Japan's Nuclear Disaster Implications on the U.S. : A Public Healt Perspective

Dr. Leonard A. Levy
Associate Dean for Education, Planning and Research
Director, Institute for Disaster and Emergency Preparedness
Professor of Family Medicine/Professor of Public Health
Nova Southeastern University College of Osteopathic Medicine

Overview

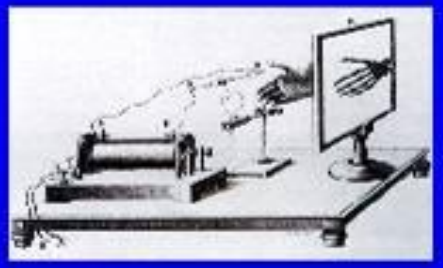
- The March 11, 2011 earthquake, tsunami, and nuclear catastrophe in Fukushima, Japan generated a considerable outpouring of fear about the public health dangers of nuclear energy.

- While this reaction is understandable, scientific evidence does not support conclusions that nuclear plants should be closed and thoughts of using such energy now and even in the future be abandoned.

Goal

- The goal of this presentation is to put into perspective the pubic health implications of this disaster and of nuclear energy in general.

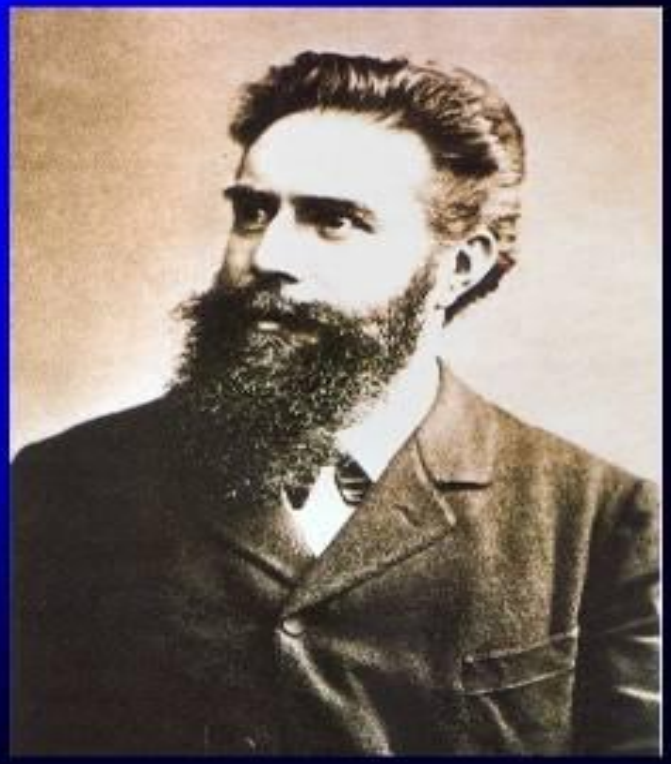
November 1895: Roentgen Discovered X Rays



W.C.Röntgens experiment in Würzburg

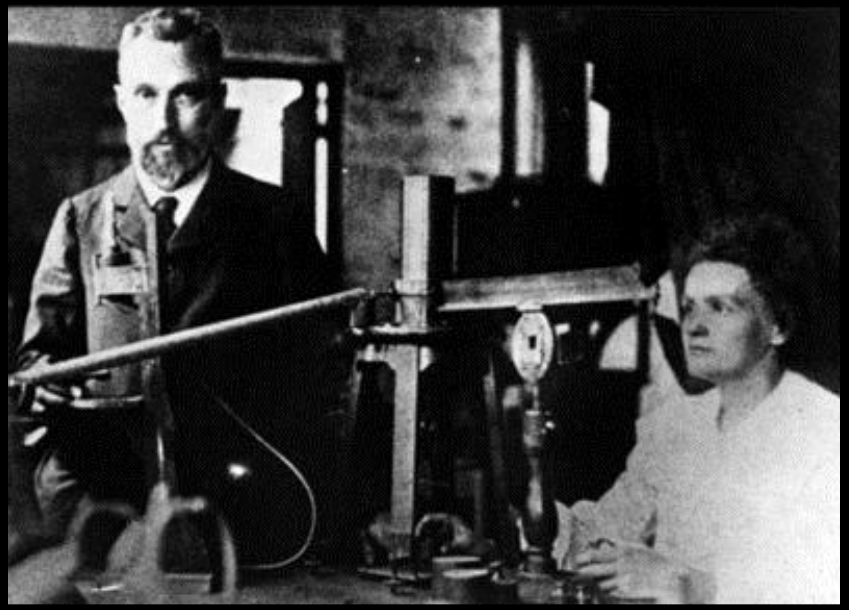
An early XX th century X-ray tube

Radiograph of Mrs. Röntgens hand, the first x-ray image ever taken, 22.Dec.1895, published in The New York Times January 16, 1896



Radioactivity

- **The spontaneous emission of energetic particles– alpha rays, beta rays, gamma rays – from radioactive materials**



Madam Marie Curie

- The discovery of radioactivity by Henri Becquerel in 1896 inspired Mme and Pierre Curie to discover how to isolate polonium, named after the country of Marie's birth, and radium.
- With her husband, in 1903 she was awarded half of the **Nobel Prize for Physics**, for studying the spontaneous radiation discovered by Becquerel, who was awarded the other half of the Prize. In 1911 she received a 2nd **Nobel Prize in Chemistry** for her work in radioactivity.

Providing a Perspective to the Dangers of Radiation Disasters: Goiânia, (Goh ee yan ya) Brazil Population 1.3 million

An abandoned medical clinic in Goiânia contained 1,400 Curies with radioactive cesium the source

- **The Goiânia incident was a radioactive contamination accident that occurred on September 13, 1987 after an old radiotherapy source was taken from an abandoned hospital site in the city.**

- **It was subsequently handled by many people, resulting in four deaths and radioactive contamination of others.**

Outcome of the Goiânia Incident

- 130,000 people (10%) came to ER / temporary screening locations
- 250 (0.2%) were contaminated
- 20 (0.01%) required treatment
- 4 people (0.003%) ultimately died

Goiânia Incident

- 99.8% were not contaminated
- 8% had psychosomatic reactions mimicking radiation exposure

Japan: An Archipelago Prone to Disasters

- Japan has one of the most sophisticated earthquake preparedness program and early-warning systems.

- After the earthquake of September 1, 1923 killing at least 100,000 people, fire-prone wood and brick buildings were replaced with towers of concrete and steel. Japan was then devastated by the atomic bombs of World War II in 1945, and then the Kobe earthquake of 1995 killed about 5,100.

- In Japan on September 1 every year is Disaster Prevention Day and many schools have celebrations that include an evacuation drill.

- **In 1981 Japan's building codes were further updated and then again in 2000.**

- **However, the magnitude 9.0 (Richter Scale) March 11, 2011 earthquake, the fourth largest in the world since 1900, was equal to 30 1906 San Francisco earthquakes and 700 times greater than the recent magnitude 7.0 earthquake in Haiti.**

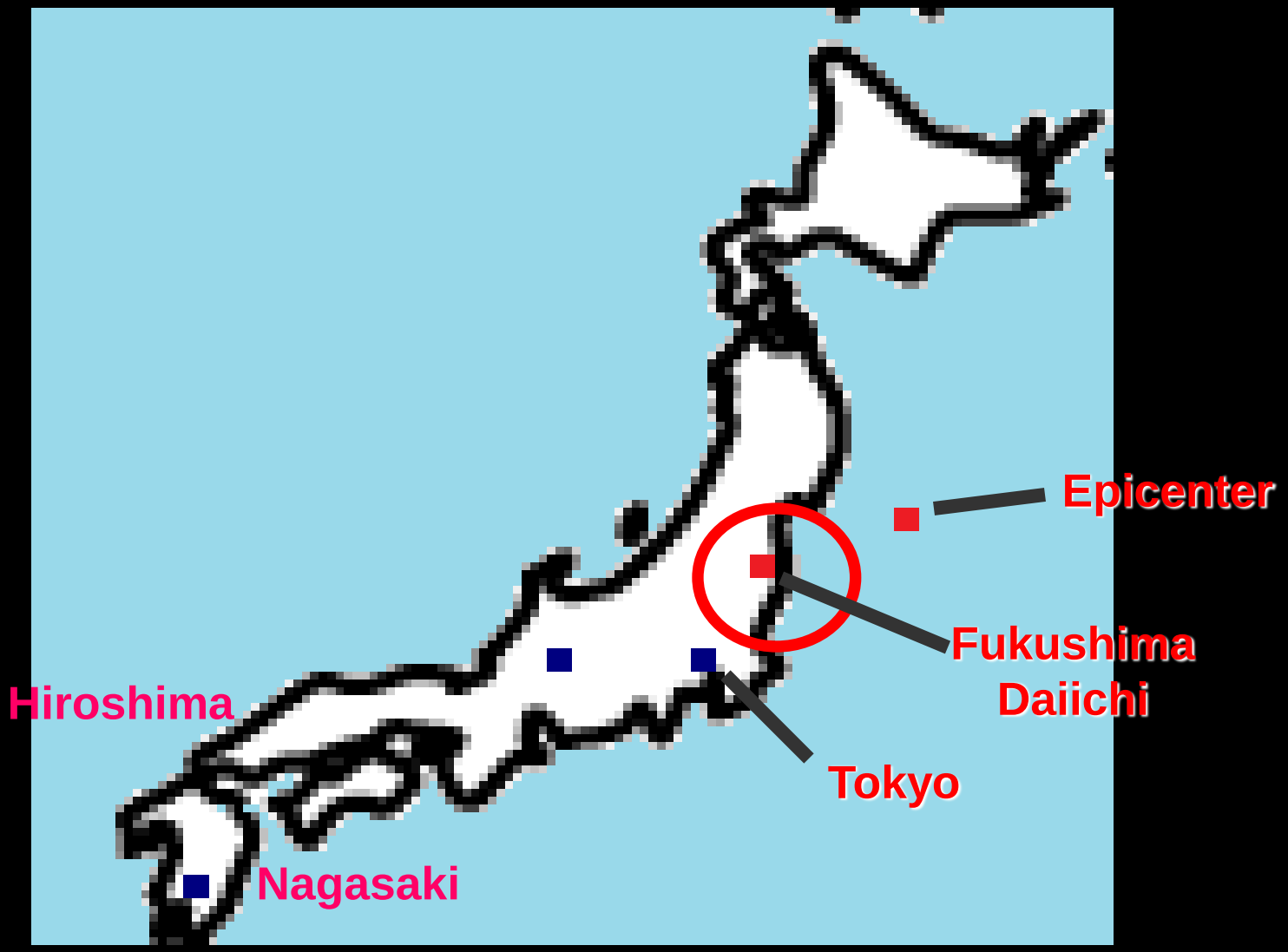
- **The quake and resulting tsunami led to the destruction of the Fukushima Daiichi nuclear energy plant, overwhelming much of Japan's preparedness. But without out its culture of preparedness, it could have been very much worse.**

How large?

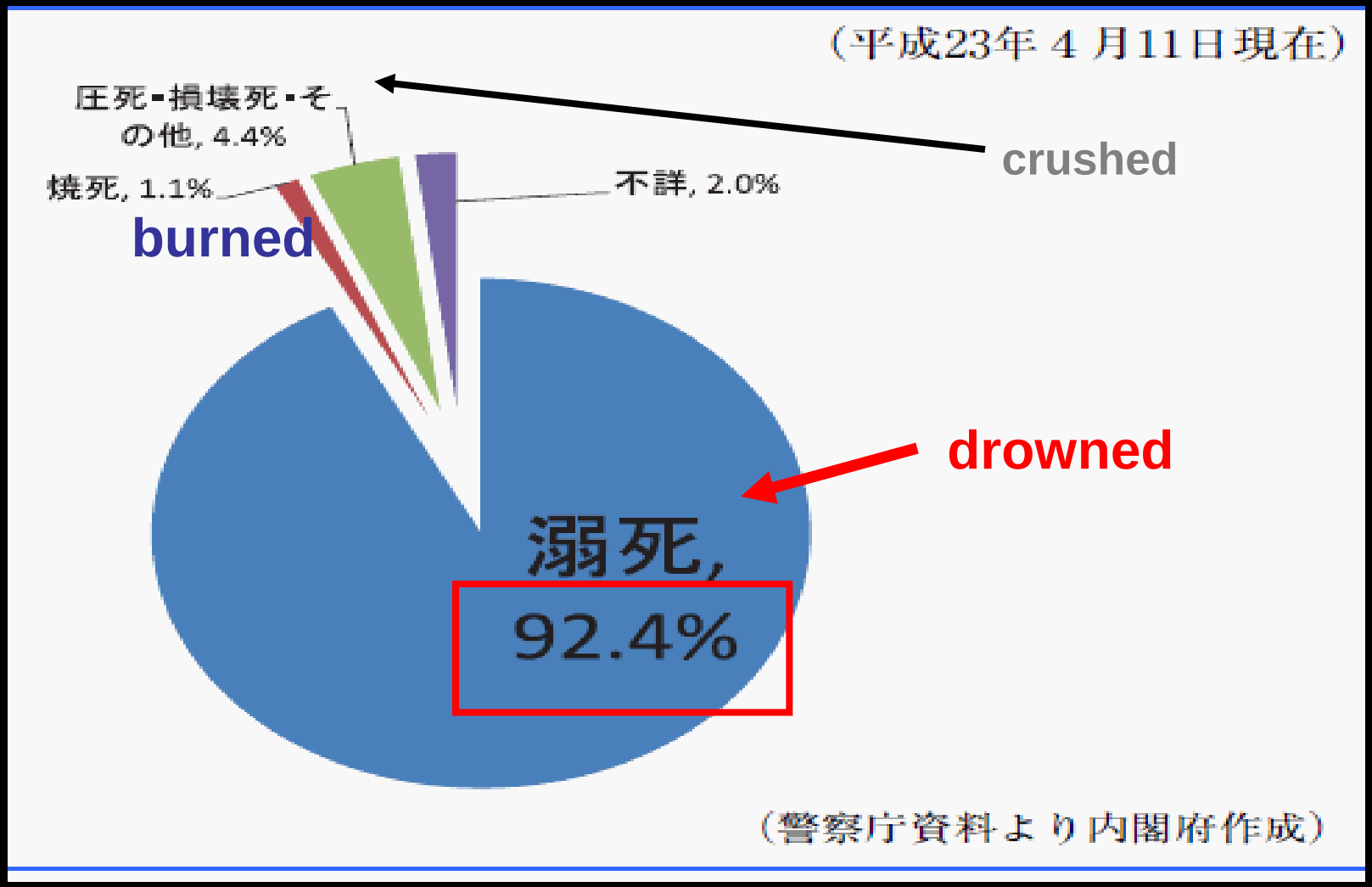
Japan = Florida x 2.2

- **The disaster triggered the first nuclear crisis of the 21st century.**

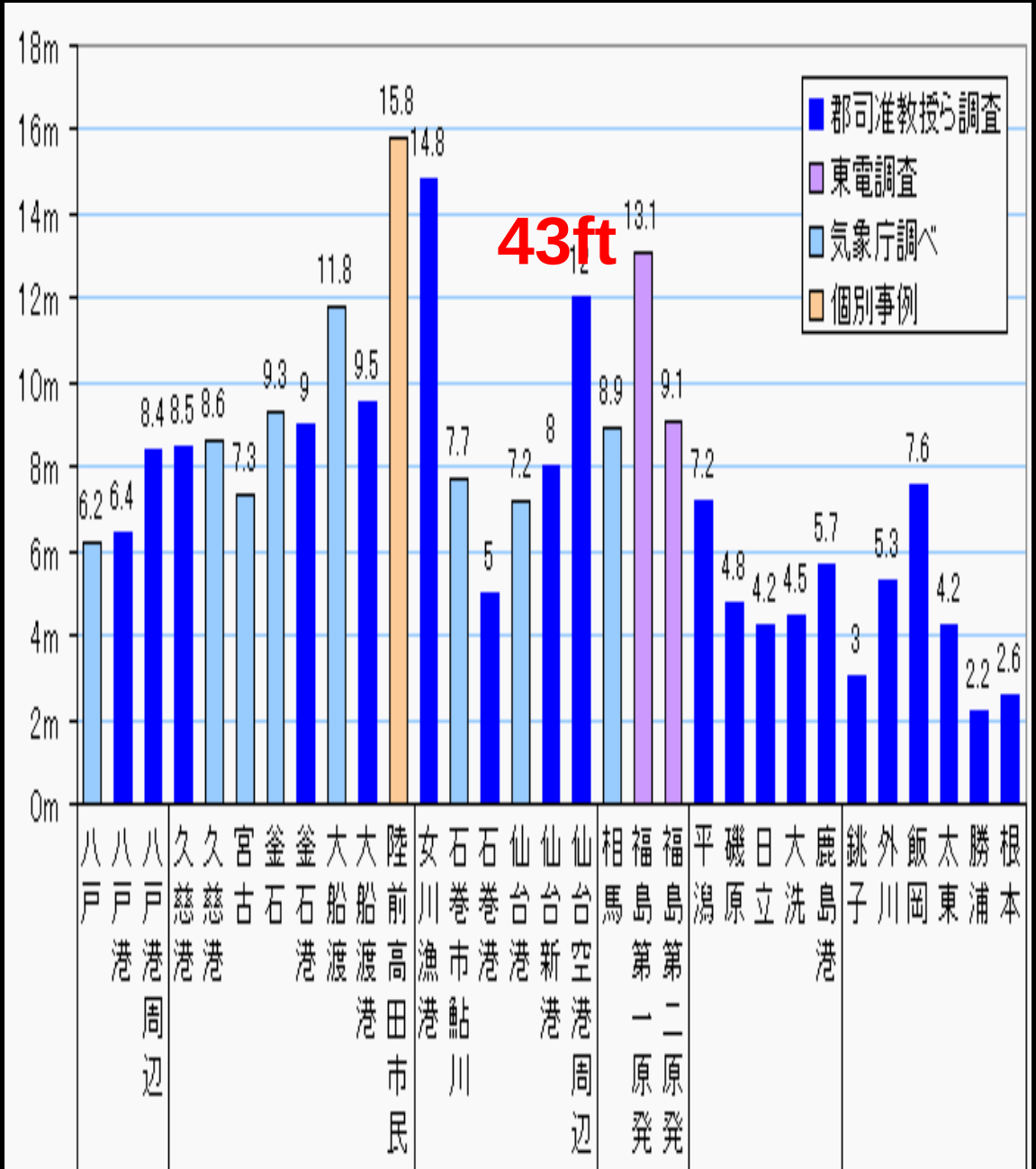
- **It resulted in a series of operational failures, explosions, and partial core meltdowns at Japan's Fukushima Daiichi nuclear power plant.**


Epicenter
Fukushima
Daiichi
Hiroshima
Tokyo
Nagasaki

Cause of death



Height of Tsunami



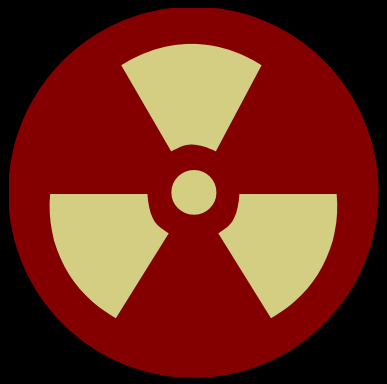
March 11, 2011 (Friday, 2:46 p.m.)
20,448 dead (as of July 24, 2011)
91,000 evacuees (as of July 14, 2011)

- **The situation at 3 of the plant's units was severe enough to warrant a level 7 rating on the International Atomic Energy Agency's International Nuclear and Radiological Event Scale.**

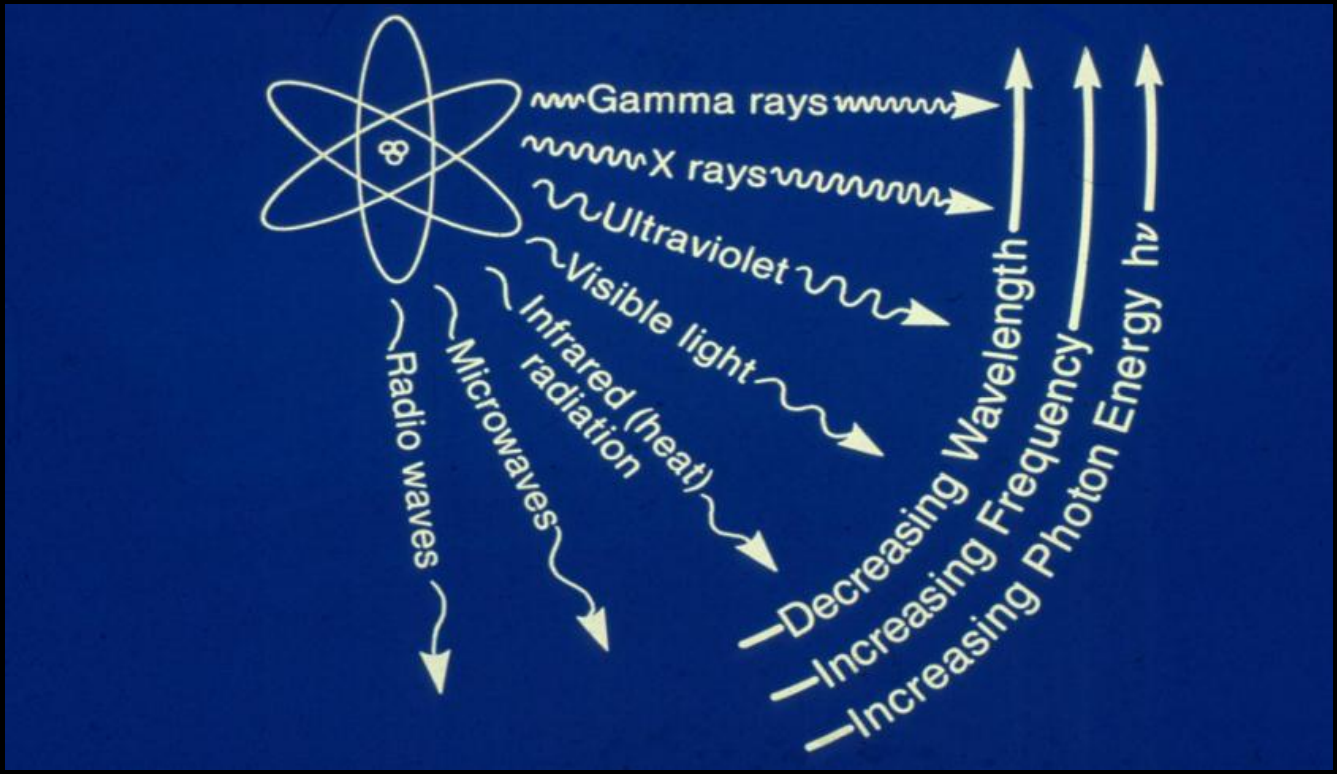
- **This classification denotes a "major incident" and a "major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures."**

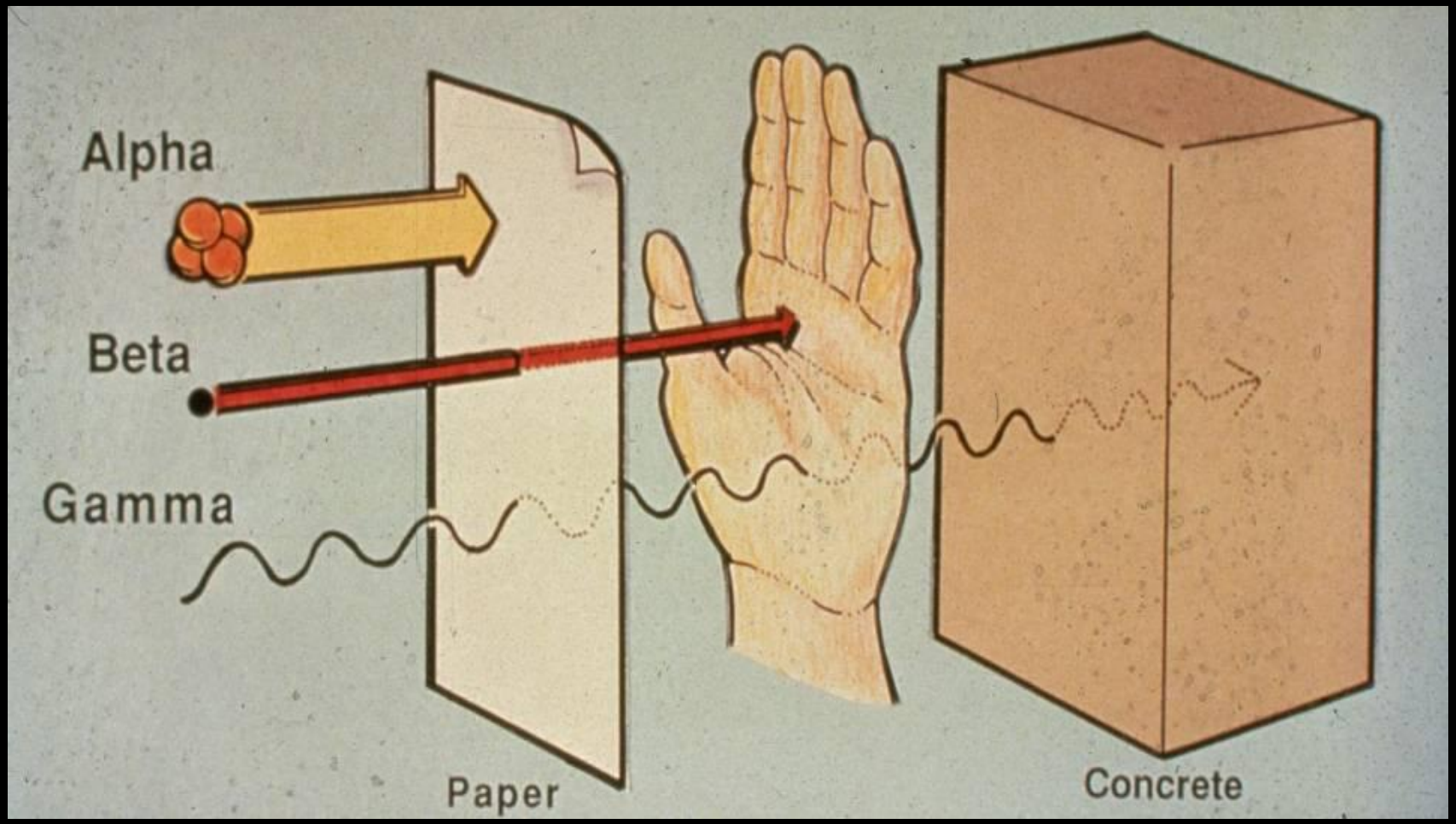
Radioactivity

- **The activity (strength) of a radioactive source (amount of radiation released into the environment) is measured in units called:**
  Curies (Ci) or Becquerels (Bq)



Radioactivity
The Electromagnetic Spectrum




Alpha
Beta
Gamma
Paper
Concrete

Radiation Dose

- Dose of radiation a person receives is measured in rems or milli-Sieverts (mSv)

- 1 rem = 10 mSv

Radiation Dose

- **10 mSv = 1 rem; 1 Sv = 100 rem**
- **1 mSv = 0.1 rem**
- **Average background radiation dose a person receives per year is about 0.66 rem (6 mSv).**
- **A mammogram produces about 0.01 mSv.**
- **A CT scan of the spine produces about 6-10 mSv (0.6 - 1 rem).**

Dose in mRem from Common Sources of Radiation

- X-rays: Extremity 1; Dental 1 Pelvis/Hip 65 ; Skull/Neck 20; Barium Enema 405; Upper GI 245
- CT Scan (Head and Body) – 110
- Nuclear Medicine (e.g., Thyroid Scan) – 14
- Cosmic Radiation in Feet: Sea Level 26 compared to 96 mRem at 9,000 feet

Effects of Radiation on People

- One sievert (Sv) is a large dose (100 rem)
- 10 Sv- Risk of death within days or weeks (1000 rem)
- 1 Sv (100 rem)- Risk of cancer later in life (5 in 100)
- 100 mSV (10 rem)- Risk of cancer later in life (5 in 1,000)
- 50 mSv (5 rem)- Threshold limit values (TLV) for annual dose for radiation workers in any one year

Health Effects	***Who's Exposed***
1. Up to 6.6 mSv (0.66 rem) Yearly	1. Avg. U.S Adult Exposure Yearly
2. 10 mSv (1 rem)	2. Person Getting 1 CT Scan
3. 20 mSv (3 rem)	3. Maximum Dose Per Year Set By Japan for Schools With Young Children (prior to 5/28/11) – now 1mSv
4. Up to 30 mSv (3 rem)	4. Chernobyl Residents
5. 250 mSv (25 rem) Nausea, Vomiting, Fatigue in Hours	5. Emergency Workers Exposure at Fukushima Daiishi
6. 10,000 mSv (1000 rem)	6. Hair Loss, Hemorrhage, Internal Bleeding Could Develop Over 2 Months, Followed by Death

Placing in Perspective the Current Situation in the U.S. Due to the Radiation Coming From Japan

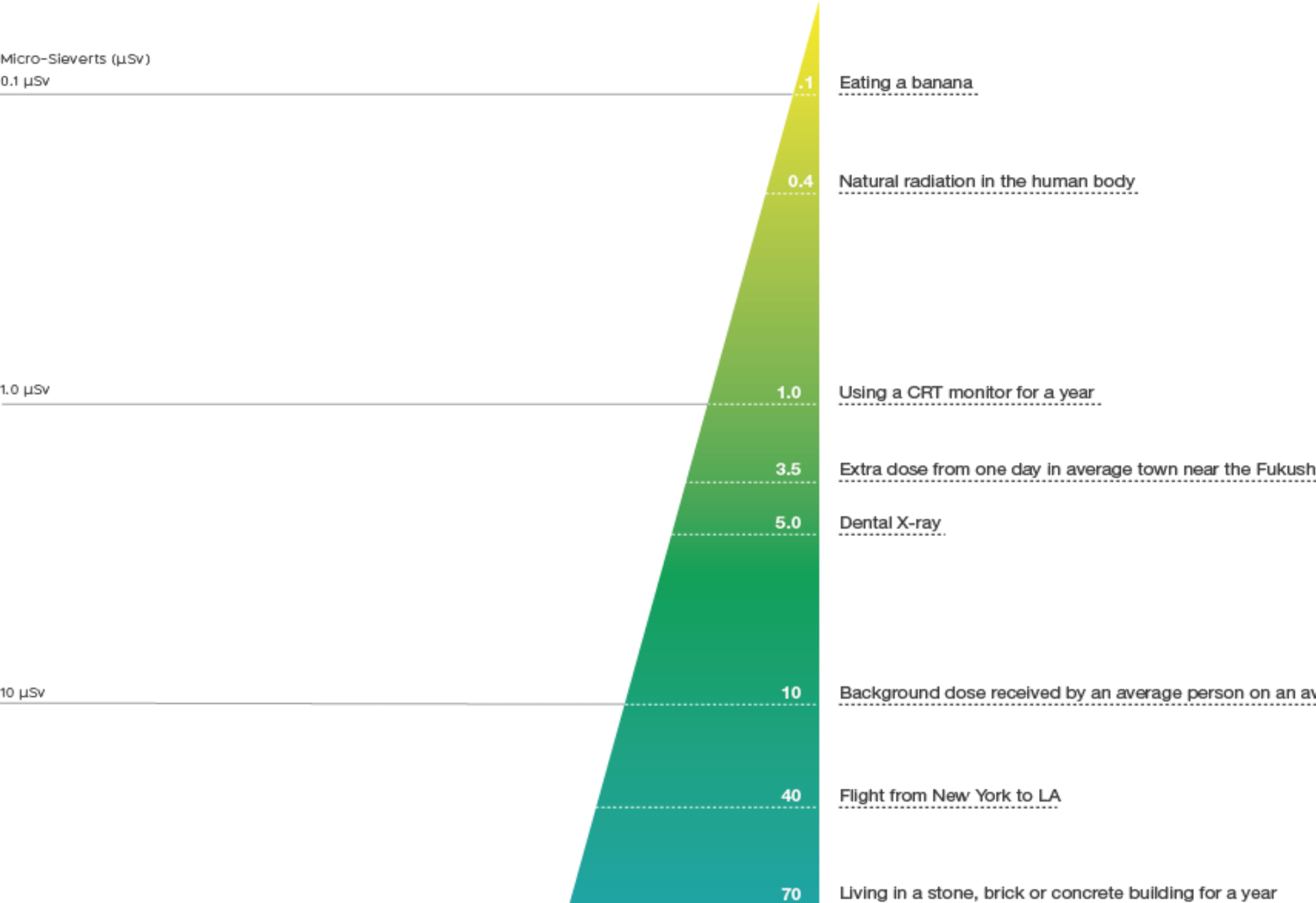
- **Trace amounts of radiation from Japan have been detected across the United States. But natural background radiation is > 100,000 times more than the highest levels detected.**

- **Radiation levels detected in milk from Washington State were 5,000 times lower than limits set by the Food and Drug Administration. A person would have to drink *1,552 gallons* of this milk to reach the limit.**

- **Radiation in rainwater in British Columbia was less than one millionth the amount shown to cause thyroid diseases. A person would have to drink *three million glasses* at *one time* to reach a problematic dose in the thyroid.**

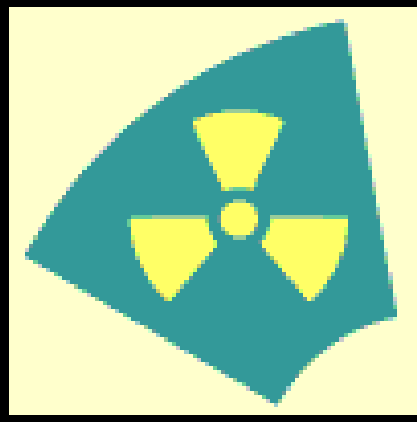
Sources: British Columbia Centre for Disease Control, U.S. Environmental Protection Agency, Food and Drug Administration, Nuclear Regulatory Commission, International Atomic Energy Agency

Radiation Dosage Chart



Radiation Dosage Table

- 100 µSv Chest X-ray
- 250 µSv Release limit for a nuclear plant per year
- 400 µSv Yearly dose per person from food
- 1000 µSv Environmental Protection Agency yearly limit for a nuclear power plant



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µSV = microSieverts

1000 microSieverts = 1 milliSievert= 1 mSV= 0.1 rem

- 1.5 mSv Spinal X-ray
- 3.0 mSv Mammogram
- 3.6 mSv 1 day dose at 2 sites 50 km (30 miles) NW of Fukashima
- 6.0 mSv Natural background radiation we are exposed to in a year
- 6.0 mSv Dose from spending 1 hr at Chernobyl in 2010
- 10 mSv (1 rem) Average CT scan
- 36 mSv Smoking 1.5 packs per day for a year
- 50 mSv Maximums dose permitted for U.S. radiation workers

- **100 mSv (10 rem)** — **Annual dose with > lifetime cancer risk**
- **250 mSv** — **Dose limit for U.S. radiation workers in life-saving operation**
- **400 mSv** — **Maximum dose detected per hour at Fukushima**
- **500 mSv** — **1:150 lifetime > in risk of cancer**
- **1000 mSv** — **1:125 lifetime > in risk of cancer**
- **2000 mSv** — **Severe radiation poison-survival likely**
- **4000 mSv** — **Extremely severe dose/survival possible with prompt treatment**

MilliSeverts (mSv)

- 5,000 mSv (500 rem) — High chance of fatality
- 6,000 — Usually fatal
- 10,000 — Fatal dose
- 50,000 — 10 minute exposure to Chernobyl reactor after melt down
- 100,000 (10,000 rem) — Death in hours

- **A single dose of 100 mSV, 40 times the average annual exposure to natural background radiation, increases a person's chances of cancer by about 2 percent.**

National Academy of Sciences. Biological Effects of Ionizing Radiation VII; 2011

Effect of Emissions from Various Sources of Electricity Generation on Life Expectancy Compared with Nuclear Power

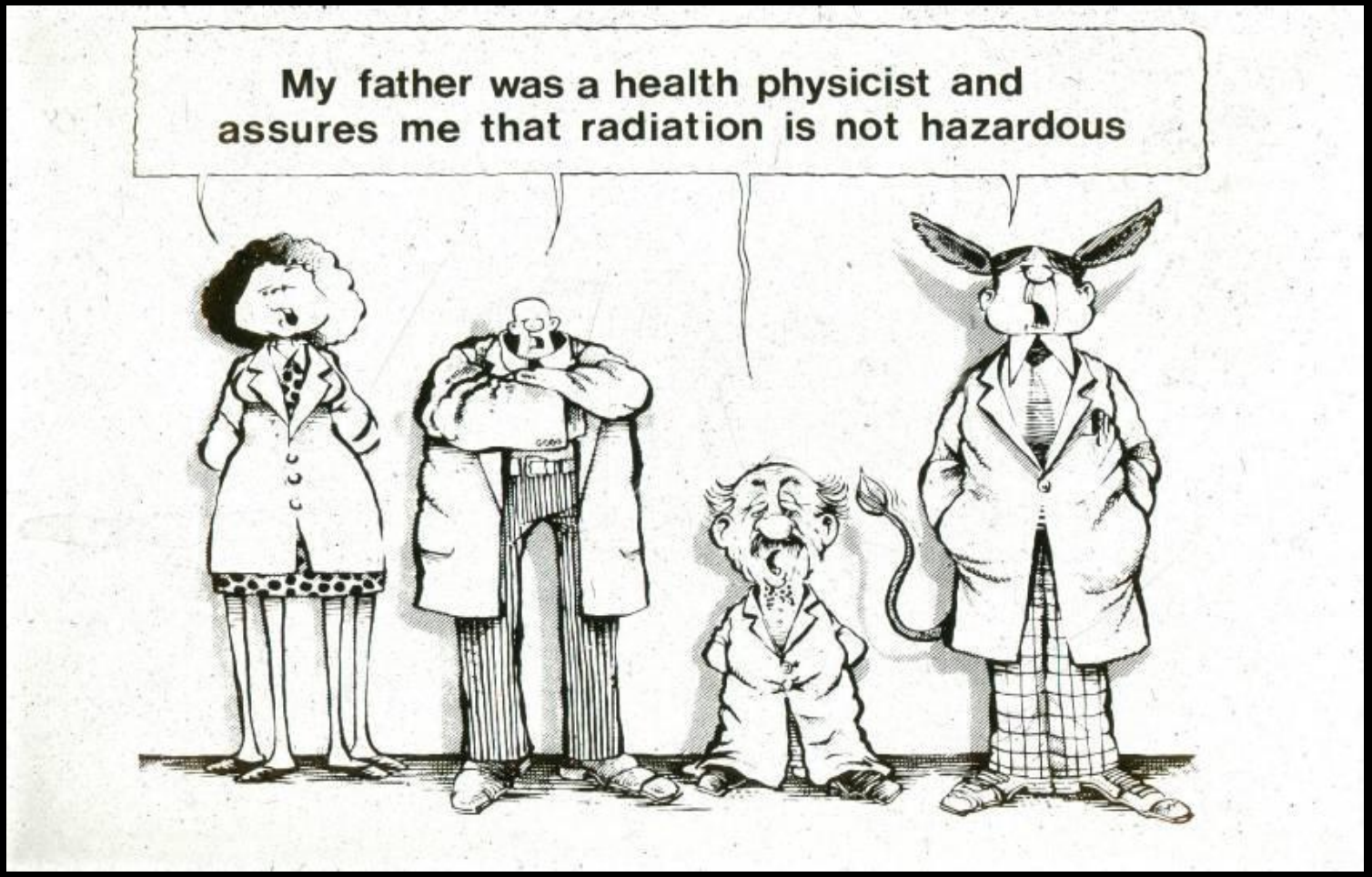
Source	
Coal	About 5 times as much
Oil	About 14 times as much
Natural Gas	About 1.7 times as much

From journal Risk Analysis;1998.
Derived from Burton Richter, Stanford University
University Nobel Prize physics professor and member of the Nuclear Energy Advisory Committee , U.S. Department of Energy

The Principal Hazards of Ionizing Radiation

- Genetic effects
- Carcinogenic effects
- Effects on the developing embryo/fetus (teratogenic)

Radiation damage does <u>not</u> work this way...



Radiation, Cancer- WW II A-bomb Survivors

- 87,000 survivors followed
- 7,800 cancer deaths seen (9.0%)
- 7,400 expected (8.5%) in those unexposed to radiation
- Therefore, 400 or 5% excess cancers

Contamination with radioactive iodine has almost exclusively been identified in the aftermath of accidents at nuclear reactors.

Ingestion of milk is the main route of internal I-131 exposure for people.

Goat's milk and sheep's milk appear to be particularly sensitive to contamination as goats and sheep feed on plants that have less water content (are more concentrated). Goat and sheep milk are reported to contain about 10 times the concentration of radioactive iodine then cow's milk.

Half-Life

- **Time for a radioactive substance to lose <u>half of its activity</u> due to radioactive decay.**

- **At the end of one half-life, 50% of the original radioactive material has decayed.**

- **I-131 has a half life of about 8 days but it takes about 10 half lives to be gone or less than 3 months.**

(American Nuclear Society)

- **Cesium 137 has a half life of about 30 years and takes about 300 years to be gone.**

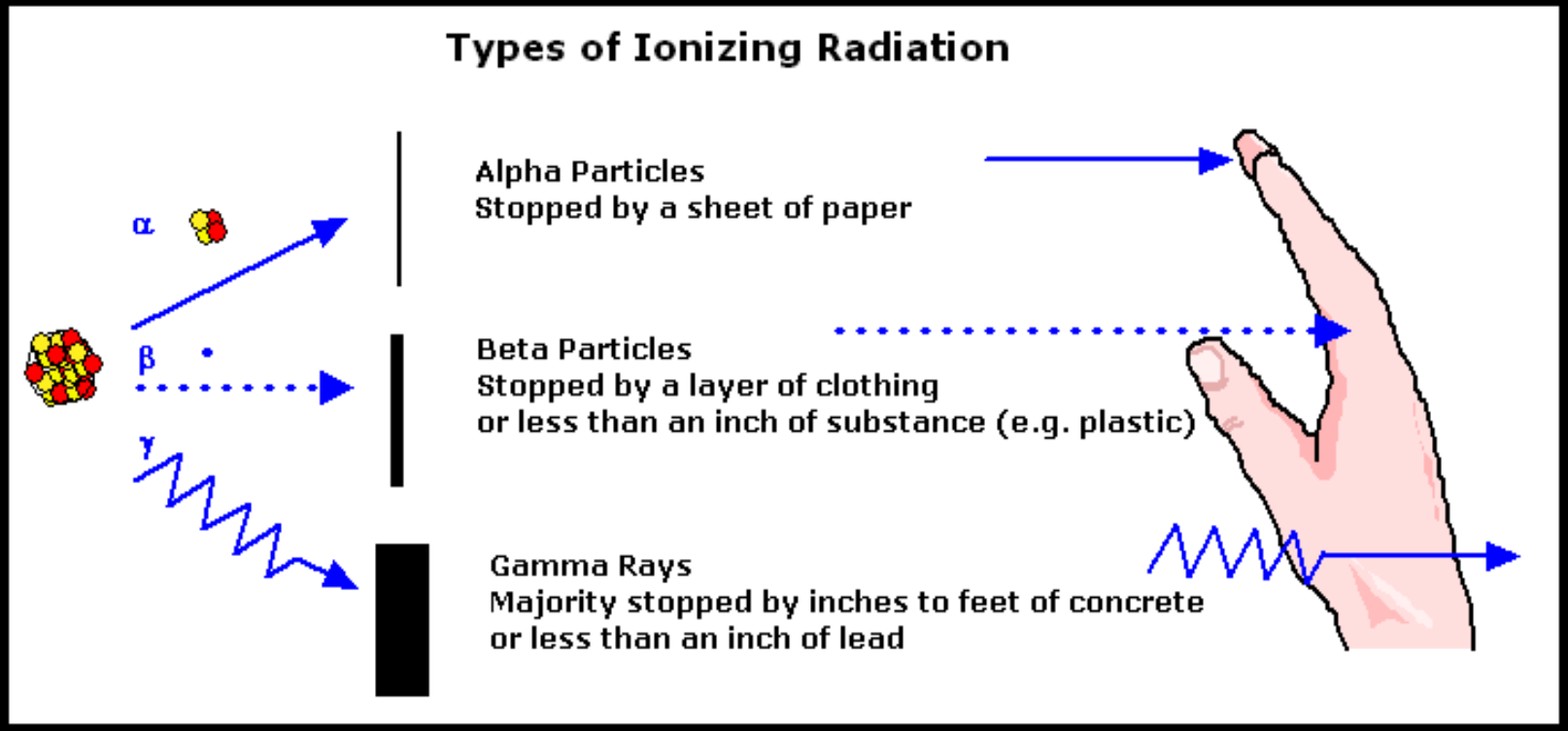
- **Biological Half Lives: how long it takes a body to eliminate them. I-131 and Cesium 137 have an overall half life of about 3 months in adults but these are cleared faster in children**

Nuclear Power Reactors

- There are 104 commercial nuclear power reactors in the US and about 36 research reactors, most in universities.
- In <u>US</u> commercial nuclear power plants the reactor core is encased in steel, then in a concrete building.

There are two operating nuclear power plants in South Florida

- St. Lucie in St. Lucie County
- Turkey Point in Miami-Dade County



Atoms producing α radiation are a major threat only if they <u>internally contaminate</u> – ingestion, inhalation, wound contamination. They are high energy low penetrating particles.

β particles can burn or penetrate the skin – are dangerous internally or externally.

Radioactive Material Characteristics

- Detection
  - Cannot detect with senses
  - Requires specialized equipment and training
- Physical form
  - Initially, an airborne solid, dust or gas.
  - Will adhere to surfaces, may dissolve in water.
  - May re-suspend over time
- Persistence
  - Depends on the “half-life”
  - Environmental transport depends on chemistry, but also physical factors
  - Both dilution and bio-concentration

Internal contamination countermeasures?

- Potassium iodide (KI) blocks radioactive iodine (I-131) from absorption by thyroid
- Its use is limited to I-131
- Available without Rx

Caveat

- Potassium Iodine is most effective when taken before exposure or within two hours after.
- It has little effect when administered days after the release of radiation.
- Iodized salt also contains iodine but not enough to block radioactive iodine from getting to your thyroid. Do not use it as a substitute for KI.

- **KI cannot prevent radioactivity from entering the body.**
- **It can only protect the thyroid from radioactive iodine, not other parts of the body.**
- **If radioactive iodine is not present, taking KI is not protective.**

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- **It can only protect the thyroid from radioactive iodine, not other parts of the body.**
- **If radioactive iodine is not present, taking KI is not protective.**

- **You should only take potassium iodide (KI) on the advice of emergency management officials, public health officials, or your doctor.**
- **There are health risks associated with taking KI.**

- **CDC: March 17, 2011**

KI Dosage

- Adults: one 130 mg tablet or two 65mg tablets or 2ml of solution.
- Breast feeding women: same adult dose.
- Children: 3-8 years- 1 65 mg tab or 1 mL of solution; adult size children (150 lbs)- full adult dose
- Infants and children between 1 month and 3 years: 32mg tablets or ½ mL of solution.
- Newborns to 1 month: 16mg or 1/4

CDC: March 17, 2011

Side Effects of KI are Rare

- Intestinal upset
- Allergic reactions
- Rashes
- Inflammation of salivary glands

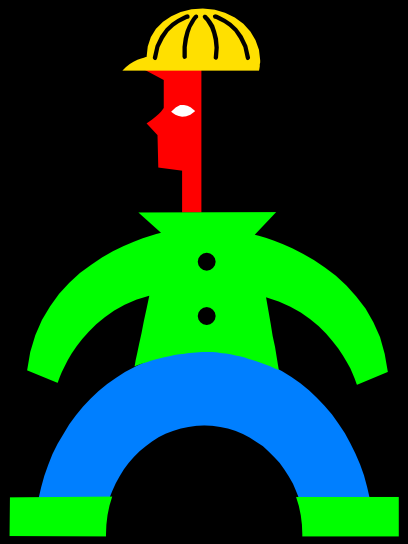
- **Japanese radiation experts claimed that few had been exposed to radiation doses after the Fukashima Daiishi disaster large enough to raise the risk significantly of developing thyroid disease, even without the ingestion of potassium iodide.**

Internal contamination countermeasures?

Prussian blue traps cesium in the intestine, so that it can be passed out of the body in the stool rather than re-absorbed

Recently approved by FDA

Only useful if the radioactive material is cesium



Thank you!