

NUCLEAR DISASTERS



RADIATION UNITS

- ▶ When dealing with the environmental effects of radiation, we are most interested in the actual dose of radiation delivered by the radioactivity.
- ▶ The energy absorbed by a mass of material is measured using the radiation absorbed dose (rad) is used
- ▶ The SI unit for radiation, which measures the biological impact, is the sievert (Sv)
- ▶ The average Canadian receives 1.5 mSv/year due to cosmic radiation, geology and medical procedures

RADIATION UNITS

- ▶ Some other units are used for measuring radiation, including: gray, rem, becquerel and curie
- ▶ Conversions between units can be very complex:
 - 1 gray (Gy) = 100 rad
 - 1 rad = 10 milligray (mGy)
 - 1 sievert (Sv) = 1,000 millisieverts (mSv) = 1,000,000 microsieverts (μ Sv)
 - 1 sievert = 100 rem
 - 1 becquerel (Bq) = 1 count per second (cps)
 - 1 curie = 37,000,000,000 becquerel = 37 Gigabecquerels (GBq)

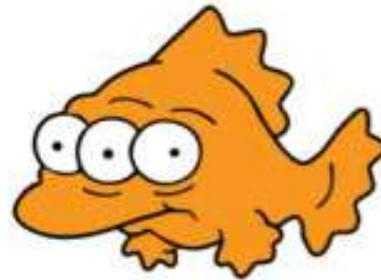
SIMPSONS GUIDE TO RADIATION



Bequerel [Bq]
How brightly your
Cesium glows



Gray [Gy]
How brightly
Cesium will make
you glow



Sieverts [Sv]
How many extra
eyes will you have
after glowing?

RADIATION UNITS

- ▶ For x-rays and gamma rays, $1 \text{ rad} = 1 \text{ rem} = 10 \text{ mSv}$
- ▶ For neutrons, $1 \text{ rad} = 5 \text{ to } 20 \text{ rem}$ (depending on energy level) = 50-200 mSv
- ▶ For alpha radiation (helium-4 nuclei), $1 \text{ rad} = 20 \text{ rem} = 200 \text{ mSv}$

RADIATION UNITS

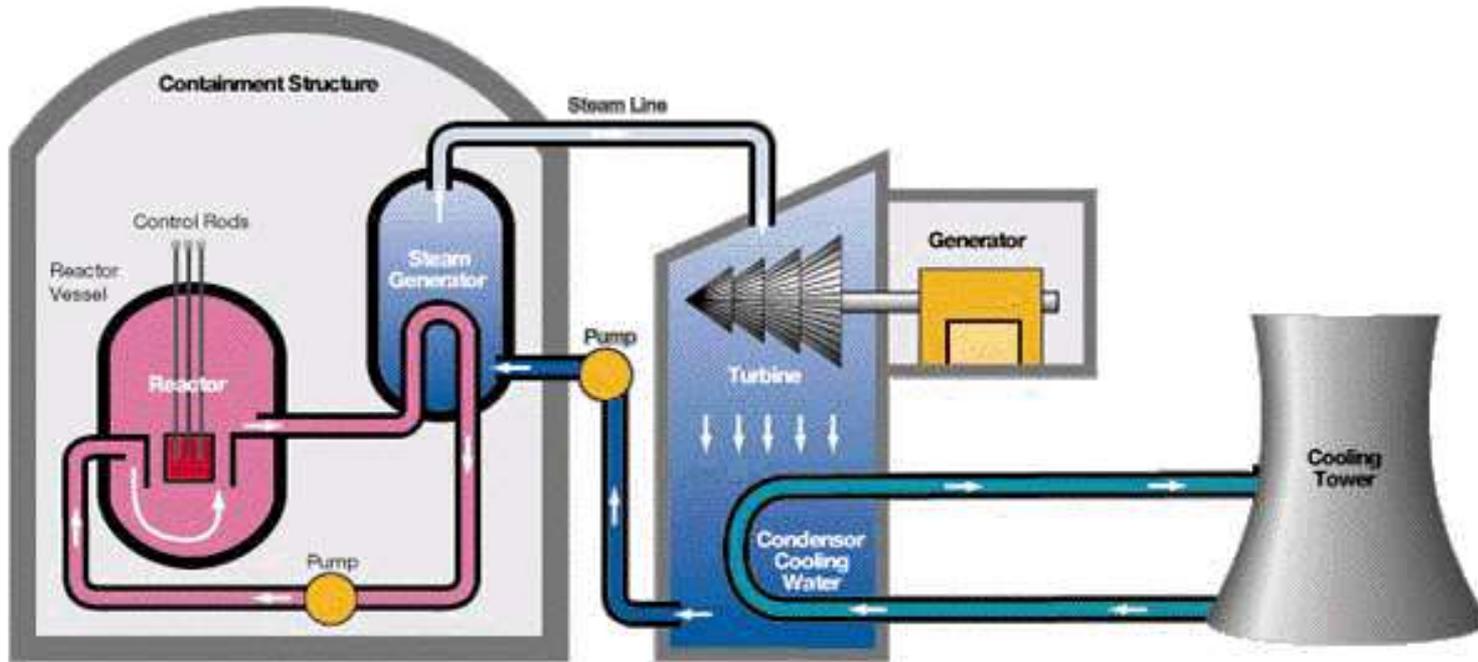
- ▶ In a nuclear disaster, all types of radioactive rays and particles can be released

THREE MILE ISLAND



THREE MILE ISLAND

- ▶ 2 Pressurized Water Reactors in Harrisburg, Pennsylvania



THREE MILE ISLAND

- ▶ March 28, 1979
- ▶ A mechanical error caused the water pumps to stop working
- ▶ The reactor still generated heat and caused a rupture in the relief tank
- ▶ Radioactive coolant leaked into the general containment building and a small explosion occurred.

THREE MILE ISLAND

- ▶ On the third day after the accident radiation levels were measured to be 12 mSv/hour.
- ▶ The reactor was too badly damaged and the decommissioning finished in December 1993 costing \$975 million.

THREE MILE ISLAND



THREE MILE ISLAND

Three Mile Island today

No. of operating units: One

Capacity: 829 megawatts

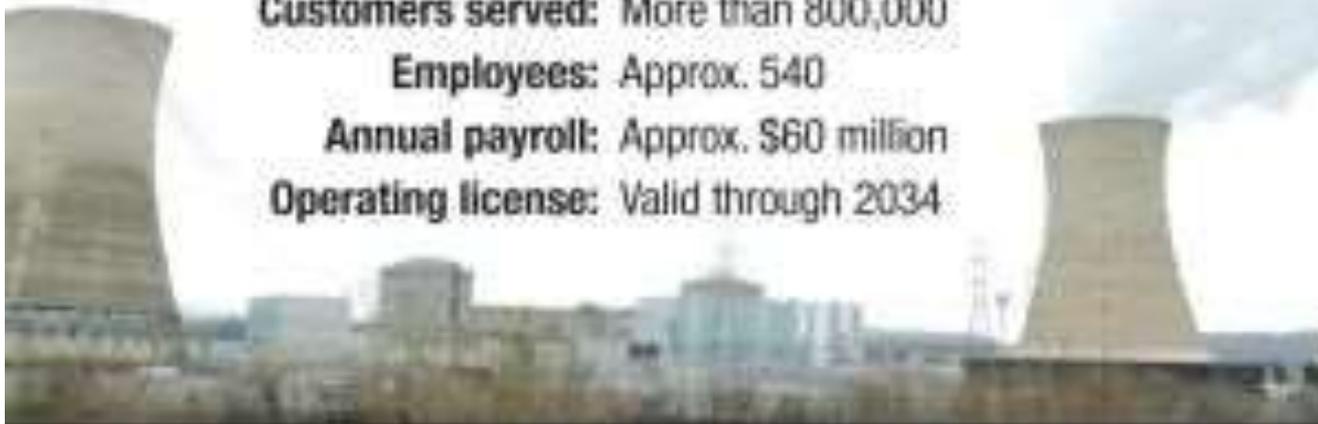
2012 generation: 7 million megawatt-hours

Customers served: More than 800,000

Employees: Approx. 540

Annual payroll: Approx. \$60 million

Operating license: Valid through 2034



Source: Exelon Corp.

Chris Enslin / Staff

CHERNOBYL

- ▶ April 26, 1986 employees were instructed to conduct an experiment during a shut down procedure
- ▶ The steam to the turbines was shut off and the rods from the core were removed.
- ▶ When the rods were reinserted into the core after a brief cooling period there was a spike in the energy production (30 GW) and the reactor overheated

CHERNOBYL

- ▶ The steam caused the first explosion and blew the lid off the reactor
- ▶ A graphite fire followed and burned until May 10

CHERNOBYL

- ▶ In the 30 km zone around the plant the average radiation dose was 430 mSv.
- ▶ There were 237 confirmed cases of radiation sickness
- ▶ 31 people died of radiation sickness
- ▶ Over the next 50 years, Chernobyl will be responsible for approximately 16 000 deaths worldwide.
- ▶ The total cost of the accident is estimated to be \$200 billion.

CHERNOBYL

- ▶ The 19 km zone around Chernobyl has become a tourist attraction



- ▶ http://www.ukrainianweb.com/chernobyl_ukraine.htm

CHERNOBYL

- ▶ 60 Minutes Episode on Chernobyl --
<https://www.youtube.com/watch?v=Zp9zy9JvG14>
- ▶ Popular Science Article, with 3 minute drone vimeo
-- <http://www.popsci.com/view-ruins-chernobyl-drone>
- ▶ New York Times Article, about the new cap --
<http://www.nytimes.com/interactive/2014/04/27/science/chernobyl-capping-a-catastrophe.html>

FUKUSHIMA



FUKUSHIMA - BEFORE



FUKUSHIMA

- ▶ A 9.0 magnitude earthquake caused a tsunami on March 11, 2011, which triggered a nuclear disaster at the Fukushima power plant
- ▶ On March 12, an explosion and radiation leak were confirmed in reactor # 1

FUKUSHIMA

- ▶ On March 14, a blast destroyed the concrete building in reactor 3
- ▶ On March 15, an explosion was reported in reactor 2 and the fuel rods were exposed for a period
- ▶ On April 2, it was found that contaminated water was leaking into the sea

FUKUSHIMA

- ▶ On April 5, 2012, highly radioactive wastewater was accidentally released into the sea

FUKUSHIMA - AFTER (8 days later)



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FUKUSHIMA

- ▶ Fukushima
- ▶ Fukushima 1
- ▶ Fukushima 2
- ▶ Fukushima 3
- ▶ Fukushima 4