



Chernobyl

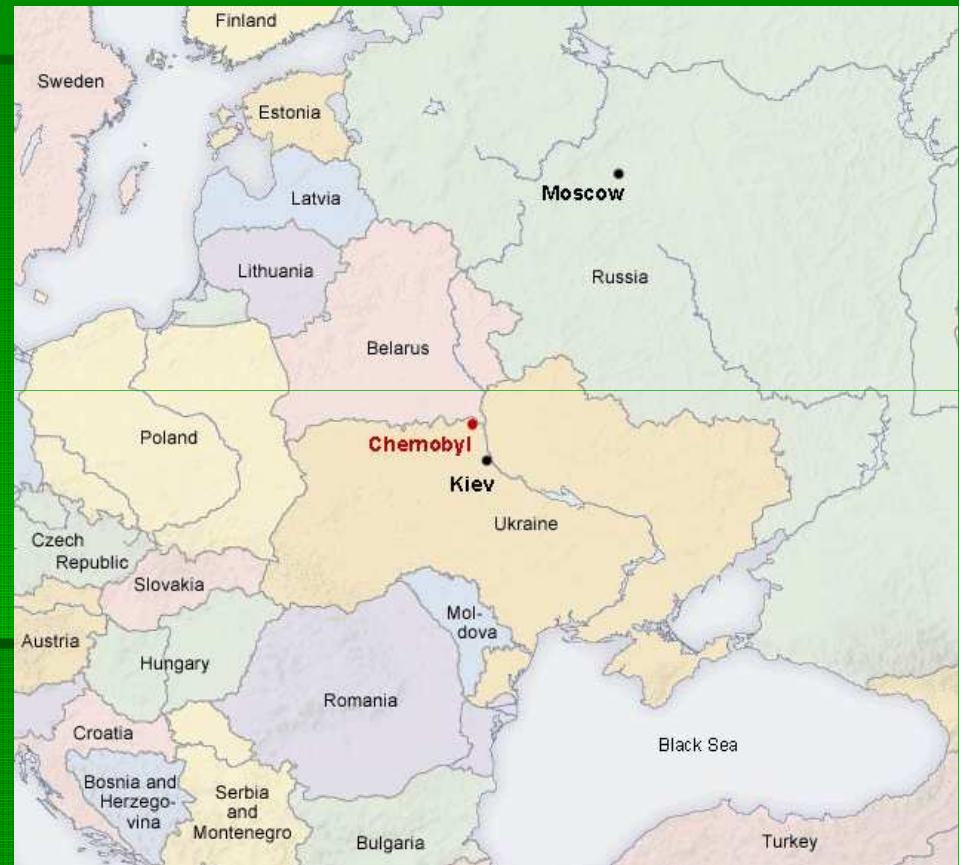
GE 4150- Natural Hazards

The disaster

- April 26, 1986
- Worst nuclear plant accident in history
- At 1:23 am reactor number 4 failed at the plant located in the Soviet Union, near Pripyat in the Ukraine.
- Resulting fire sent a plume of highly radioactive fallout into the atmosphere

Location

- Near the border of Ukraine and Belarus
- Toxic plume drifted over parts of the Soviet Union and Europe



<http://www.greenfacts.org/en/chernobyl/figtableboxes/map-chernobyl.htm>

Chernobyl Nuclear Power Plant

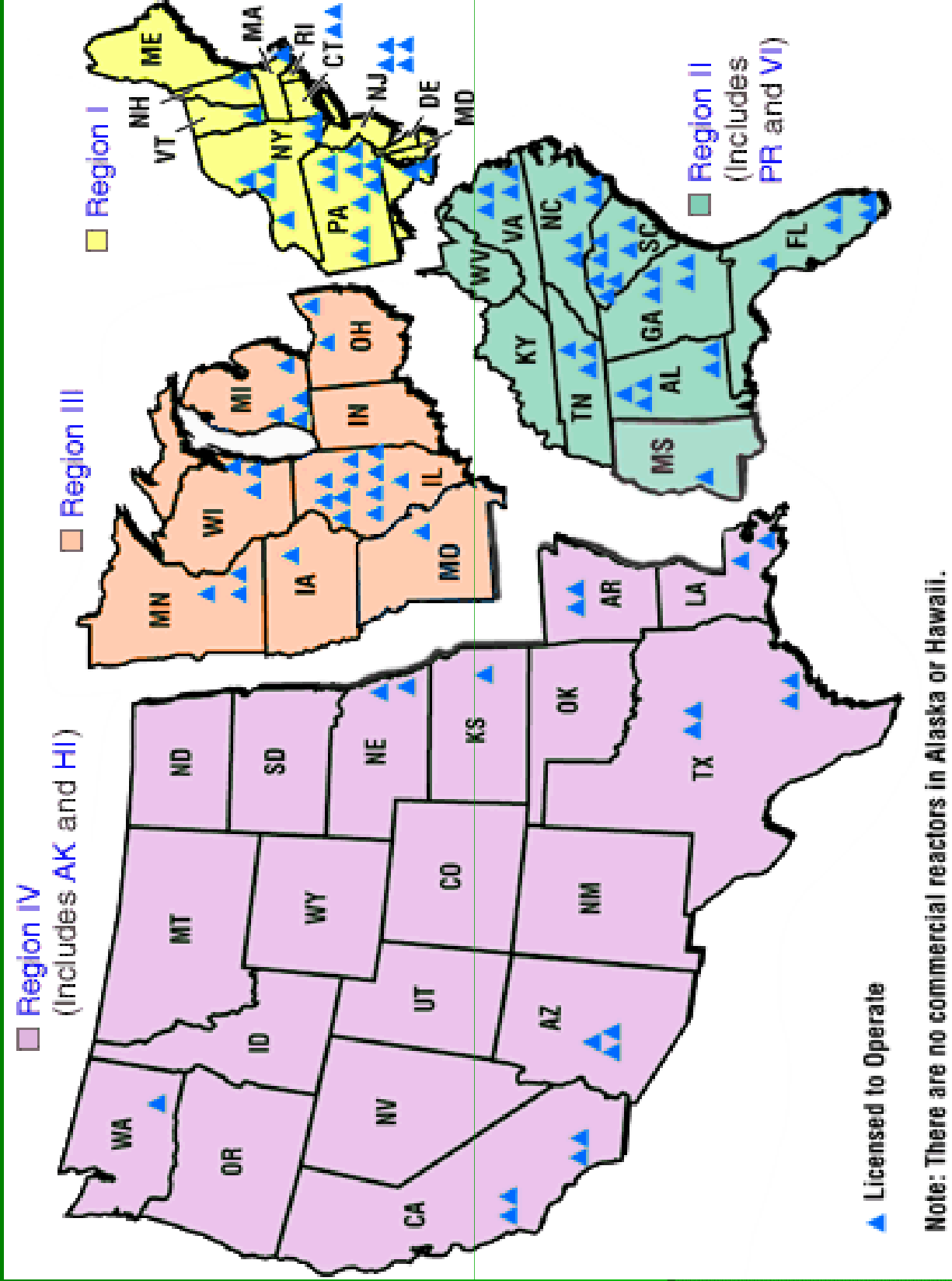
- Station consisted of 4 reactors
- Each was capable of producing 1 gigawatt of electric power
- The 4 reactors together produced 10% of Ukraine's electricity at the time of the accident
- Construction of the plant began in the 1970's, reactor 4 was built in 1983 and two more reactors were under construction at the time of the disaster

Nuclear Power

- Uses nuclear fission to release energy for work, including propulsion, and the generation of electricity
- Nuclear energy is produced by a controlled nuclear chain reaction and creates heat- which is used to boil water, produce steam, and drive a steam turbine
- The turbine can be used for mechanical work which provides electricity

Nuclear Power

- In 2004 nuclear power provided 6.5% of the world's energy, and 15.7% of the world's electricity
- U.S., France, and Japan accounting for 57% of nuclear generated electricity
- As of 2007 there are 439 nuclear power reactors in operation throughout the world in 31 countries
- The U.S. produces the most nuclear energy, with nuclear power providing 20% of the electricity it consumes



Uranium-fueled Reactors

- Natural uranium is highly energetic, one kilogram of it can generate as much energy as 10 tones of oil
- Reactors using U_{235} as fuel need to slow down the neutrons, which is done using a moderator which acts as coolant
- Pressurized Water and Boiling Water reactors are the most common in the U.S.
- <http://www.nrc.gov/reading-rm/basic-ref/students/animated-pwr.html>
- <http://www.nrc.gov/reading-rm/basic-ref/students/animated-bwr.html>

Chernobyl Reactor

- RBMK-reactor of high power of the channel type
- Graphite-moderated nuclear power reactor, which was only built in the Soviet Union
- RBMK was the reactor type in the Chernobyl disaster
- In 2004 several were still operating, but there are no plans to build more

Sequence of Events

- Test Plan- planned to test whether the turbines could produce sufficient energy to keep the coolant pumps running in the event of a loss of power until the emergency diesel generator was activated
- Safety systems were deliberately switched off
- The reactor had to be powered down to 25 % of it's capacity, this procedure did not occur and the reactor power fell to less than 1%

Sequence of Events

- 30 seconds after the test there was a sudden and unexpected power surge
- The reactor's emergency shutdown should have prevented the reaction, but it did not
- Within fractions of a second the power level and temperature rose and the reactor lost control

Sequence of Events

- A violent explosion occurred blowing the 1000 ton cap off of the reactor building
- The fuel rods melted at temperatures over 2000°C
- The graphite covering of the reactor ignited
- This released the radioactive fission products released during the core meltdown and were sucked up into the atmosphere

Reactor Fire

- Firefighters pumped cooling water into the reactor core 10 hours after the accident, but did not work
- From April 27-May 5, 30 military helicopters flew over the reactor and dropped 2400 tons of lead and 1800 tons of sand to try and smother the fire and absorb the radiation, which did work either
- The core of the reactor was finally cooled with Nitrogen and not until May 6 was the fire and radioactive emission under control

Radiation Effects

- The 600 men who helped with the firefighting were the most severely irradiated group
- Radiation is measured in sieverts (Sv); 1 millisievert is the maximum dose people should be exposed to living near a nuclear power plant, as defined by the European Union.
- The above men were exposed to radiation 13,000 times that limit, 31 one of them died shortly after exposure
- http://en.wikipedia.org/wiki/Radiation_poisoning

Types of Radiation

- More than 40 different radionuclides were released in the first 10 days
- The most significant are:
 - Iodine-131 (Half-life 8 days)
 - Cesium-137 (Half-life 30 years)
 - Strontium-90 (Half-life 29 years)
- Assumed that 50% of the reactor's iodine content and 30% of the cesium were released into the atmosphere



http://upload.wikimedia.org/wikipedia/commons/thumb/2/23/Chernobyl_radiation_map_1996.svg/568px-Chernobyl_radiation_map_1996.svg.png

Evacuation

- April 27, 36 hours after the accident, 45,000 inhabitants from Pripyat were evacuated in buses, and the town remains inhabited until this day
- Within 10 days 130,000 people from 76 settlements also evacuated

Closure of the Core

- 7 months after the disaster the core was enclosed within a reinforced concrete casing which was supposed to absorb the radiation. The structure was hastily built
- In 1997 a shelter implementation plan was created which would contain the radioactive substances for 100 years
- The 20,000 ton structure will enclose the the residual waste within reactor #4
- The structure will be completed in 2008 and will cost 768 million euro

Water Contamination

- Two rivers transported radiation on their surfaces in the first ten days after the accident
- Radiation has concentrated in lake sediments. Regardless people still fish there. Fish are among the most severely contaminated animals since they feed on the contaminated sediment
- Strontium and plutonium are a major concern for ground water

Soil contamination

- In Belarus, which received 70% of the fallout, about 22% of the country was contaminated with cesium-137
- They estimate 16% of the territory will still be contaminated in 2016
- Measurements from 1996 showed that 90% of the radioactive cesium was still deposited in the top 5 centimeters of soil

Food contamination

- Contamination of mushrooms, berries, game, and fish
- Still the region has many local families farming and producing their own food
- The governments have tried to educate citizens so this does not occur

Cancer

- The nuclear disaster has produced the biggest group of cancers from a single incident
- From 1992-2000 4,000 cases of thyroid cancer were diagnosed between the ages of 0-18 years at the time of the disaster
- Children need iodine during their development, which is taken up by the thyroid gland. Much of the radioactive material accumulated here in high concentrations

Leukemia

- In the Gomel region in Belarus reported a 50% increase in Leukemia after the disaster
- The Russian Liquidators (clean-up crew) had a significant rise in the number of leukemia cases

Cancer in Adults

- In the Gomel Region every 346 out of 100,000 people are expected to develop cancer (240 would be the normal value)
- Belarus showed a 40% increase in cancer between 1990-2000
- Men have developed tumors of the lungs, stomach, skin, and prostate
- Women have developed tumors of the breast, uterus, stomach, and skin

Other Diseases

- Belarus and Ukraine have a life expectancy 10 years lower than Sri Lanka, once of the 20 poorest countries
- In Belarus diseases of the nervous and endocrine system occur 1:3 times more frequently, and diseases of the blood 1:2 times more frequently than those in the uncontaminated areas

Illness

- The Ukrainian government agency, Chernobyl Interinform, found that of the approximately 3 million people who received increased doses of radiation, 84% have since become ill
- Among the liquidators, the rates is as high as 92%

Effects on pregnancy

- Exposure of the mother to radiation can lead to severe organ and brain damages in the newborn
- From 1986-1990 Ukraine had an increased number of miscarriages, premature births, still births, and 3 times the normal rate of deformities and developmental abnormalities in newborns

Economic Losses

- Estimates show that Belarus will suffer losses of USD 43.3 billion in the first 30 years after the accident
- The total damage is projected to be \$235 billion over this period
- Chernobyl related costs accounted for 22.3% of the country's national budget in 1991, currently the costs are 6% of the budget

Economic Losses

- Ukraine estimates the economic damage to their country are USD 201 billion by 2015, with the country's budget being USD 37 billion in 2001
- Today 5-7% of the budget is contributed to the disaster
- Costs to Russia totaled USD 3.8 billion between 1992 and 1998, 3 billion being paid to the helpers and victims

Sources

- <http://www.chernobyl.info/index.php?userhash=30077179&navID=10&IID=2>
- http://en.wikipedia.org/wiki/Chernobyl_disaster
- <http://www.nrc.gov/reactors.html>
- <http://www.youtube.com/watch?v=eAEfJ5K51LU&feature=related>
- <http://www.youtube.com/watch?v=-iDqzsTb3OM>