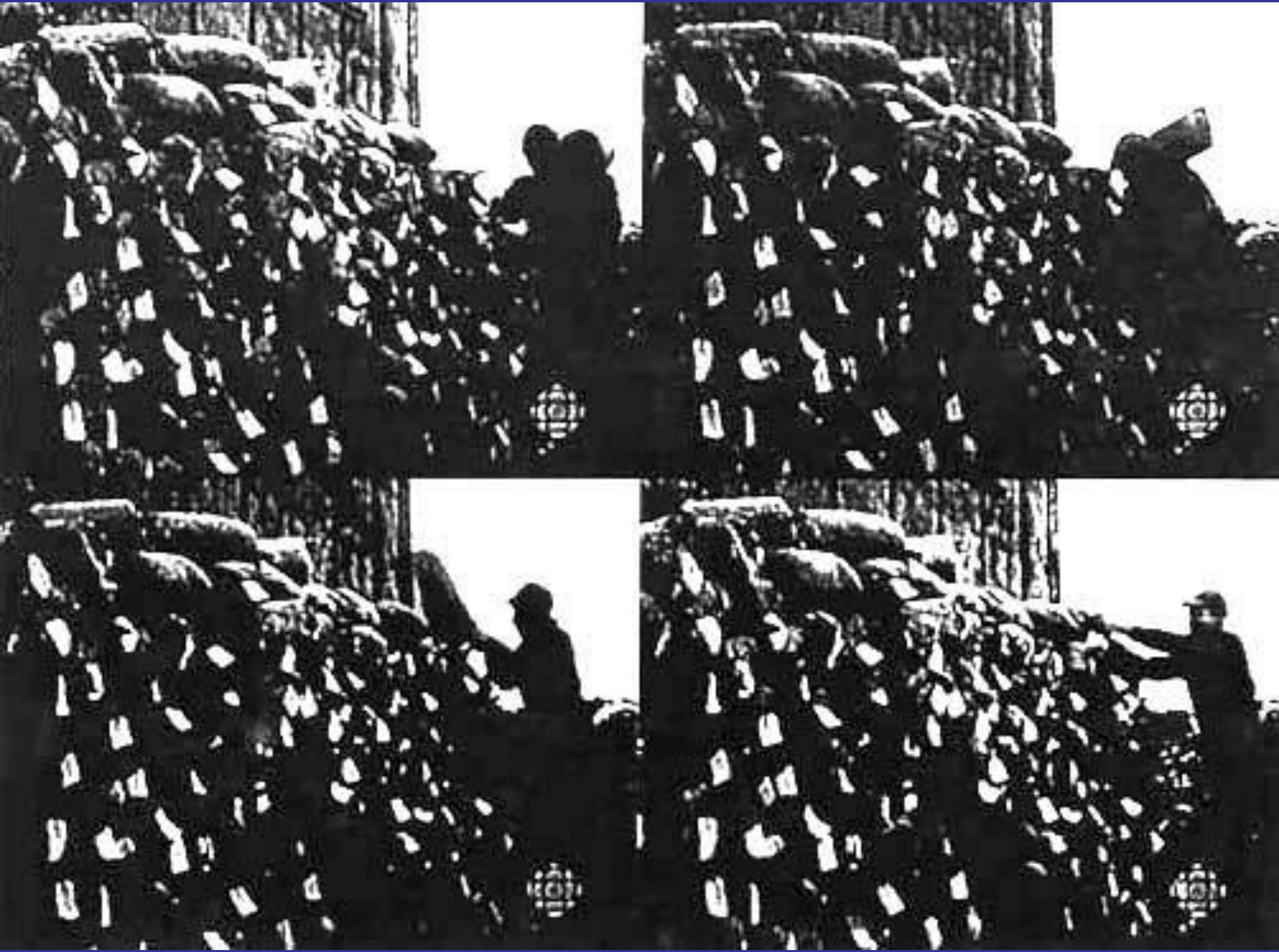
LUNGS
radon–222 (and whole body)
alpha ; 3,8 days
uranium–233 (et os)
alpha ; 162 000 years
plutonium–239 (and bone)
alpha ; 24 000 years

SPLEEN
polonium–210 (and whole body)
alpha ; 138 days

KIDNEYS
uranium–238 (and bone)
alpha ; 4 500 000 years
ruthenium–106
gamma (beta) ; 1 year

BONE
radium–226
alpha ; 1 620 years
zinc–65
gamma ; 245 days
strontium–90
beta ; 28 years
yttrium–90
beta ; 64 hours
promethiium–147
beta ; 2 years
barium–140
beta (gamma) ; 13 days
thorium–234
beta ; 24,1 days
phosphorus–32
beta ; 14 days
carbon–14 (and fat)
beta ; 5 600 years





Four Types of Atomic Radiation

- *Alpha*
- *Beta*
- *Gamma*
- *Neutron*

Four Types of Atomic Radiation

- *Alpha* 2 protons + 2 neutrons heavy particle
  (stopped by paper) *(pos. charge)*
- *Beta*
- *Gamma*
- *Neutron*

Four Types of Atomic Radiation

• *Alpha*	2 protons + 2 neutrons *(stopped by paper)*	heavy particle *(pos. charge)*
• *Beta*	1 high-energy electron *(stopped by aluminum)*	lightest particle *(neg. charge)*
• *Gamma*		
• *Neutron*		

Four Types of Atomic Radiation

• *Alpha*	2 protons + 2 neutrons *(stopped by paper)*	heavy particle *(pos. charge)*
• *Beta*	1 high-energy electron *(stopped by aluminum)*	lightest particle *(neg. charge)*
• *Gamma*	1 high-frequency photon *(stopped by lead)*	E-M wave *(no charge)*
• *Neutron*		

Four Types of Atomic Radiation

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• *Gamma*	1 high-frequency photon *(stopped by lead)*	E-M wave *(no charge)*
• *Neutron*	1 high-energy particle *(stopped by water)*	medium particle *(no charge)*

Four Types of Atomic Radiation

• *Alpha*	2 protons + 2 neutrons *(stopped by paper)*	heavy particle *(pos. charge)*
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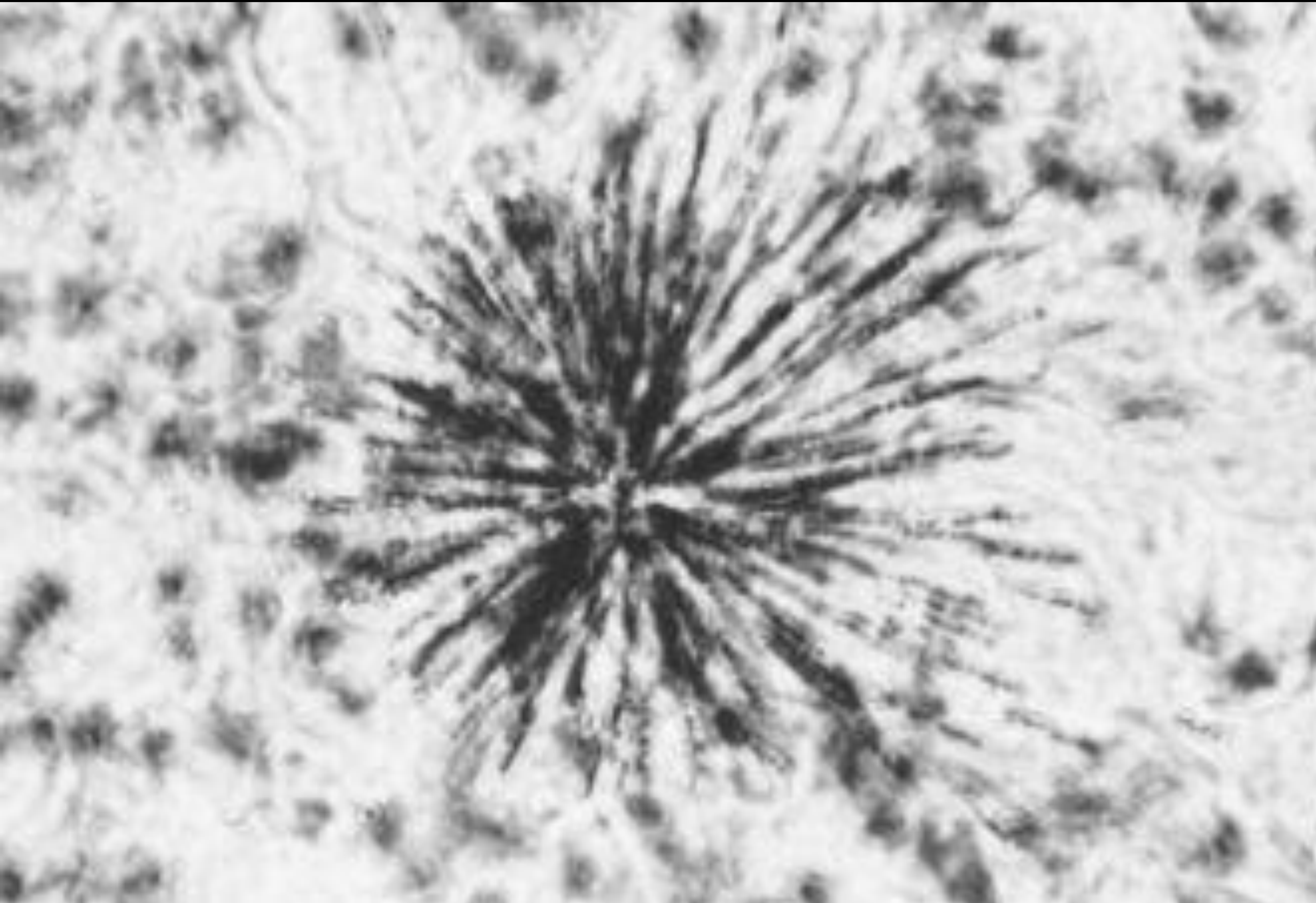
(Note: X-Rays are similar to gamma rays but are less energetic)

l'uranium appauvri est utilisé aussi pour des bombes nucléaires

on fabrique des cylindres creux d’uranium appauvri



BCMA Report (1980)

- Summary of doubling dose estimates for lung cancer in uranium miners:

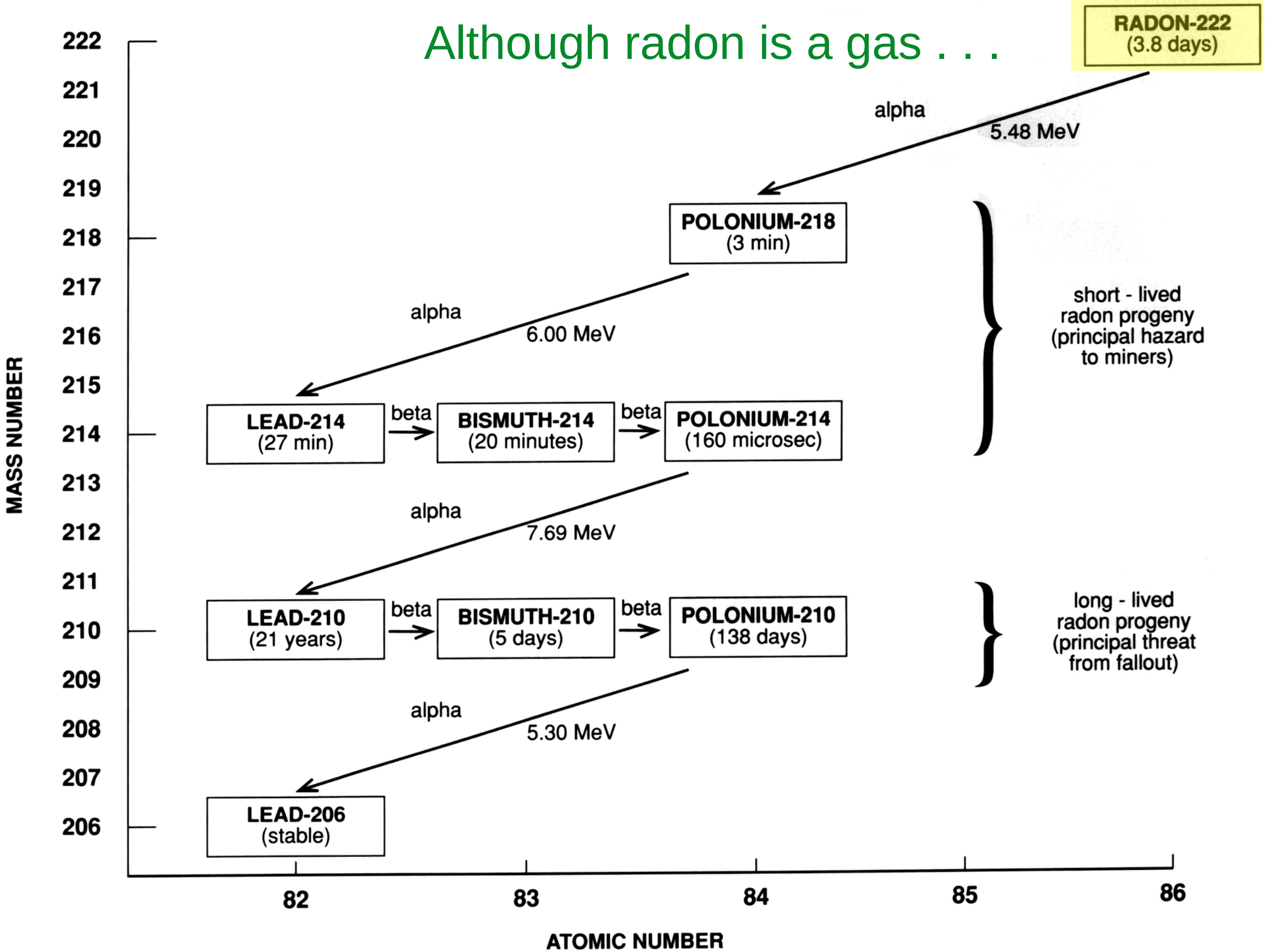
– Archer (1967)		120 WLM
– Hewitt (1980)	Ontario	40-50 WLM
–	Newfoundland	50 WLM
– Sevc (1976).		~50 WLM
– US EPA (1980).		~40 WLM
– Ellett (1980).		40 WLM
– BEIR-II (1972)		34 WLM
– BCMA (1980)	NIOSH & Sevc	19-20 WLM
– BEIR-III (1980).		12-17 WLM
– Axelson (1980)		2 WLM

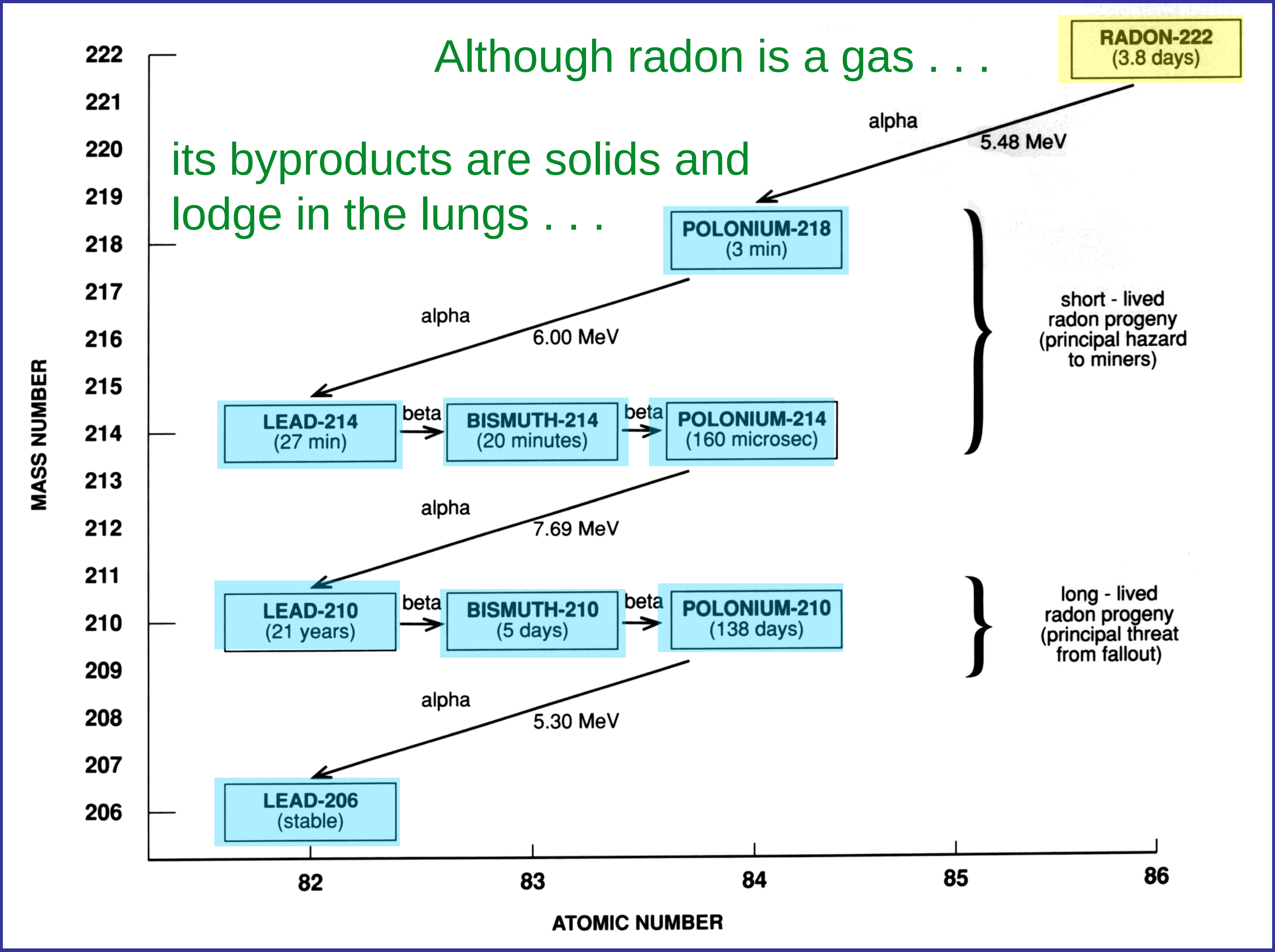
- The lifetime incidence of lung cancer in males is 52.5 per thousand, The doubling dose from exposure to radon would be 40 WLM or less.

- Thus, there is a risk of 12.5 lung cancers per 1000 workers per WLM. The risk would be 4 times as high at today's permissible exposures.

- Compare this with the risk of accidental death in “safe” industries of 0.1 accidental deaths per million workers per year!

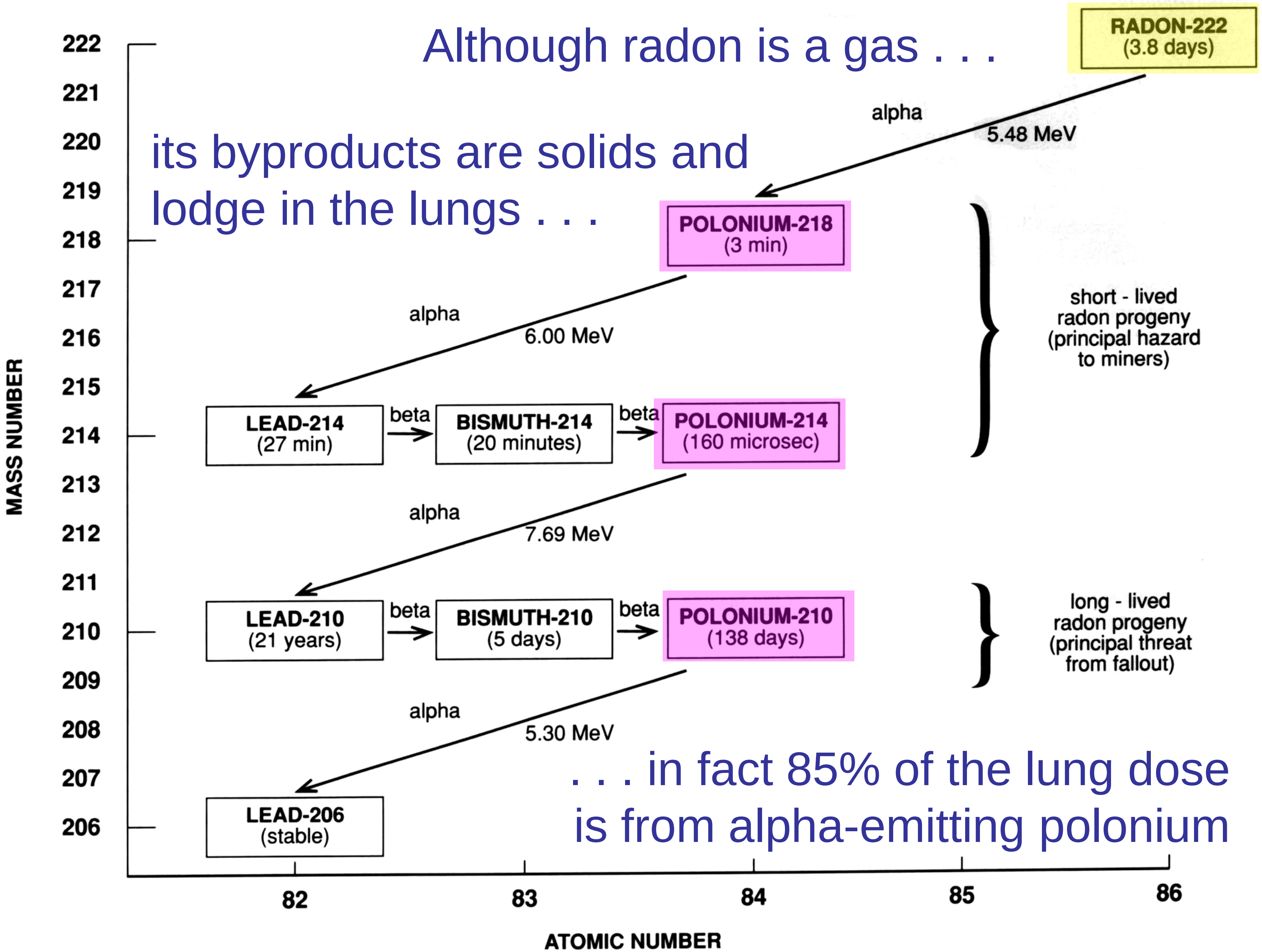
Although radon is a gas . . .



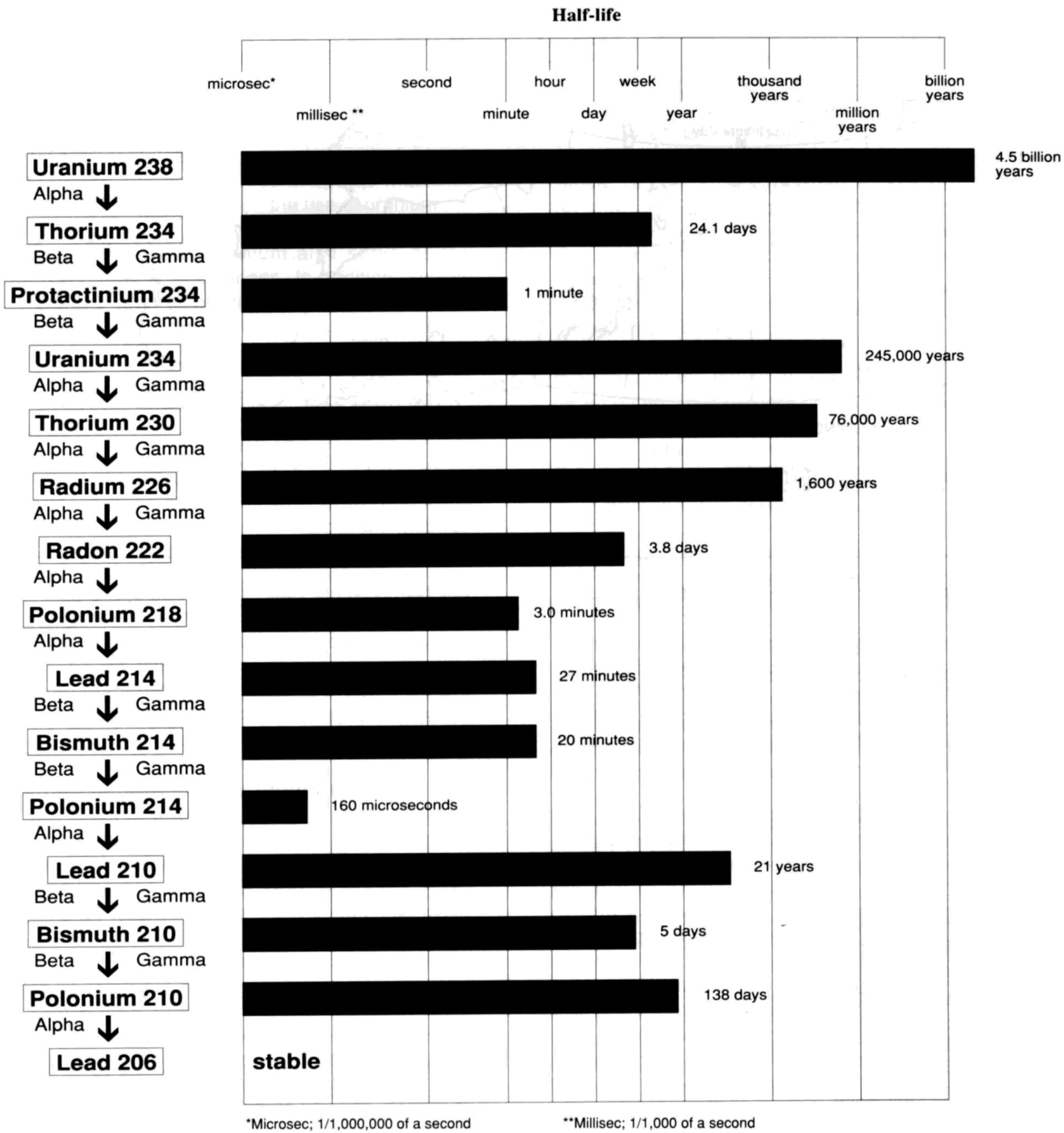

Although radon is a gas . . .
its byproducts are solids and
lodge in the lungs . . .
RADON-222
(3.8 days)
alpha
5.48 MeV
POLONIUM-218
(3 min)
alpha
6.00 MeV
LEAD-214
(27 min)
beta
BISMUTH-214
(20 minutes)
beta
POLONIUM-214
(160 microsec)
short - lived
radon progeny
(principal hazard
to miners)
alpha
7.69 MeV
LEAD-210
(21 years)
beta
BISMUTH-210
(5 days)
beta
POLONIUM-210
(138 days)
long - lived
radon progeny
(principal threat
from fallout)
alpha
5.30 MeV
LEAD-206
(stable)
MASS NUMBER
222
221
220
219
218
217
216
215
214
213
212
211
210
209
208
207
206
ATOMIC NUMBER
82
83
84
85
86

Although radon is a gas . . .

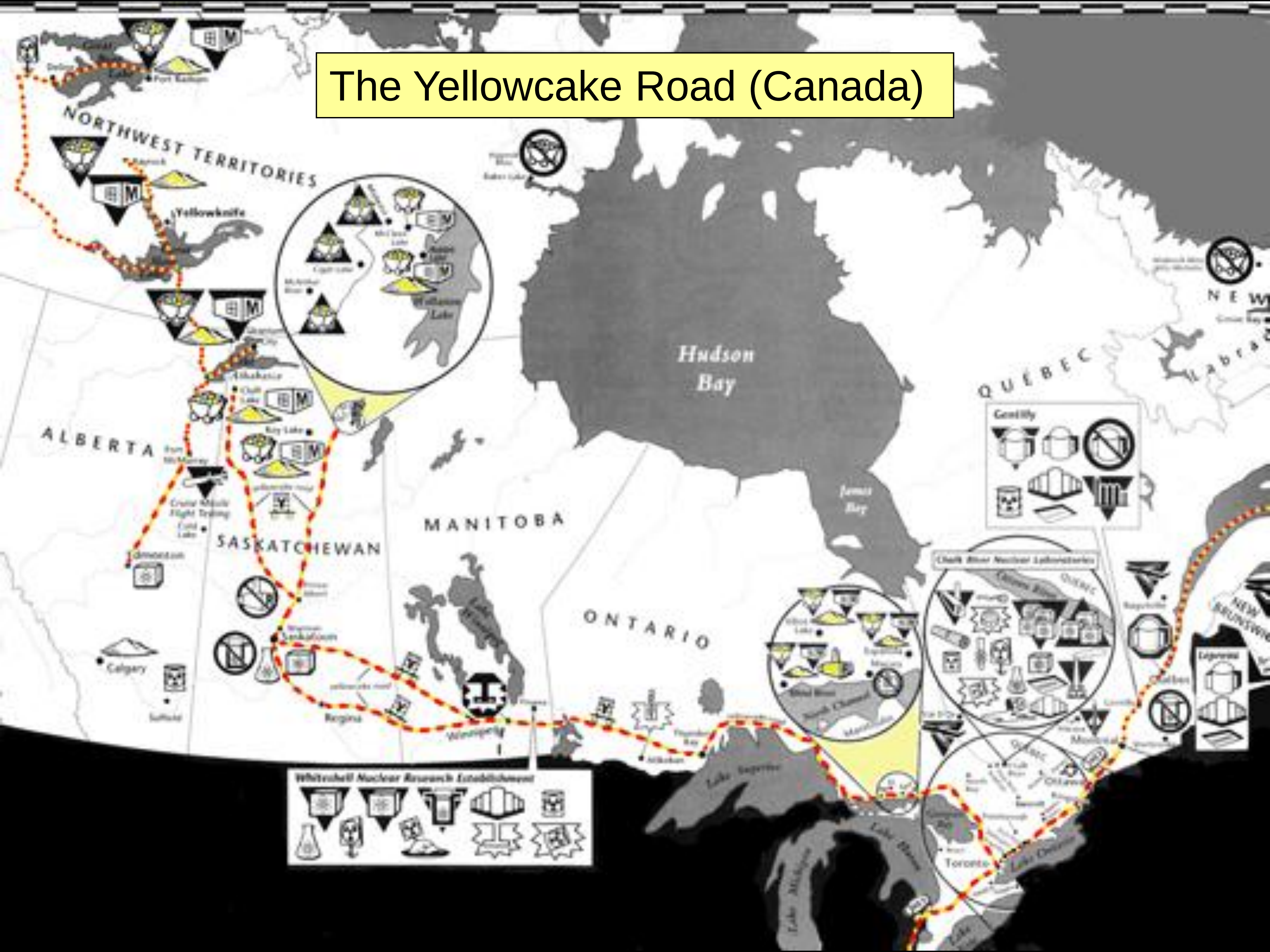
its byproducts are solids and lodge in the lungs . . .

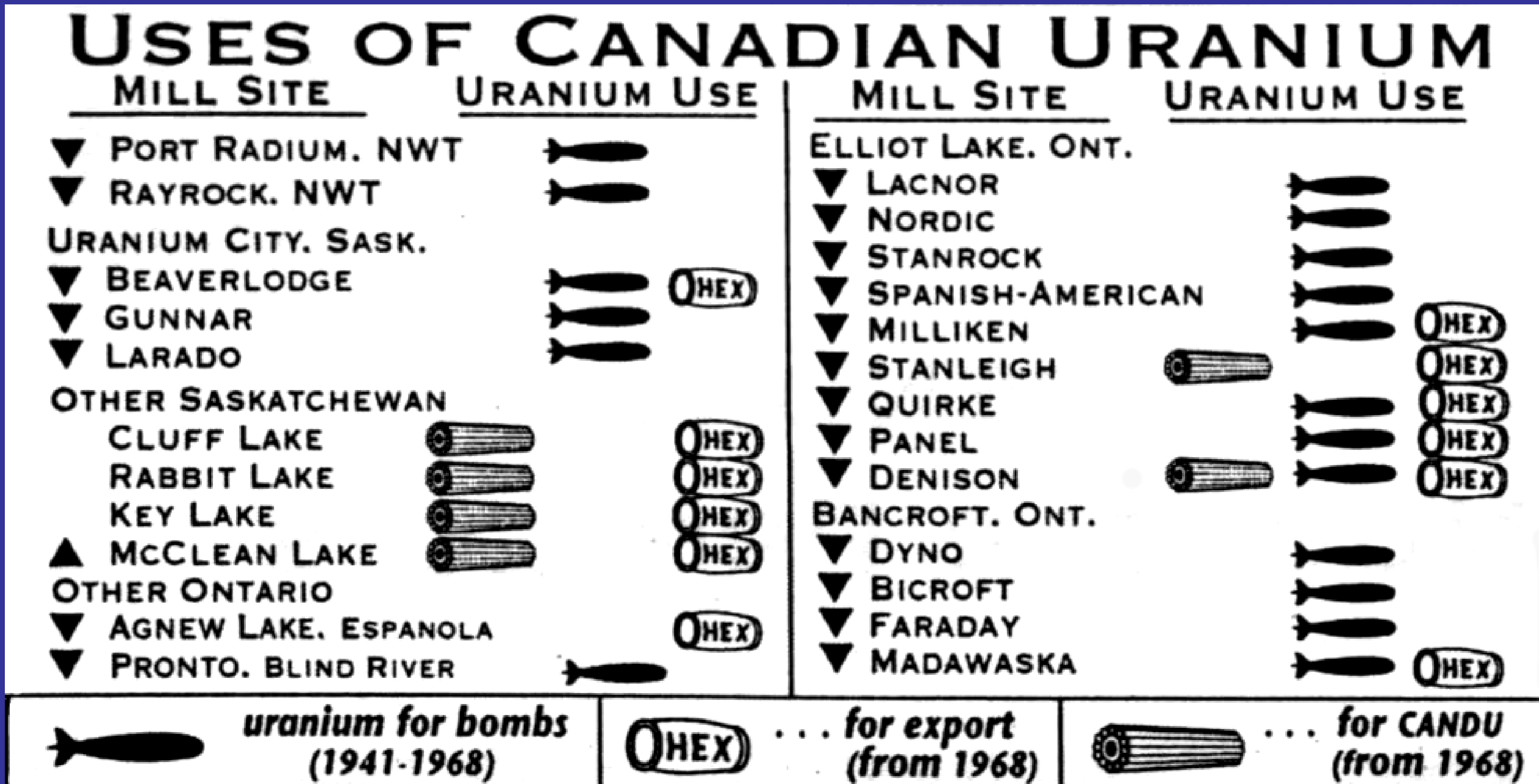


. . . in fact 85% of the lung dose is from alpha-emitting polonium une usine d'enrichissement

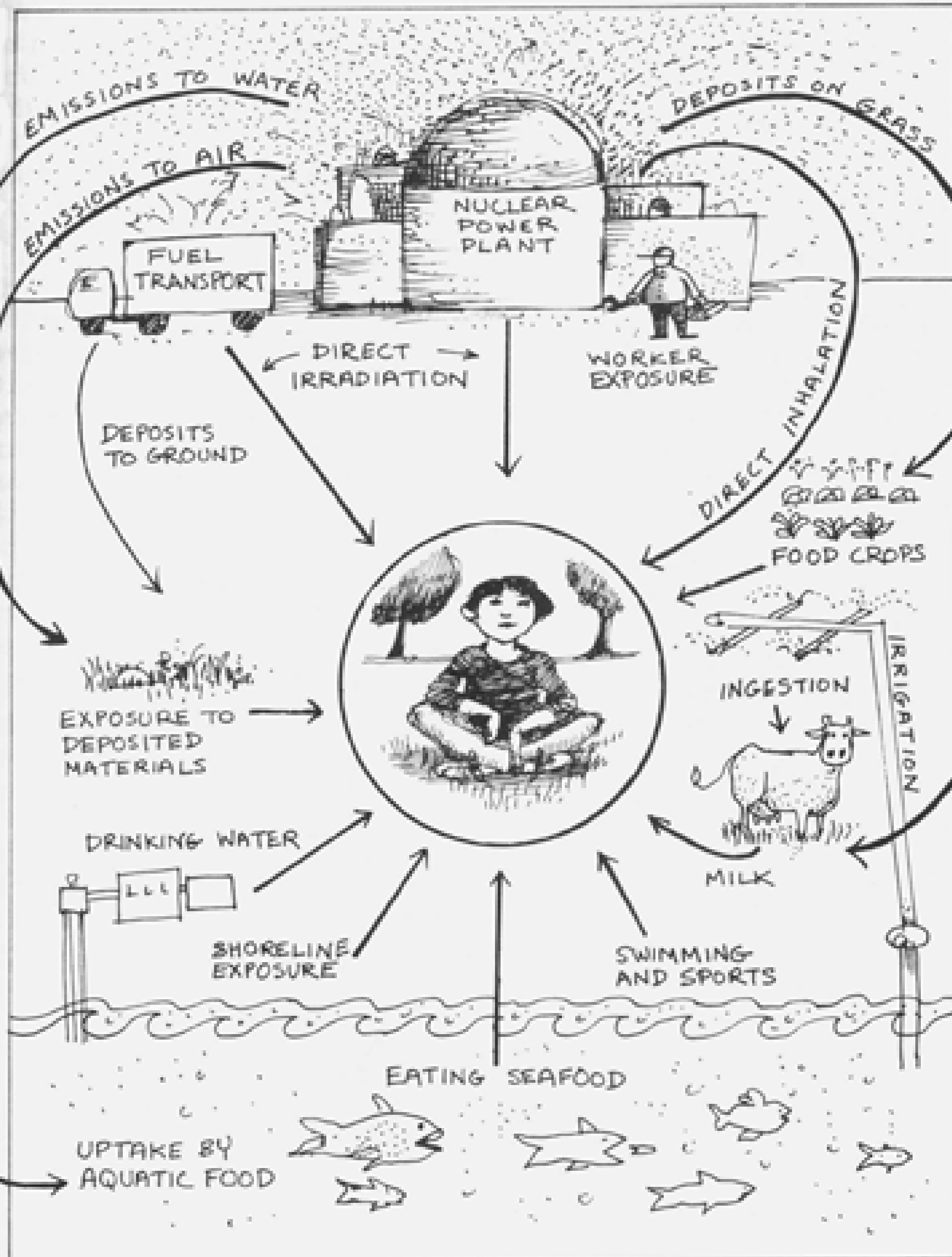

Half-life
microsec*
millisec **
second
minute
hour
day
week
year
thousand years
million years
billion years
Uranium 238
Alpha
Thorium 234
Beta Gamma
Protactinium 234
Beta Gamma
Uranium 234
Alpha Gamma
Thorium 230
Alpha Gamma
Radium 226
Alpha Gamma
Radon 222
Alpha
Polonium 218
Alpha
Lead 214
Beta Gamma
Bismuth 214
Beta Gamma
Polonium 214
Alpha
Lead 210
Beta Gamma
Bismuth 210
Beta Gamma
Polonium 210
Alpha
Lead 206
4.5 billion years
24.1 days
1 minute
245,000 years
76,000 years
1,600 years
3.8 days
3.0 minutes
27 minutes
20 minutes
160 microseconds
21 years
5 days
138 days
stable
*Microsec; 1/1,000,000 of a second
**Millisec; 1/1,000 of a second

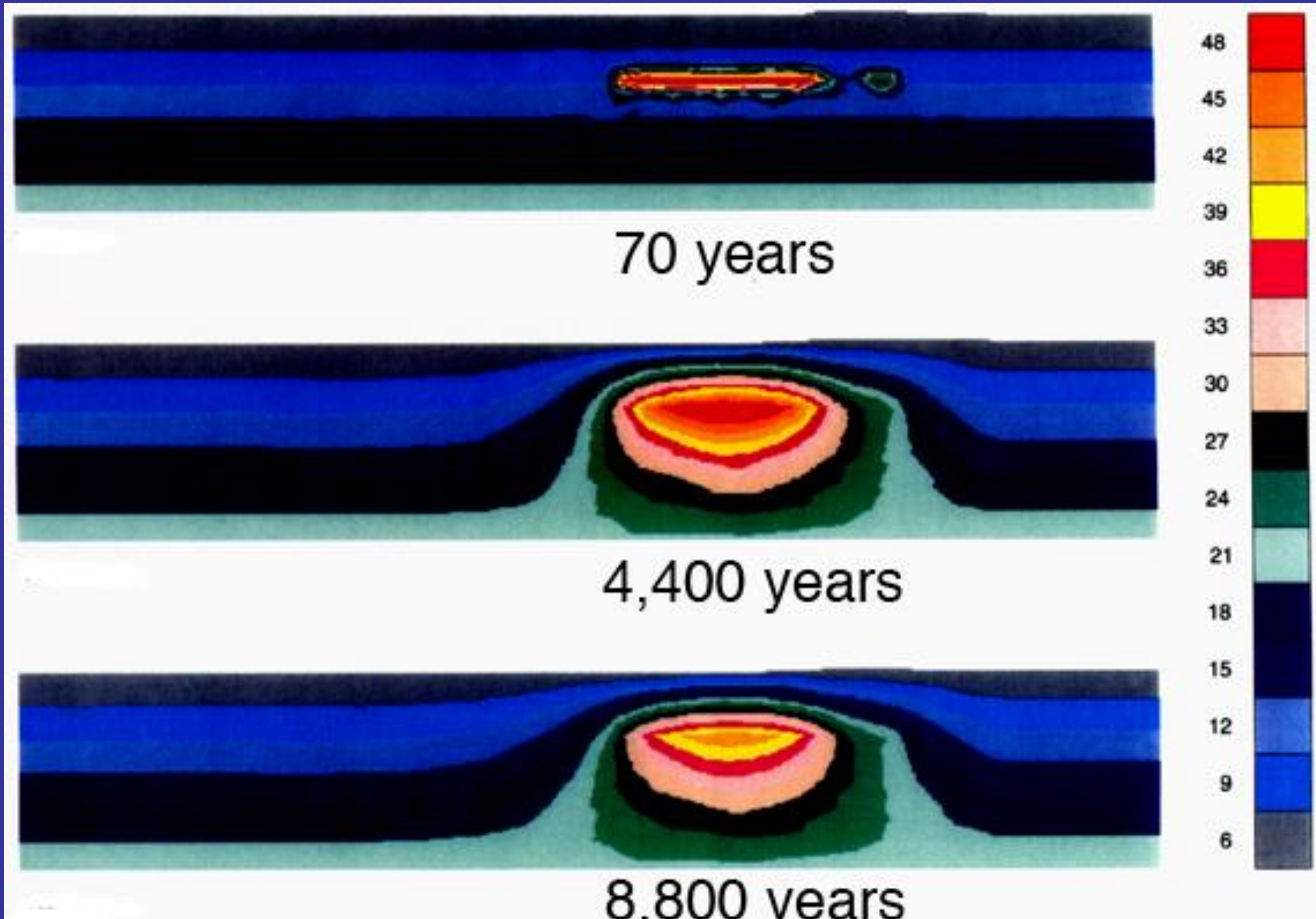
The Yellowcake Road (Canada)




USES OF CANADIAN URANIUM
MILL SITE
URANIUM USE
PORT RADIUM. NWT
RAYROCK. NWT
URANIUM CITY. SASK.
BEAVERLODGE
HEX
GUNNAR
LARADO
OTHER SASKATCHEWAN
CLUFF LAKE
RABBIT LAKE
KEY LAKE
MCCLEAN LAKE
OTHER ONTARIO
AGNEW LAKE. ESPANOLA
PRONTO. BLIND RIVER
ELLIOT LAKE. ONT.
LACNOR
NORDIC
STANROCK
SPANISH-AMERICAN
MILLIKEN
STANLEIGH
QUIRKE
PANEL
DENISON
BANCROFT. ONT.
DYNO
BICROFT
FARADAY
MADAWASKA
uranium for bombs (1941-1968)
. . . for export (from 1968)
. . . for CANDU (from 1968)

Sources of Exposure




70 years
4,400 years
8,800 years
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6

Radioactive Inventory

Main Components:

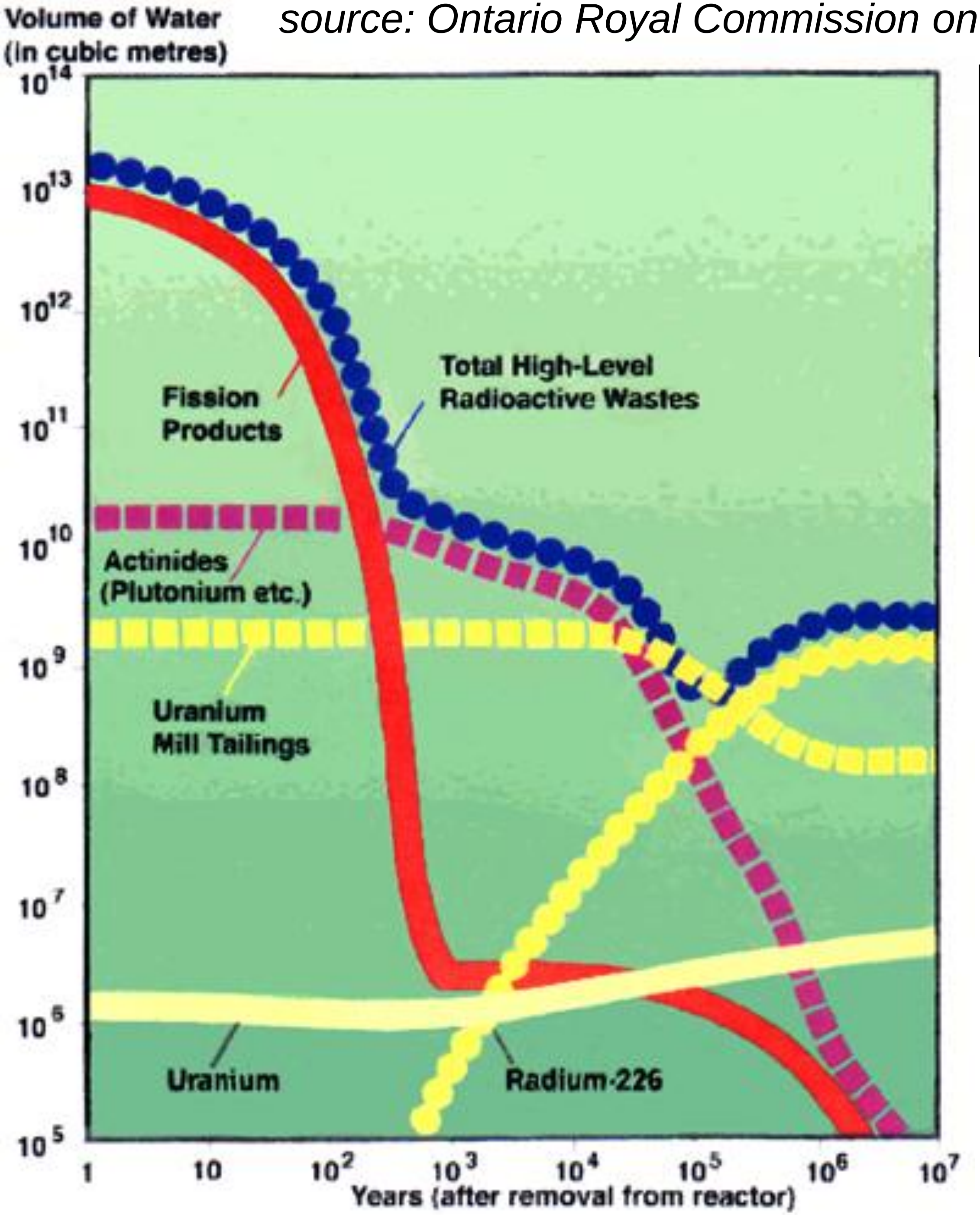
Radioactive Tailings

Northwest Territories	2.7 million tonnes
Ontario	
Elliot Lake	145.3 million tonnes
Bancroft	6.2 million tonnes
Other	5.0 million tonnes
Saskatchewan	
Uranium City	14.8 million tonnes
Cluff Lake	2.2 million tonnes
Rabbit Lake	10.1 million tonnes
Key Lake	3.9 million tonnes
Other / Canada	3.0 million tonnes
Total	**193.2 million tonnes**

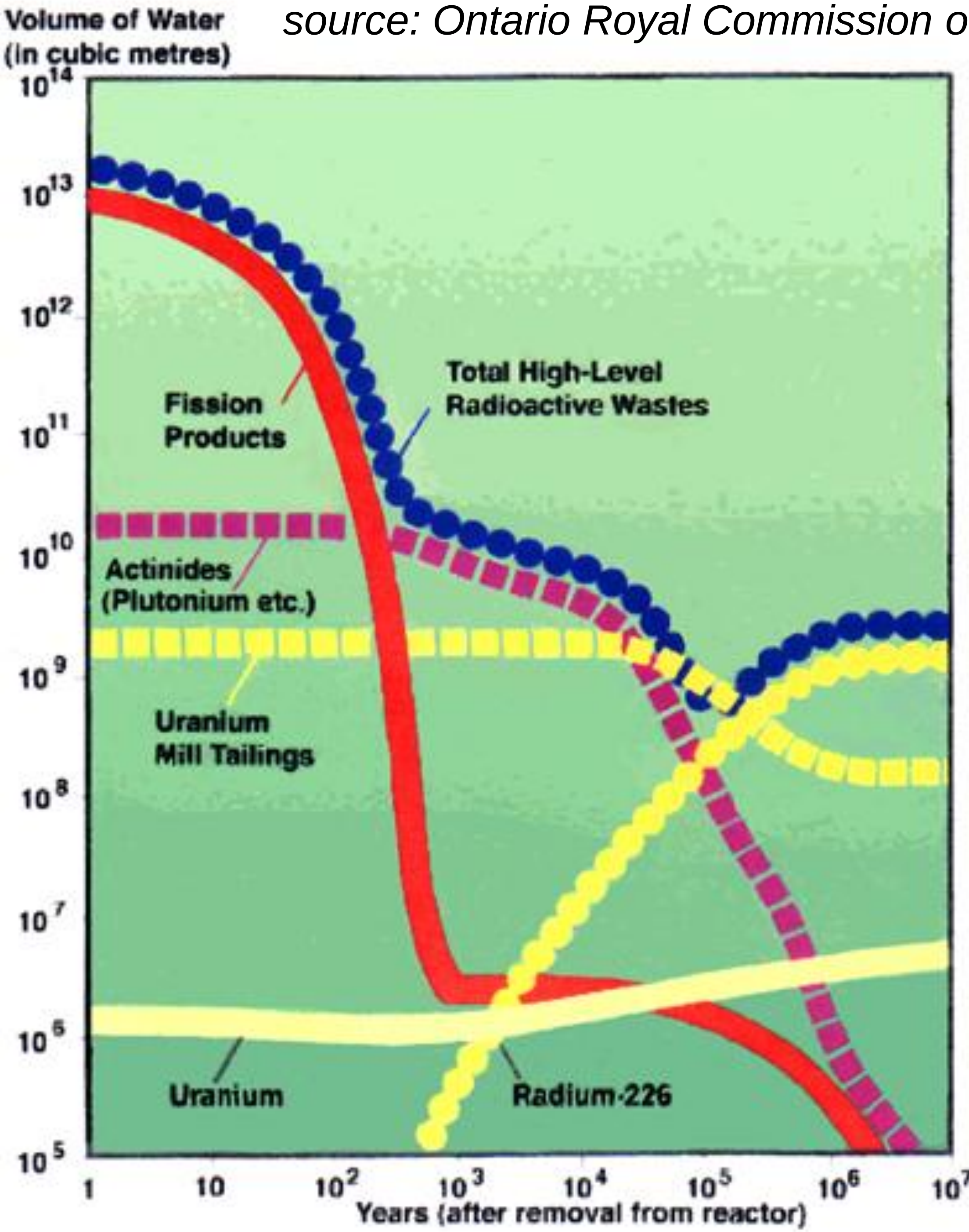
High Level Radioactive Waste

Bruce	11.1 million kilograms
Darlington	1.8 million kilograms
Pickering	8.4 million kilograms
Gentilly	1.1 million kilograms
Pt. Lepreau	1.3 million kilograms
Total	**23.7 million kilograms**

source: Ontario Royal Commission on Electric Power Planning (1978)



The toxicity of irradiated CANDU fuel over a period of ten million years *source: Ontario Royal Commission on Electric Power Planning (1978)*



The toxicity of irradiated CANDU fuel over a period of ten million years

This graph represents the irradiated fuel produced in a single year by one CANDU.

The minimum amount of water needed to dilute this waste is about the same as the amount of water in Lake Superior.

Tritium (Hydrogen-3)

- Radioactive isotope of hydrogen (with 2 extra neutrons)
- Produced in large amounts from heavy water in CANDUs
- Released in the form of liquid water or water vapour
- Levels of tritium in Great Lakes is measurably growing
- Intake by inhalation, ingestion, and through the skin
- Crosses the placenta, can cause teratogenic effects
- DNA especially sensitive, can cause genetic damage
- Permissible levels in Canada highest in the world

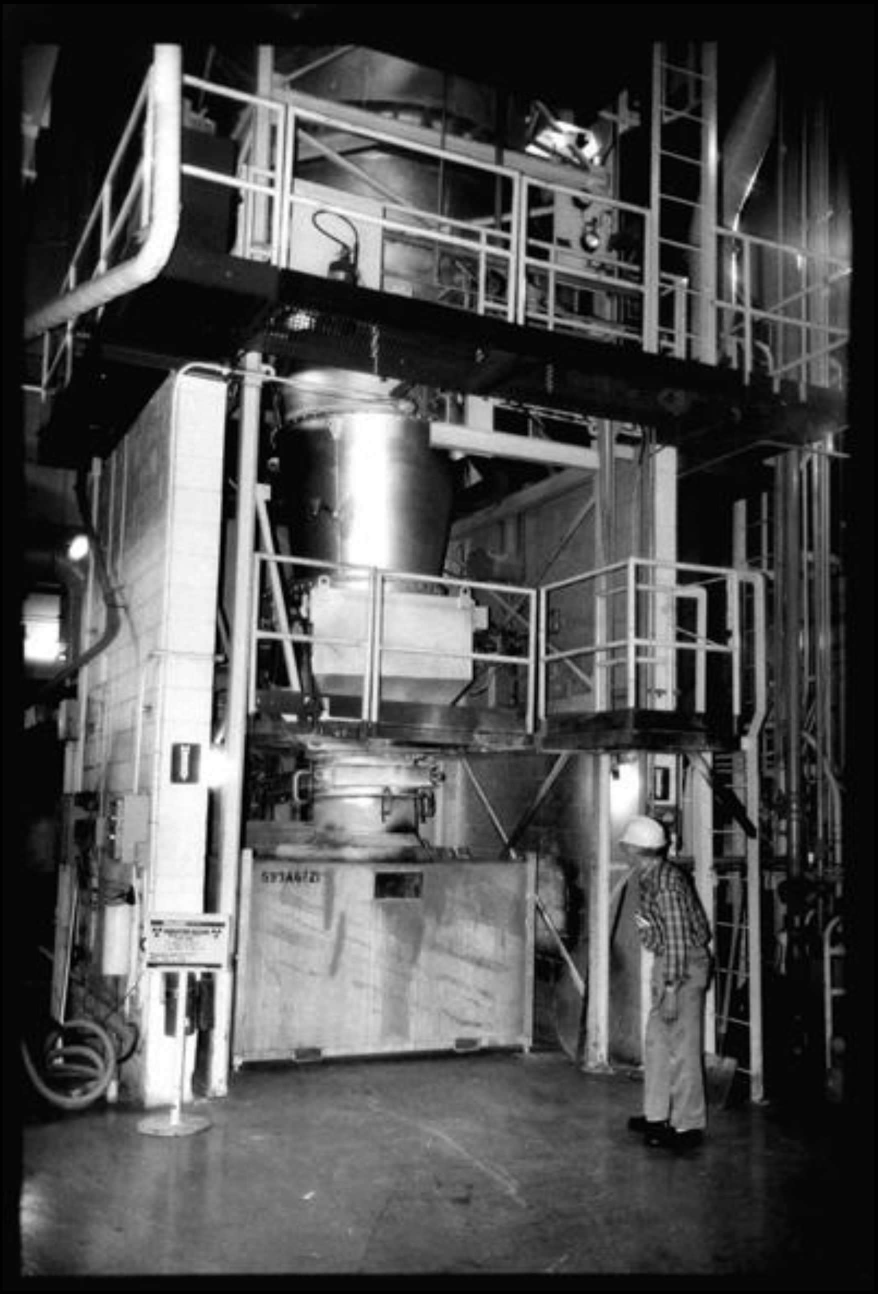
Carbon-14

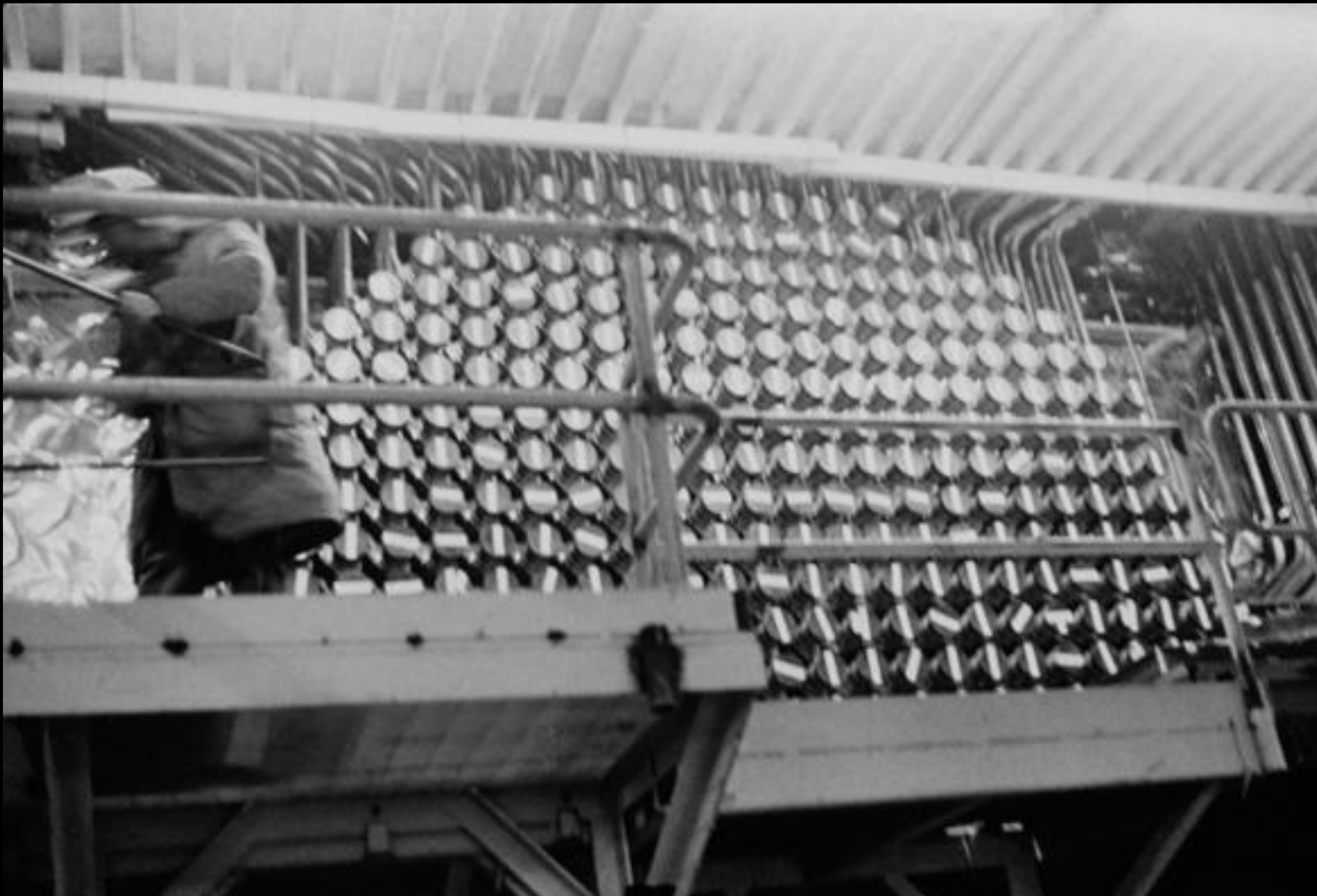
- Radioactive isotope of carbon (2 extra neutrons)
- Released in the form of CO_2 and radioactive dust
- Produced in large amounts by activation of nitrogen
- Six thousand year half-life means global accumulation
- Enters into all organic molecules (organically bound)
- DNA especially sensitive, may cause genetic damage
- Permissible levels in Canada highest in the world

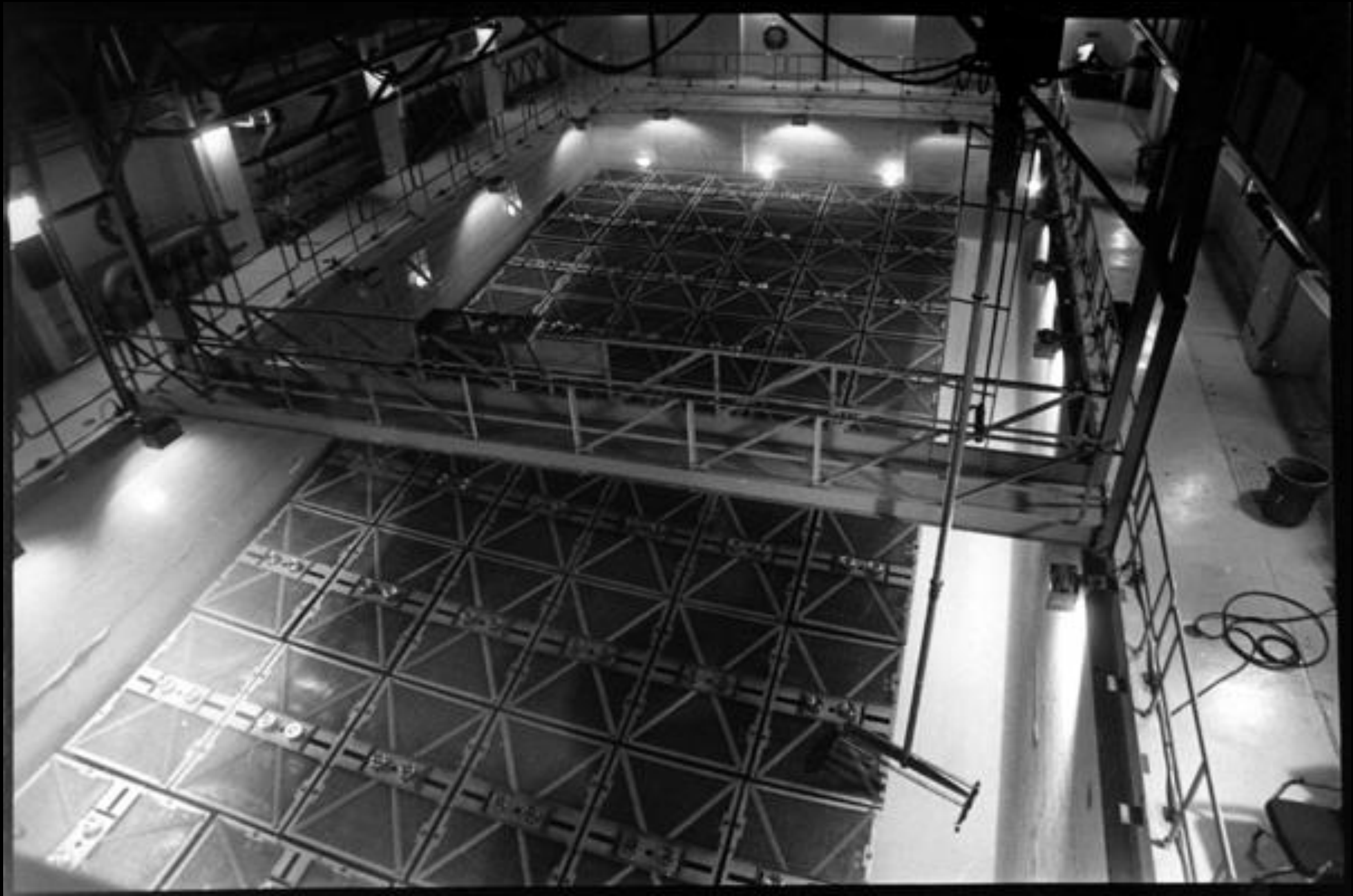
Tritium (Hydrogen-3) and Carbon-14

- Prodigious amounts produced by CANDUs
- Both pure beta emitters (no gamma at all)
- Both very low energy (short track radiation)
- Do not bio-concentrate in the food chain
- Long half-lives leads to environmental build-up
- Essential constituents of organic molecules
- Reproductive risks exceed cancer risks


FAT MAN
AN TYPE
ATOMIC BOMB LIKE THE
BOMB EXPLODED OVER
JAPAN
IN WAR II

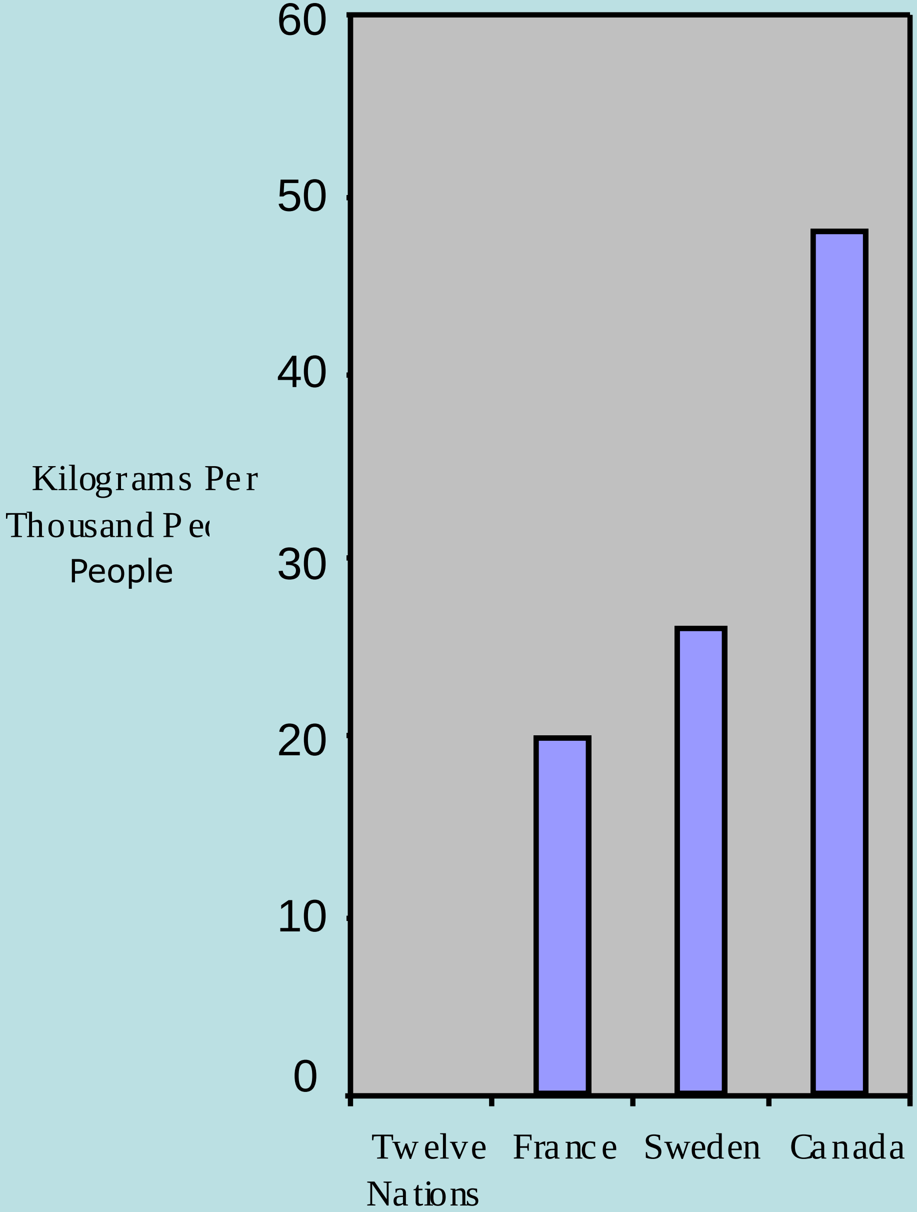







GATE
L3-312

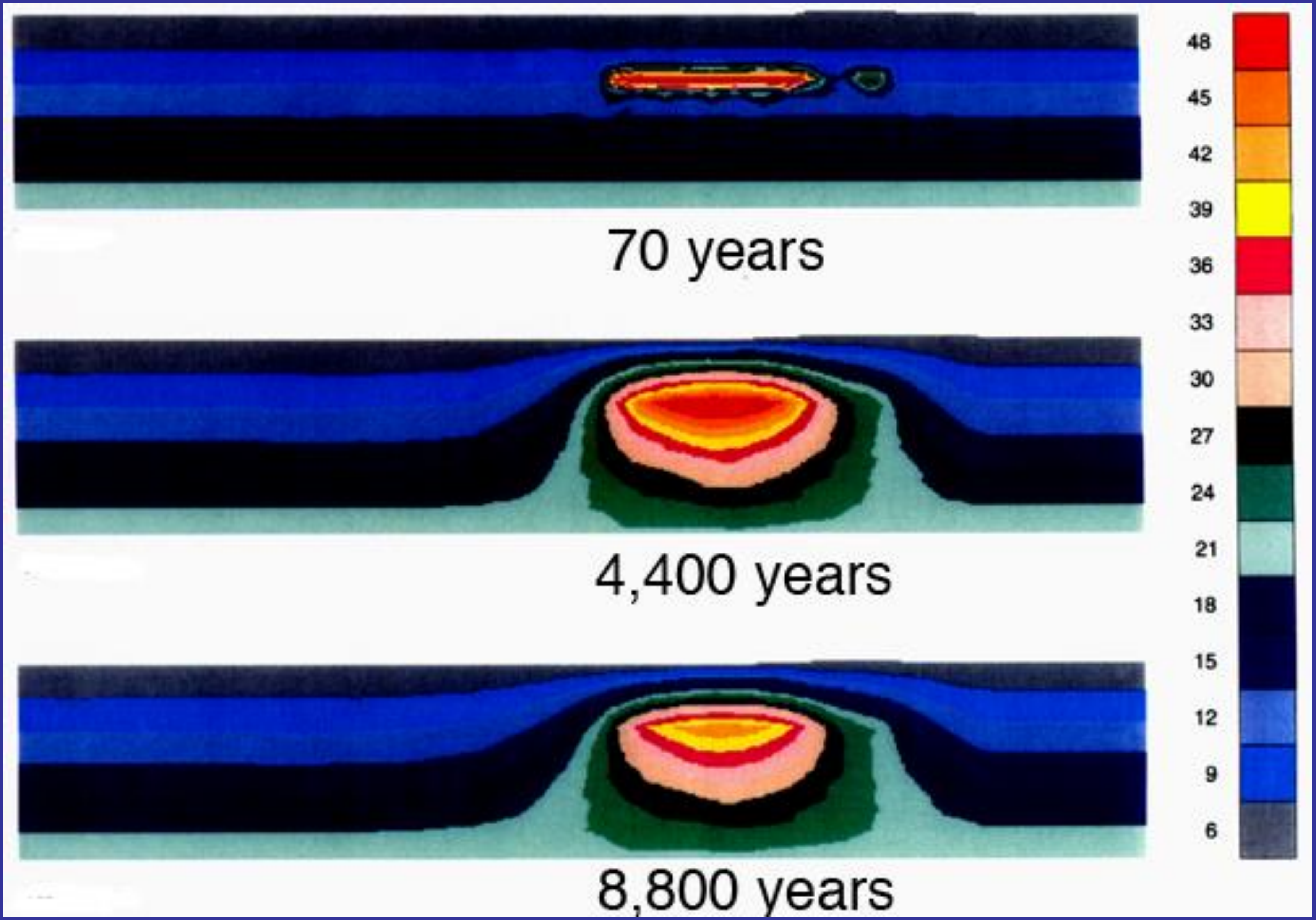

DANGER



Nuclear waste generated in kilograms per thousand people.

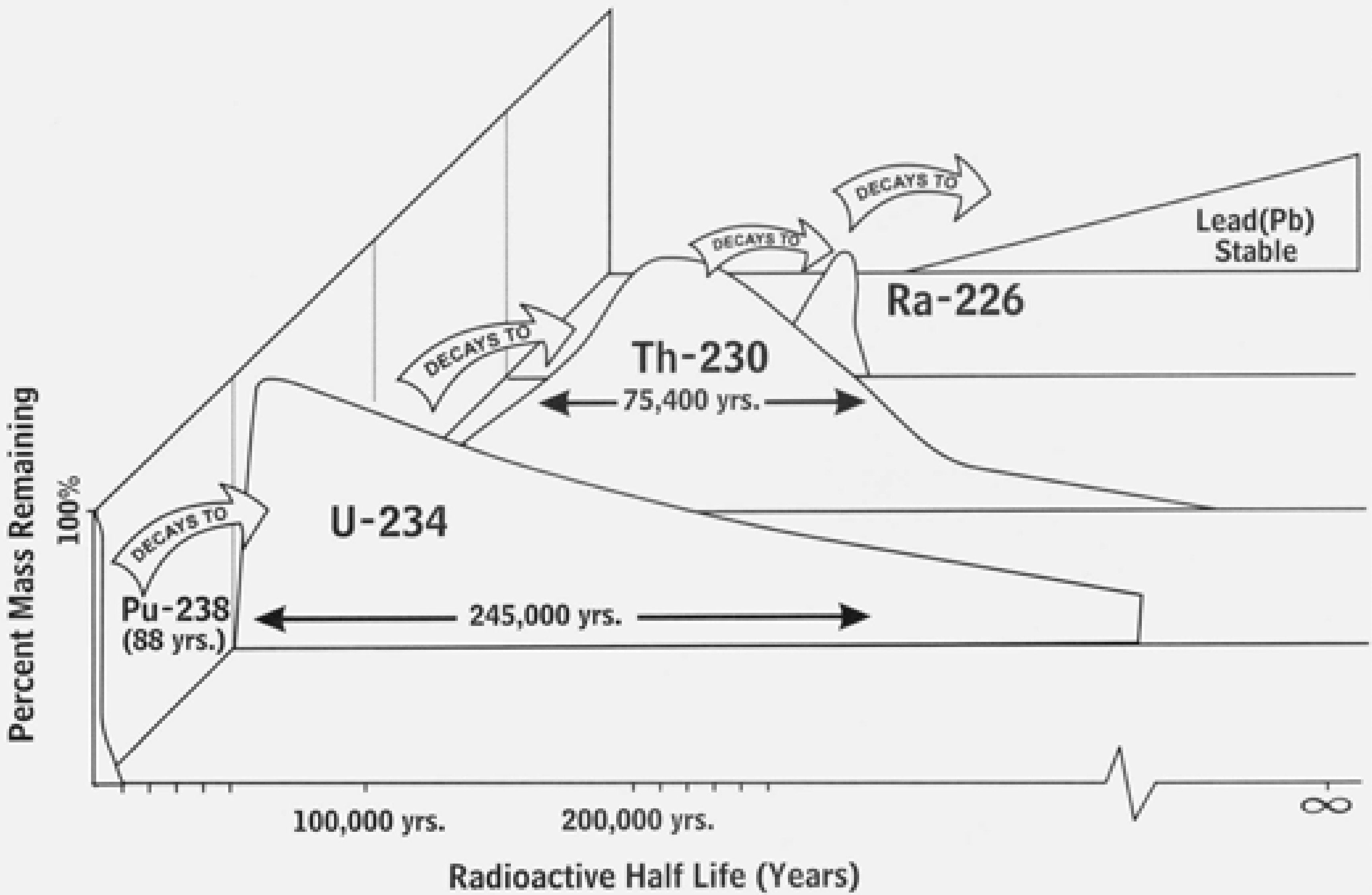
Source: OECD environmental data 1999

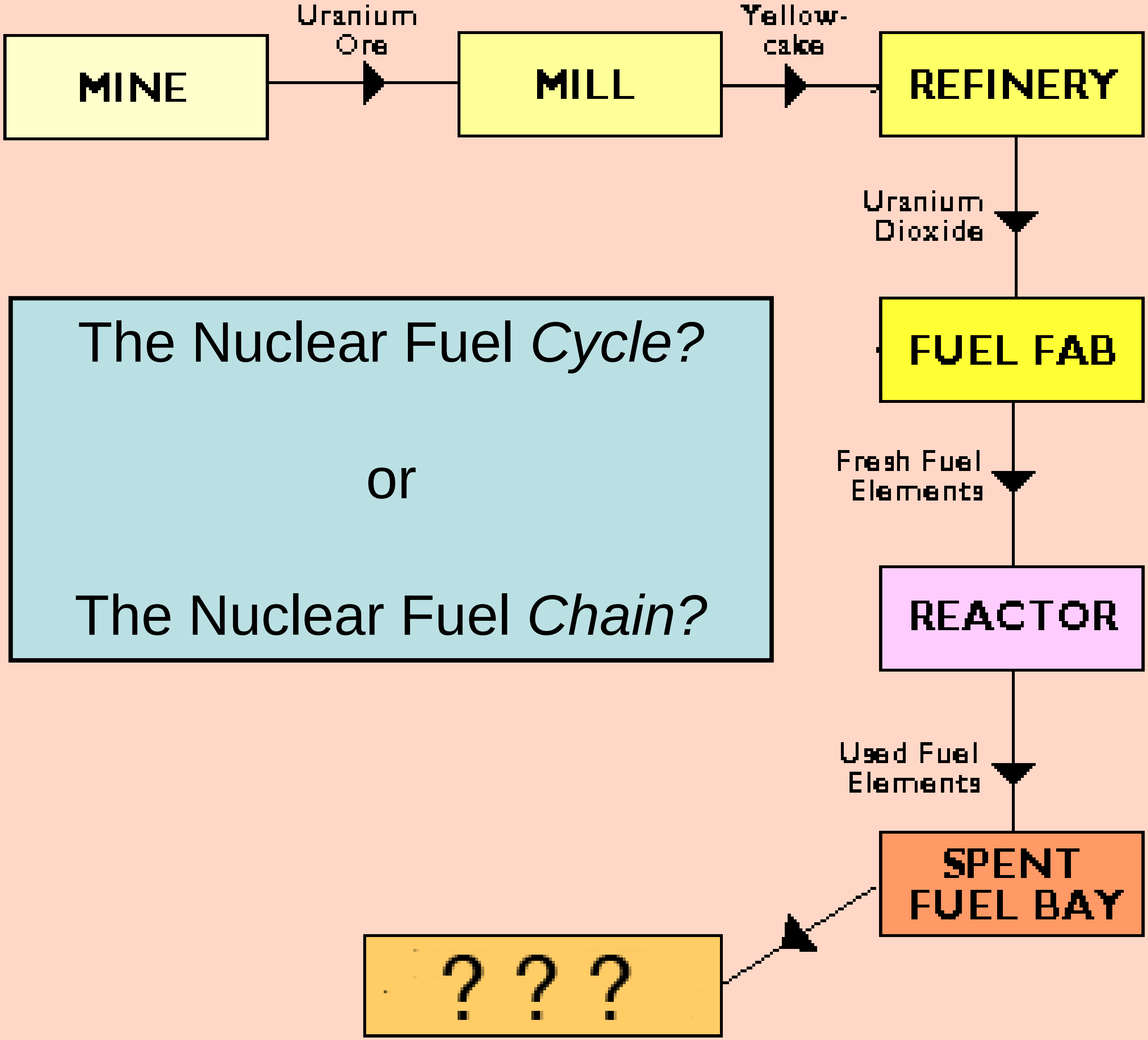

NUCLEAR



. . . it takes 70,000 years for temperatures to return to normal

Exhibit 4: Some Radionuclides with Relatively Short Half Lives Decay into Radioactive Decay Products with Half Lives Measured in Geologic Time

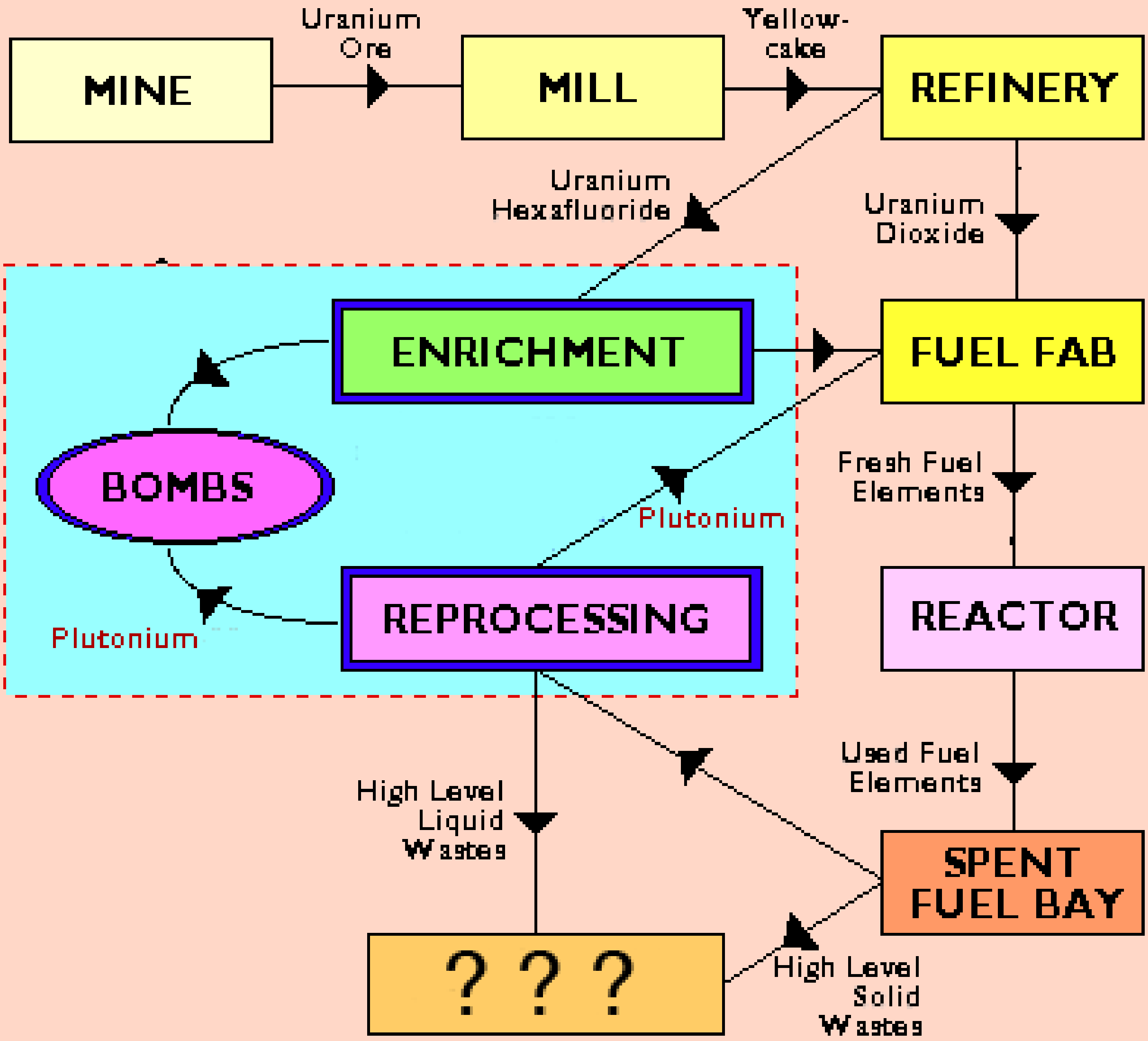


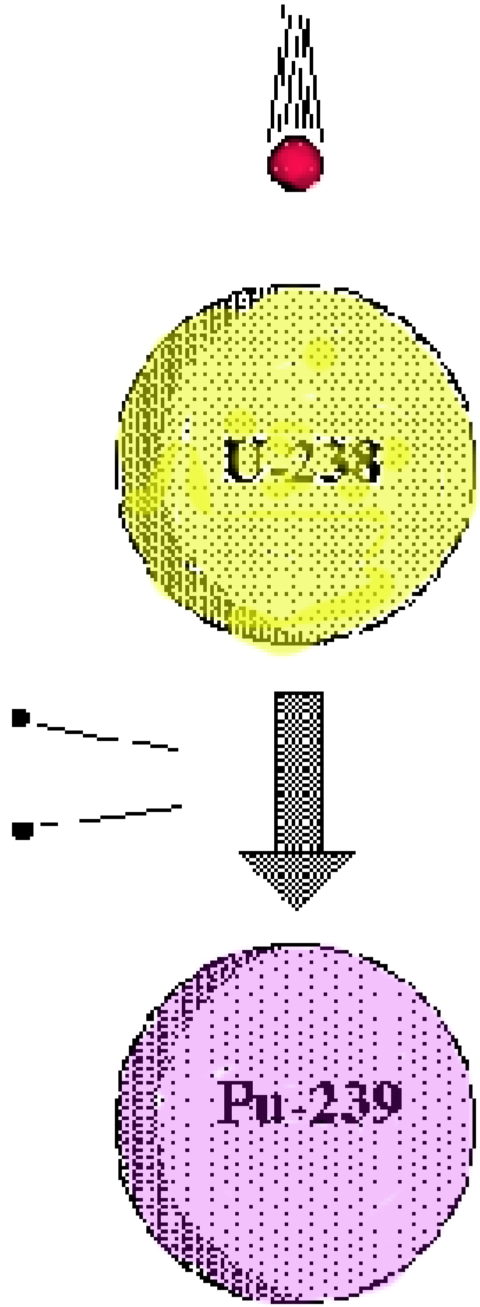


The Nuclear Fuel *Cycle?*

or

The Nuclear Fuel *Chain?*


MINE
Uranium Ore
MILL
Yellow-cake
REFINERY
Uranium Hexafluoride
Uranium Dioxide
ENRICHMENT
FUEL FAB
BOMBS
Fresh Fuel Elements
Plutonium
REPROCESSING
REACTOR
Plutonium
Used Fuel Elements
High Level Liquid Wastes
SPENT FUEL BAY
? ? ?
High Level Solid Wastes



when a neutron

strikes a non-fissile atom of uranium-238

two beta particles are given off

and an atom of plutonium-239 is created

PLUTONIUM LIFE SPAN


THE ZEEP REACTOR
LE RÉACTEUR ZEEP
A nuclear chain reaction was first initiated in Canada on September 5, 1945, when the ZEEP reactor went into operation here at Chalk River. Originally part of an effort to produce plutonium for nuclear weapons, the reactor was designed by a team of Canadian, British and French scientists and engineers assembled in Montreal and in Ottawa in 1942-45 under the administration of the National Research Council. Named Zero Energy Experimental Pile because it was developed to produce only one watt of heat, the ZEEP reactor was used to provide data for the design of the powerful NRX (National Research Experimental) reactor. In 1952 the project was transferred from NRC to Atomic Energy of Canada Limited.

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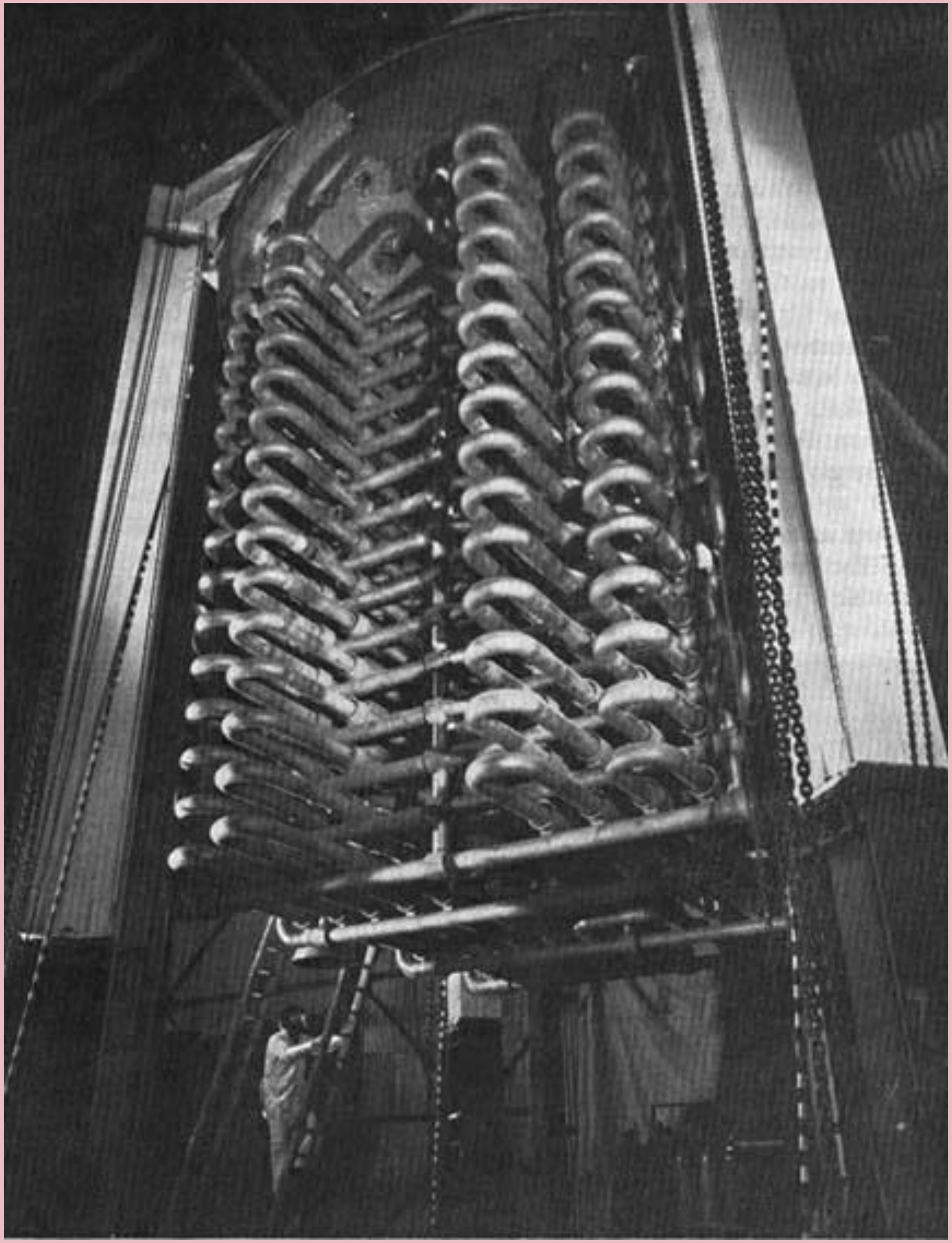

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

can have an 18% share of the total

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

2.7 % of total energy

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

can have an 18% share of the total

electricity supply in 2030

at carbon prices up to 50 US $ per ton of CO_2 equivalent,

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

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electricity supply in 2030

3 % of total energy

IPCC: Working Group III report

"Given costs relative to other supply options,

nuclear power, which accounted for 16%

of the electricity supply in 2005,

can have an 18% share of the total

electricity supply in 2030

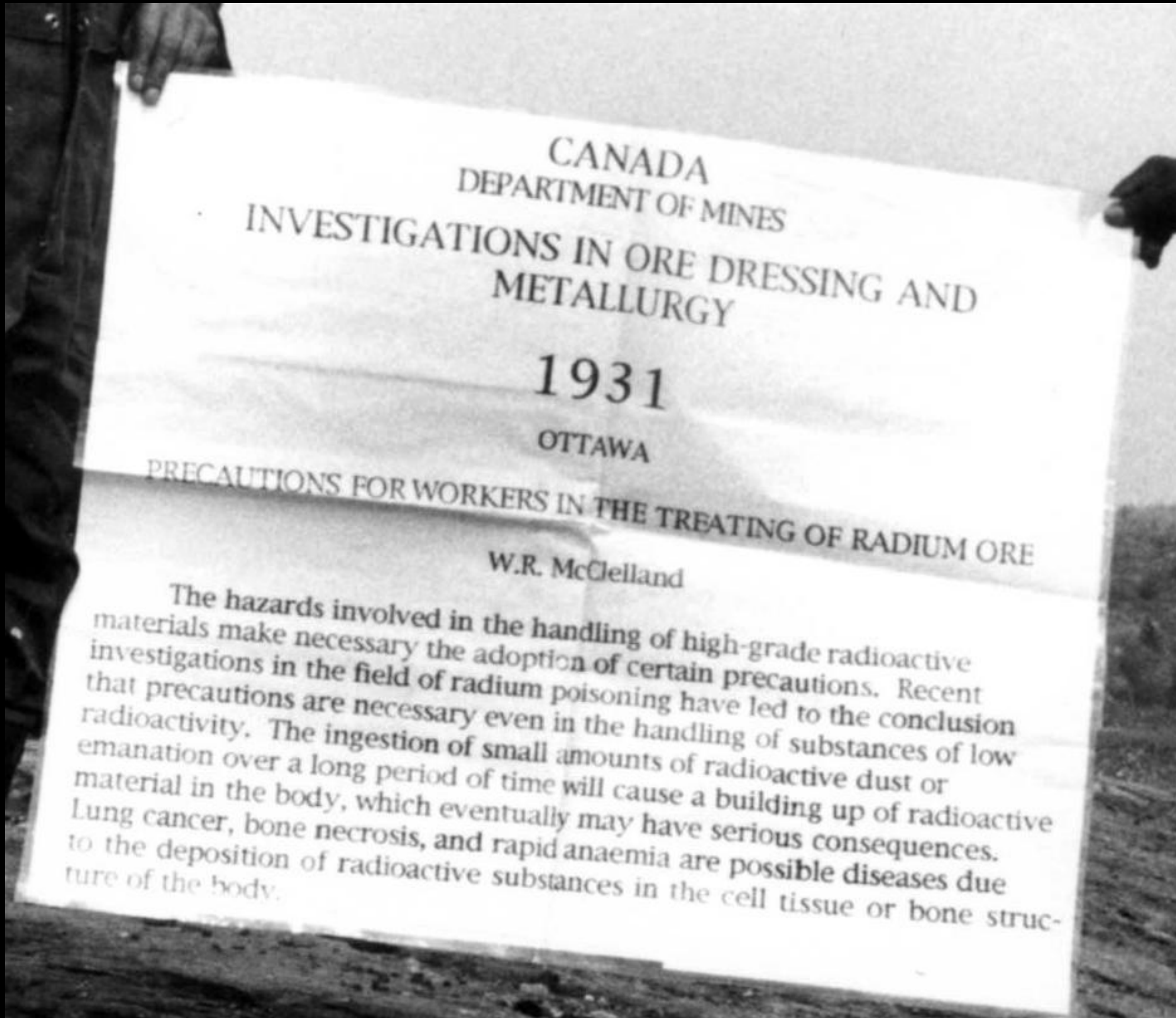
at carbon prices up to 50 US $ per ton of CO_2 equivalent,

but **safety, weapons proliferation**

and waste remain as constraints"

U


КУРЧАТОВ



CANADA
DEPARTMENT OF MINES
INVESTIGATIONS IN ORE DRESSING AND METALLURGY

1931

OTTAWA

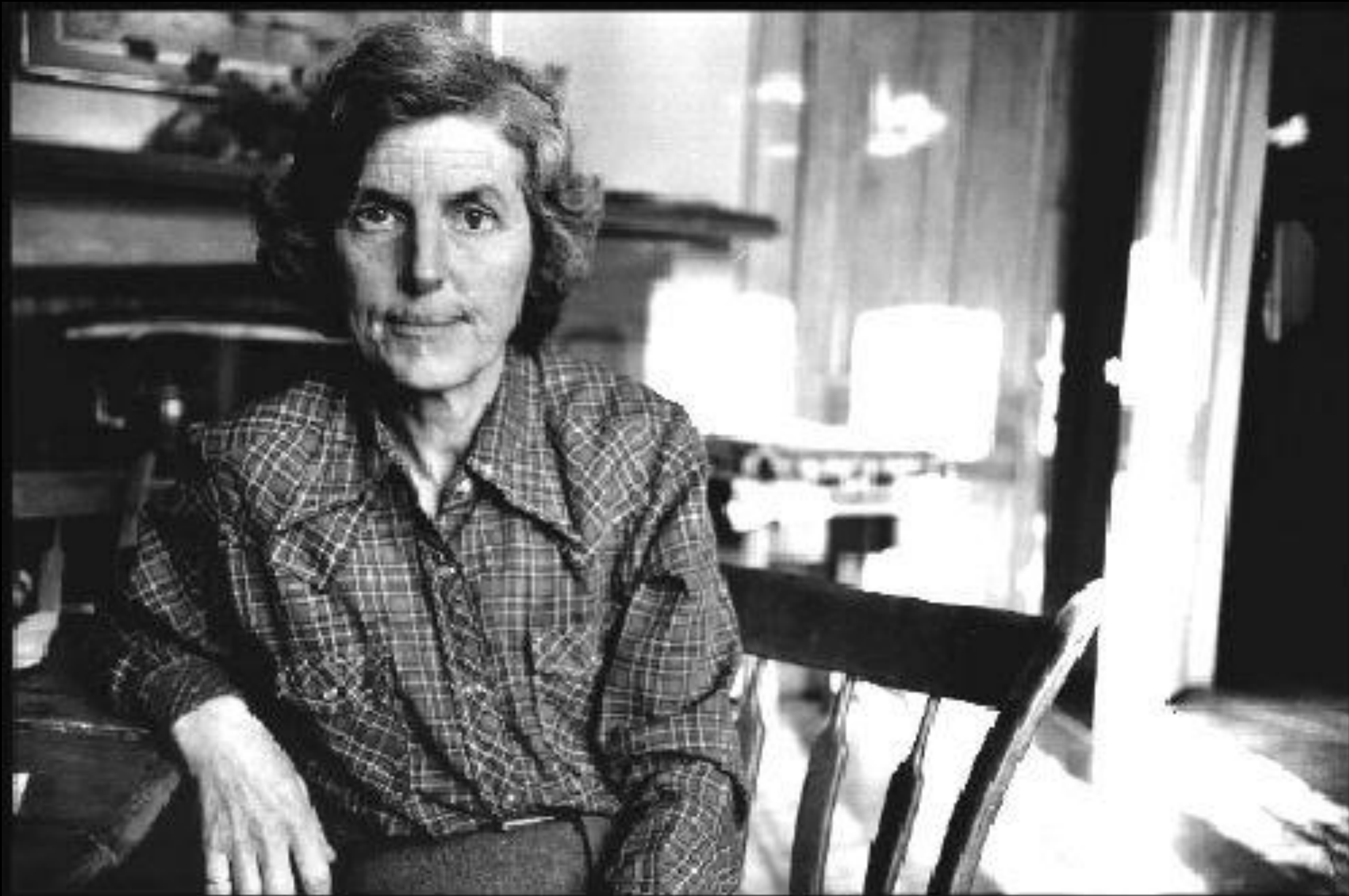
PRECAUTIONS FOR WORKERS IN THE TREATING OF RADIUM ORE

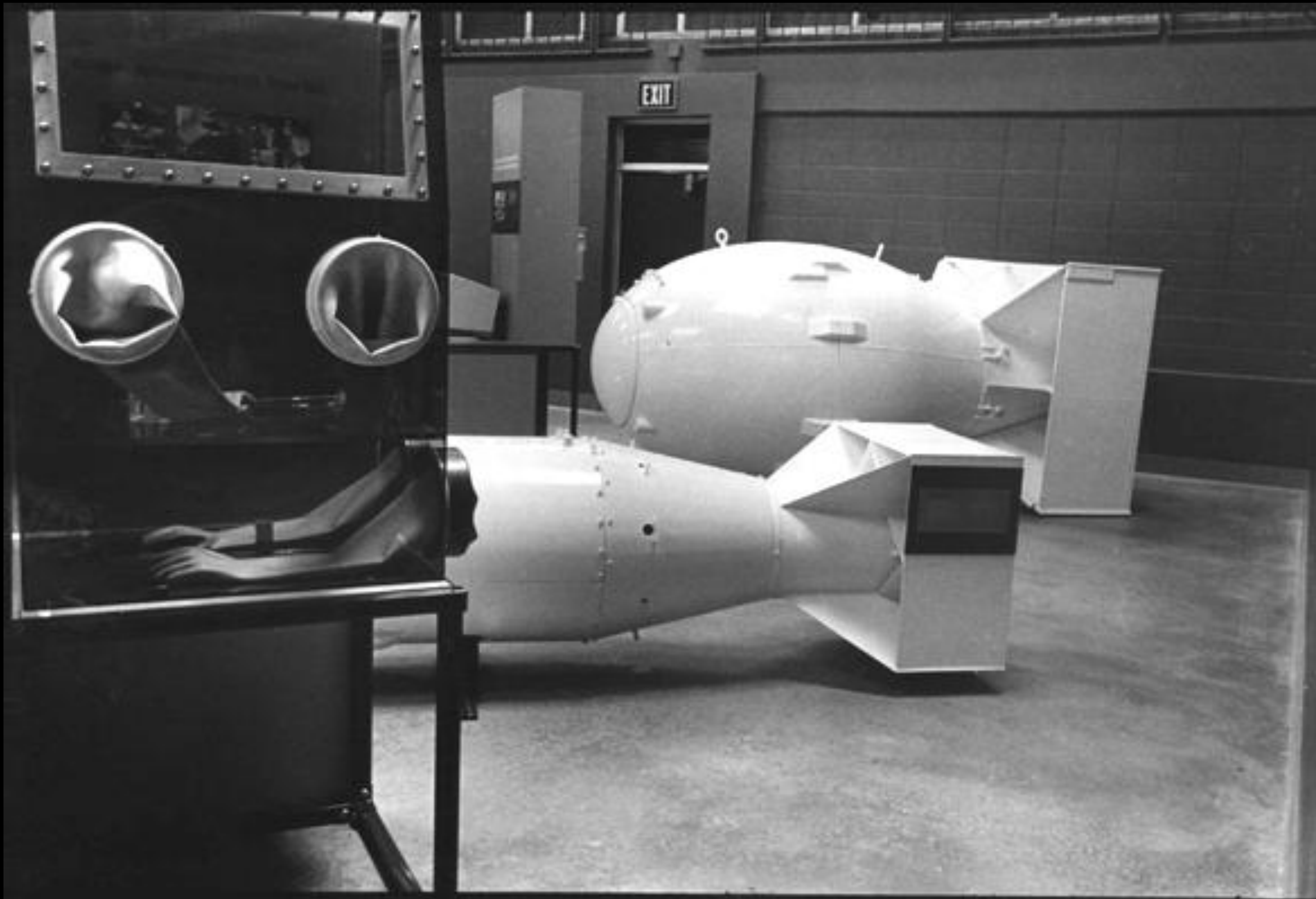
W.R. McClelland

The hazards involved in the handling of high-grade radioactive materials make necessary the adoption of certain precautions. Recent investigations in the field of radium poisoning have led to the conclusion that precautions are necessary even in the handling of substances of low radioactivity. The ingestion of small amounts of radioactive dust or emanation over a long period of time will cause a building up of radioactive material in the body, which eventually may have serious consequences. Lung cancer, bone necrosis, and rapid anaemia are possible diseases due to the deposition of radioactive substances in the cell tissue or bone structure of the body.


RADIATION
LOW
HIGH


RADIATION
LOW
2
HIGH
75




EXIT

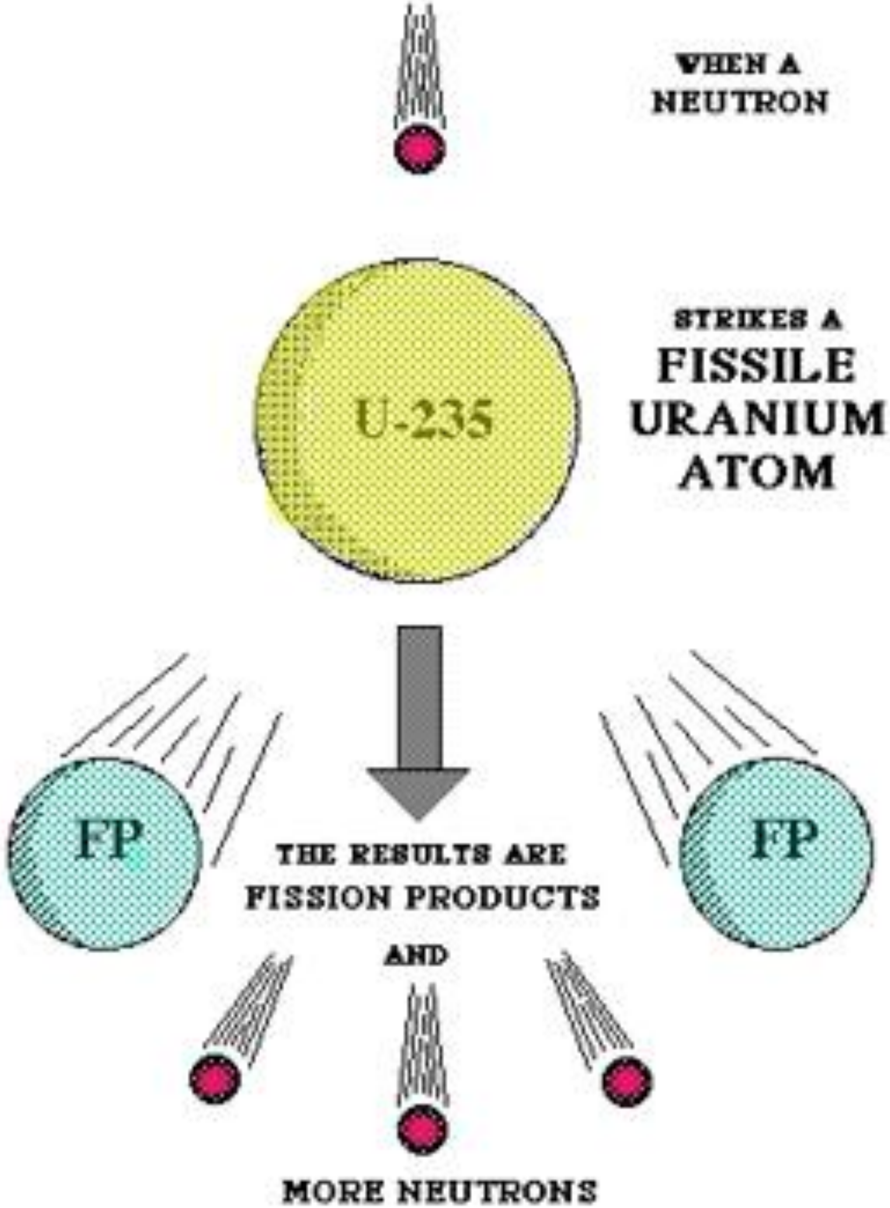
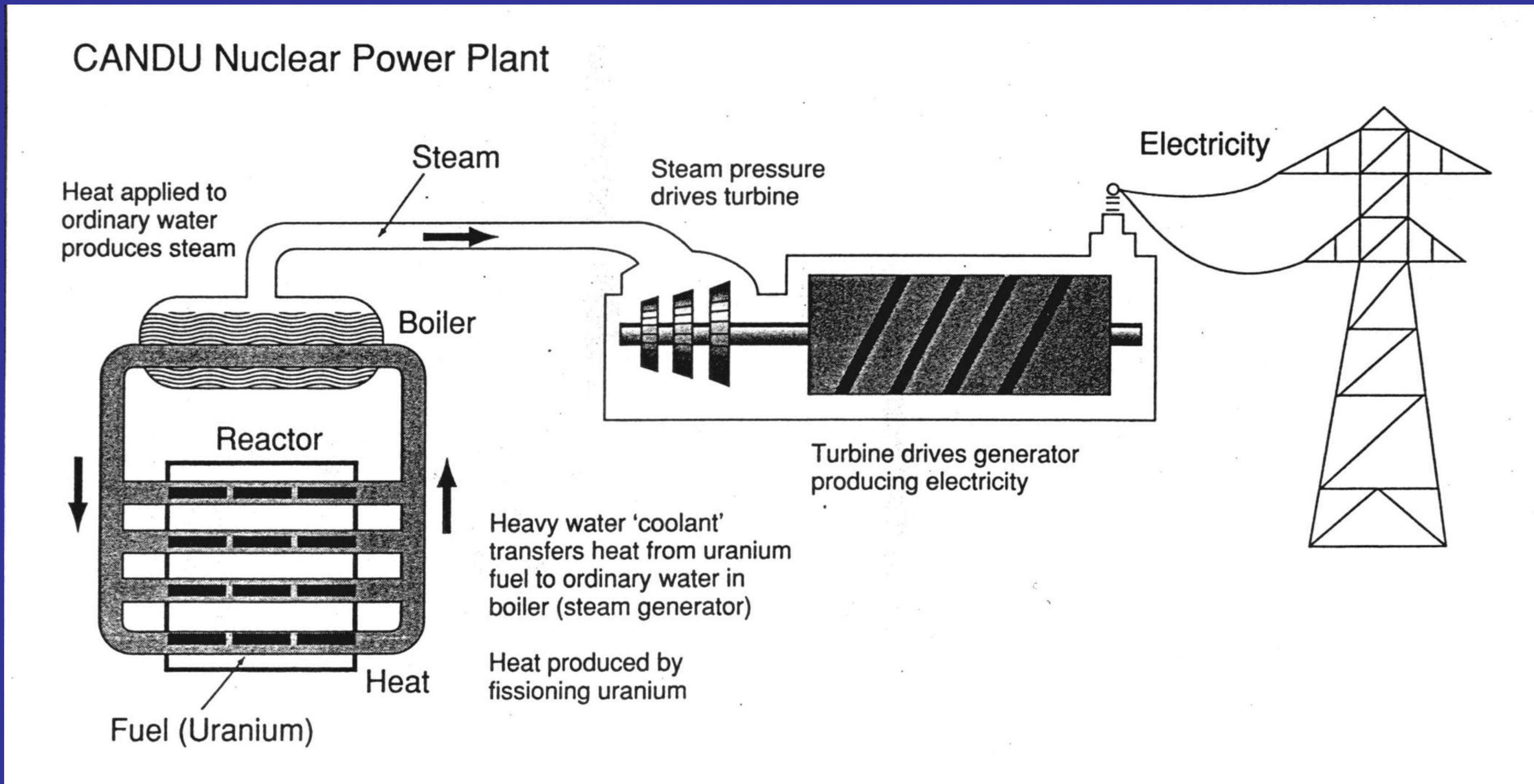
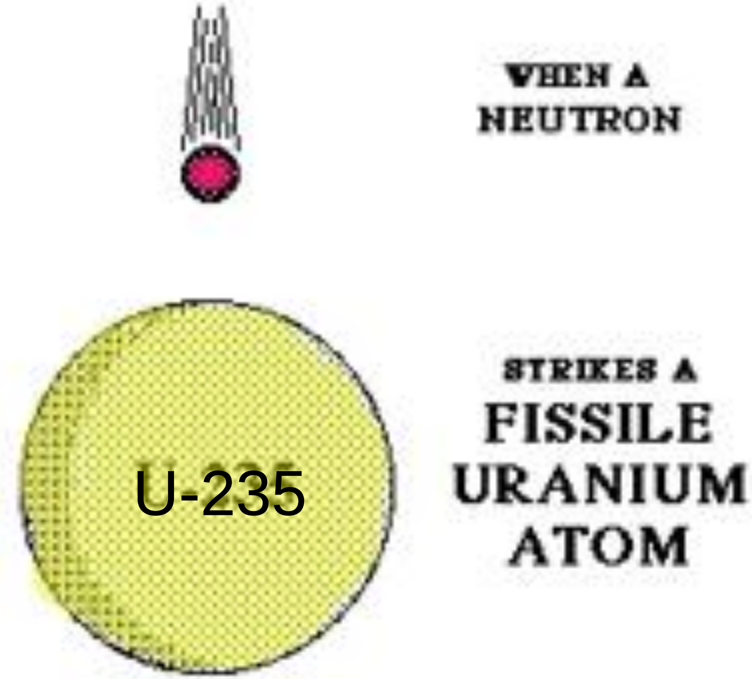
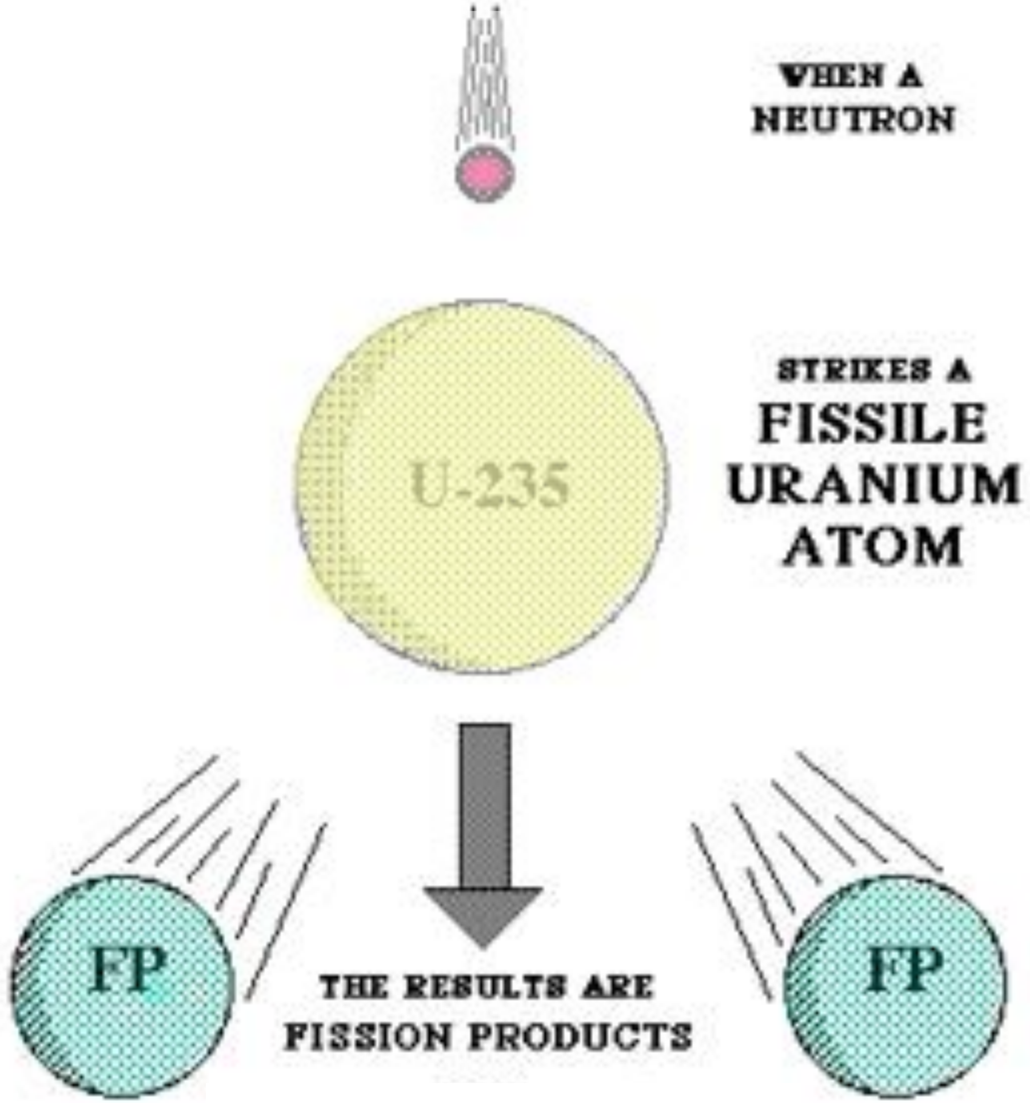
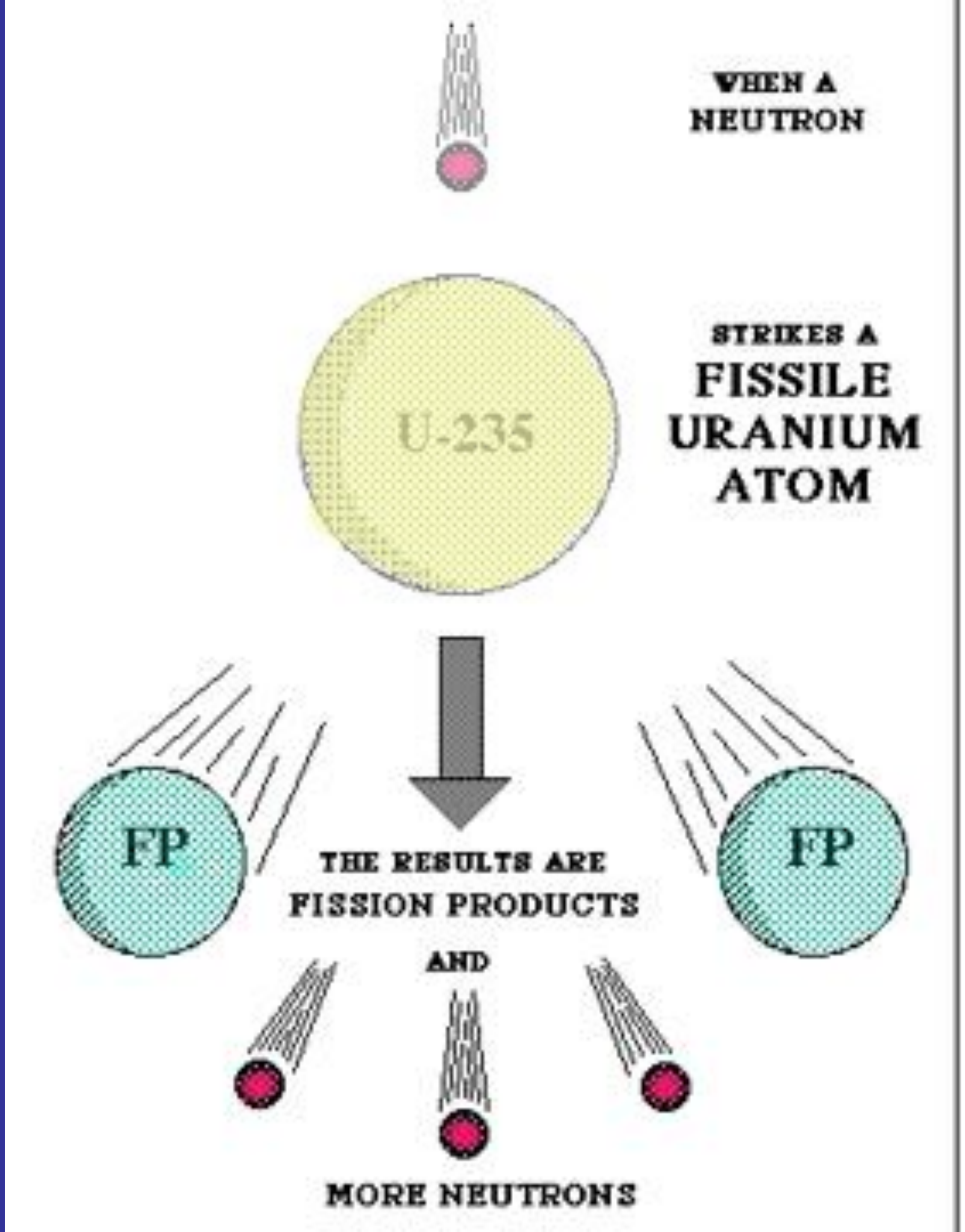


Figure 6. Nuclear fission using U-235 as fissile material


CANDU Nuclear Power Plant
Steam
Heat applied to ordinary water produces steam
Steam pressure drives turbine
Electricity
Boiler
Reactor
Turbine drives generator producing electricity
Heavy water 'coolant' transfers heat from uranium fuel to ordinary water in boiler (steam generator)
Heat produced by fissioning uranium
Heat
Fuel (Uranium)


WHEN A
NEUTRON
U-235
STRIKES A
FISSILE
URANIUM
ATOM

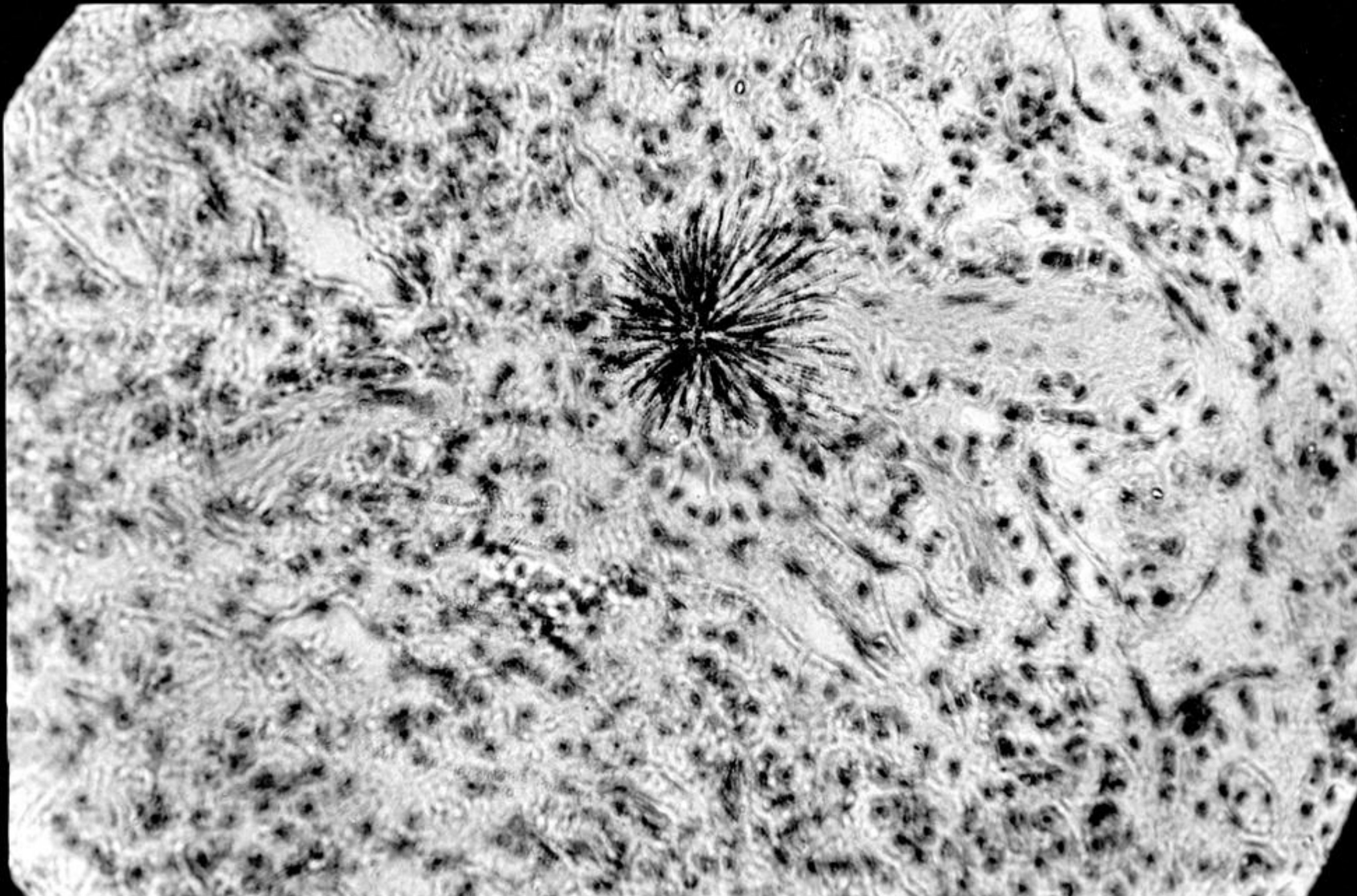

WHEN A
NEUTRON
U-235
STRIKES A
FISSILE
URANIUM
ATOM
FP
THE RESULTS ARE
FISSION PRODUCTS
FP


WHEN A
NEUTRON
STRIKES A
FISSILE
URANIUM
ATOM
U-235
FP
FP
THE RESULTS ARE
FISSION PRODUCTS
AND
MORE NEUTRONS

Radioactivity
and Human Health

featuring the photographs of Robert Del Tredici

Canadian Coalition for Nuclear Responsibility
www.ccnr.org



Alpha Radiation