CASE STUDY ON: CHERNOBYL DISASTER

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Chernobyl Nuclear Plant

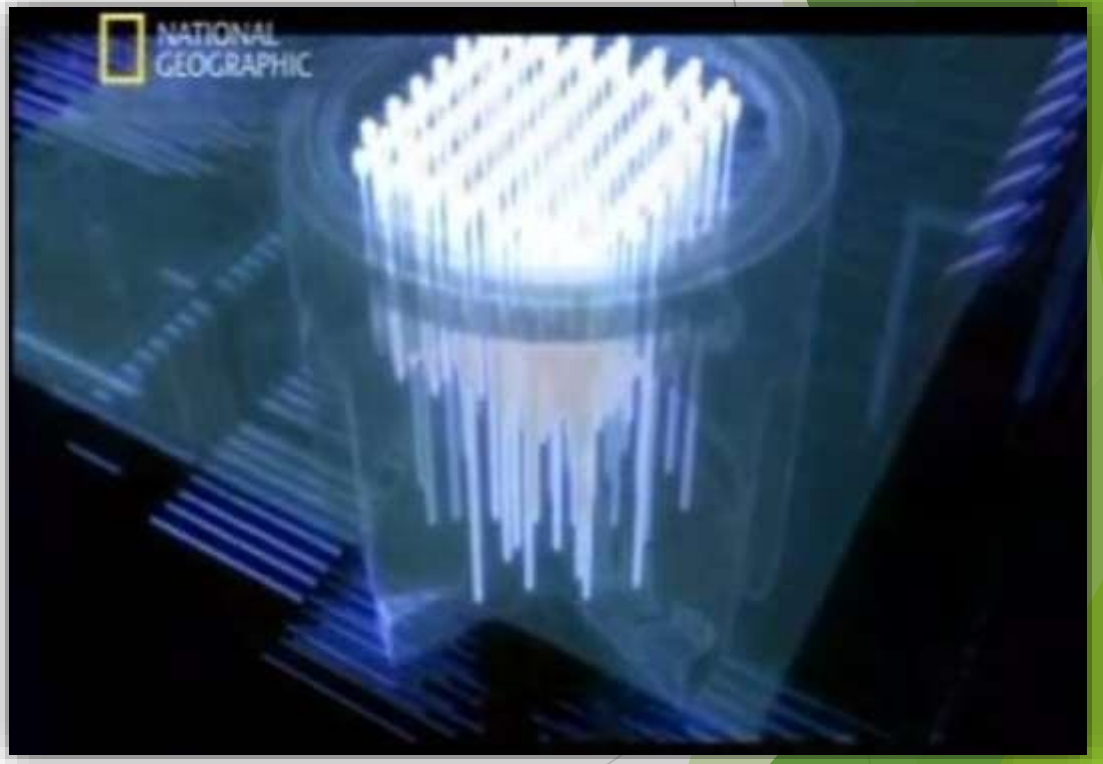
- The **Chernobyl disaster** was a nuclear reactor accident in the Chernobyl Nuclear Power Plant in the Ukraine, which used to be a part of the Soviet Union.
- It is considered to be the worst nuclear power plant disaster in history and the only level 7 instance on the International Nuclear Event Scale.

Chernobyl Nuclear Plant

- It is Decommissioned nuclear power station near the city of Pripyat
- It has Four reactors of type RBMK-1000, each capable of producing 1.000 MW
- It is known because of a explosion of a reactor due to different design failures and human errors

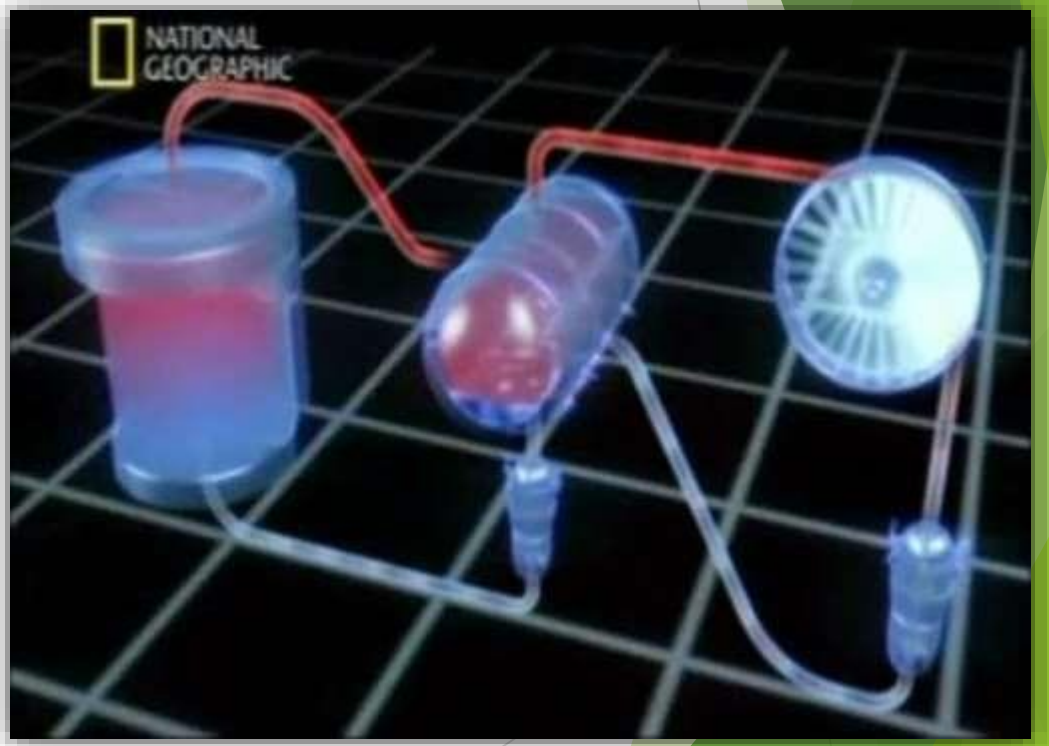
Nuclear Plant Performance - Reactor RBMK-1000

- Consists of different control rods that are responsible for regulating the heat with nuclear reactions
- To decrease the heat, more rods are inserted into the reactor
- The reactor produce more energy if it has more control rods down



Nuclear Plant Performance - Energy Generation

- The reactor has water on it, that transform into steam with the energy produced
- This foam steam boosts a turbine to generate electricity
- The water (in liquid state) also keeps the reactor on a appropriate temperature

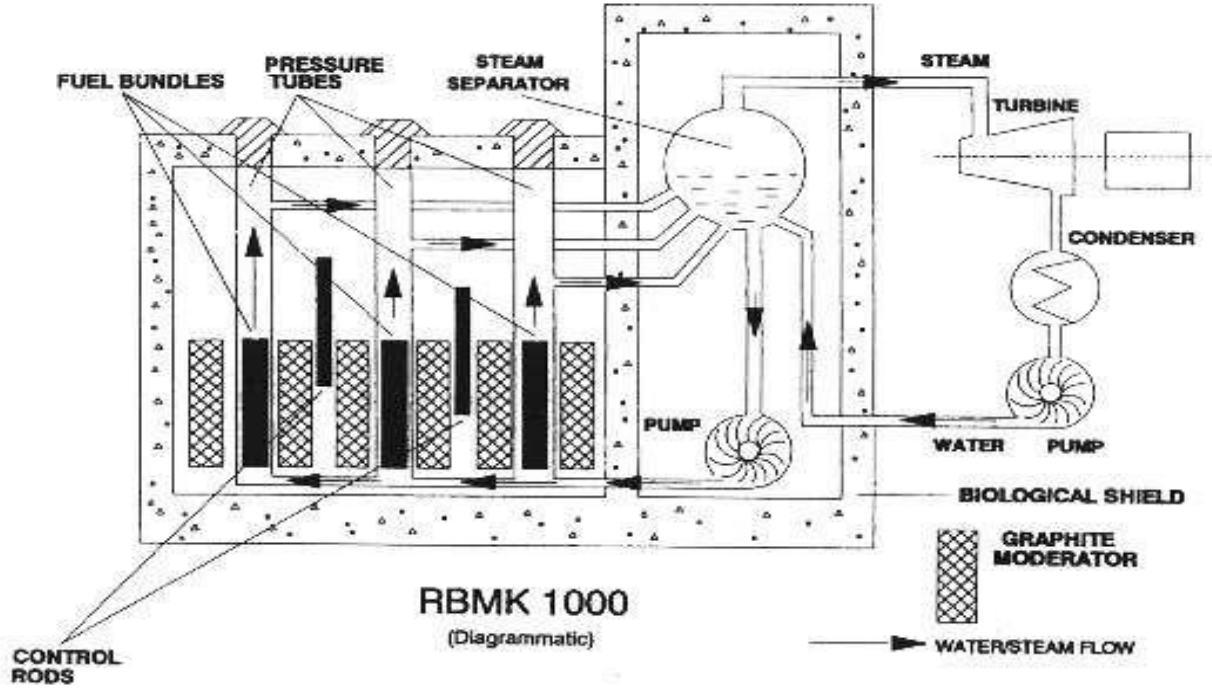


REACTOR PLANT SCENARIO

1. As the reaction occurs, the uranium fuel becomes hot
2. The water pumped through the core in pressure tubes removes the heat from the fuel
3. The water is then boiled into steam
4. The steam turns the turbines
5. The water is

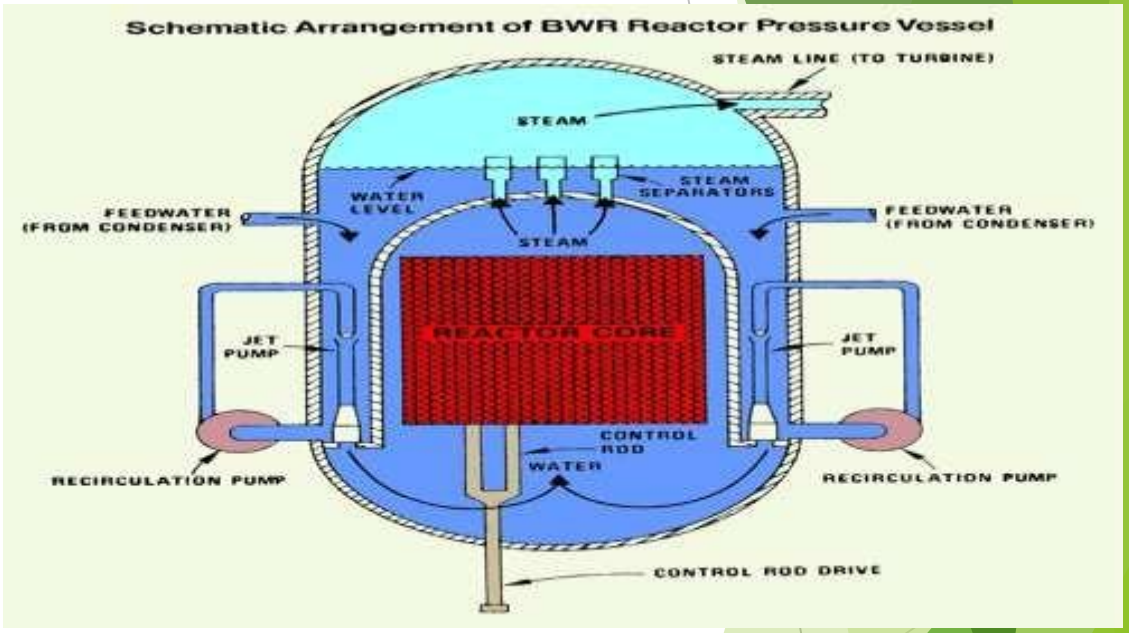
   then cooled
6. Then the process

   repeats



Why is it dangerous?

Nuclear power technology produces materials that are active in emitting radiation and are therefore called “radioactive.” We are all exposed daily to a little radiation but too much or in mass quantities can destroy cells, cause organs to shut down or after long and continuous exposure cause cancer.



WHAT HAPPENED?

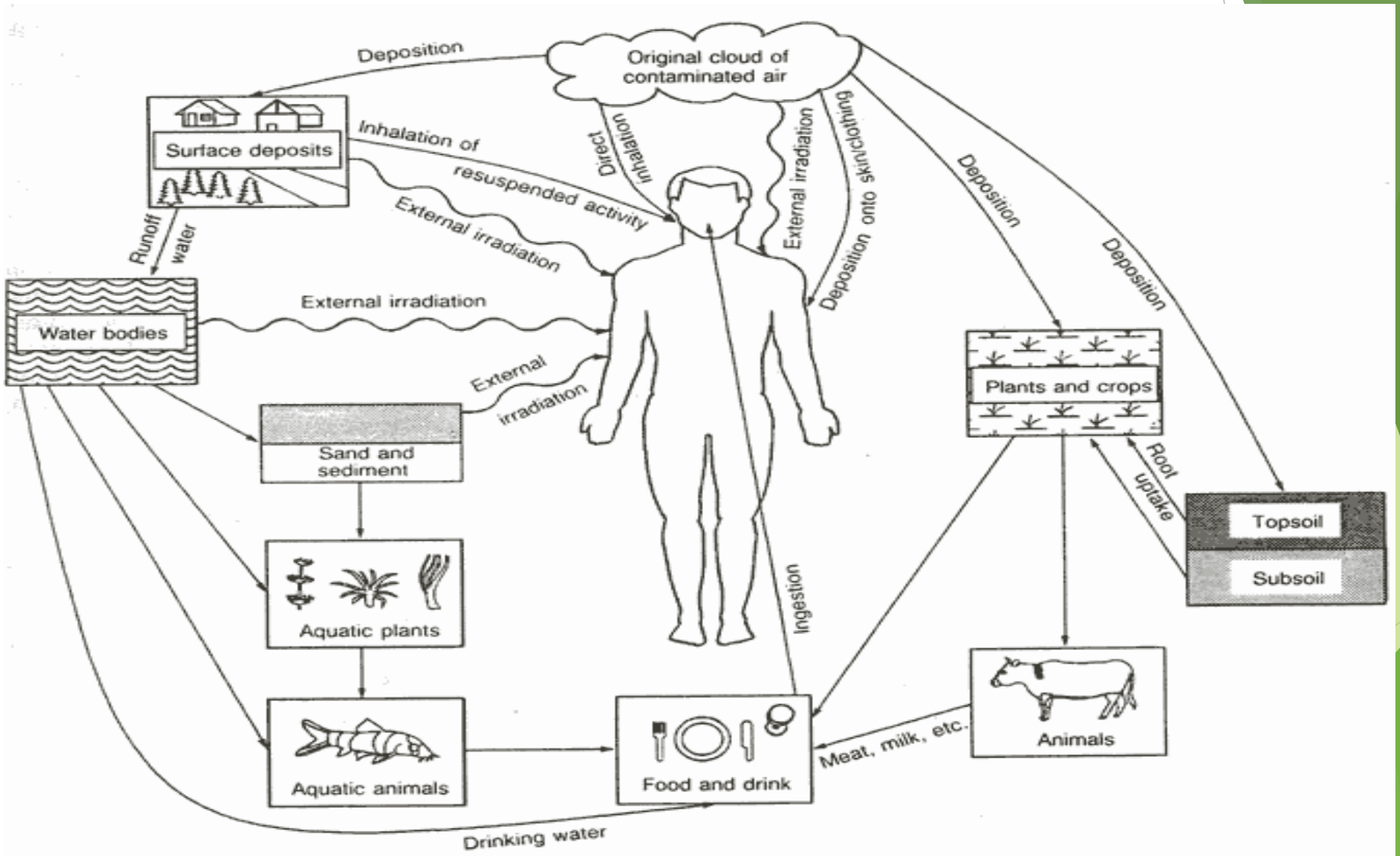
- -The experiment involved shutting down the coolant pumps,
- which caused the coolant to rapidly heat up and boil.

- -Pockets of steam formed in the coolant lines. When the coolant expanded in this particular design, the power level went up.

- -All control rods were ordered to be inserted. As the rods were inserted, they became deformed and stuck. The reaction could not be stopped.

- -The rods melted and the steam pressure caused an explosion, which blew a hole in the roof. A graphite fire also resulted from the explosion.

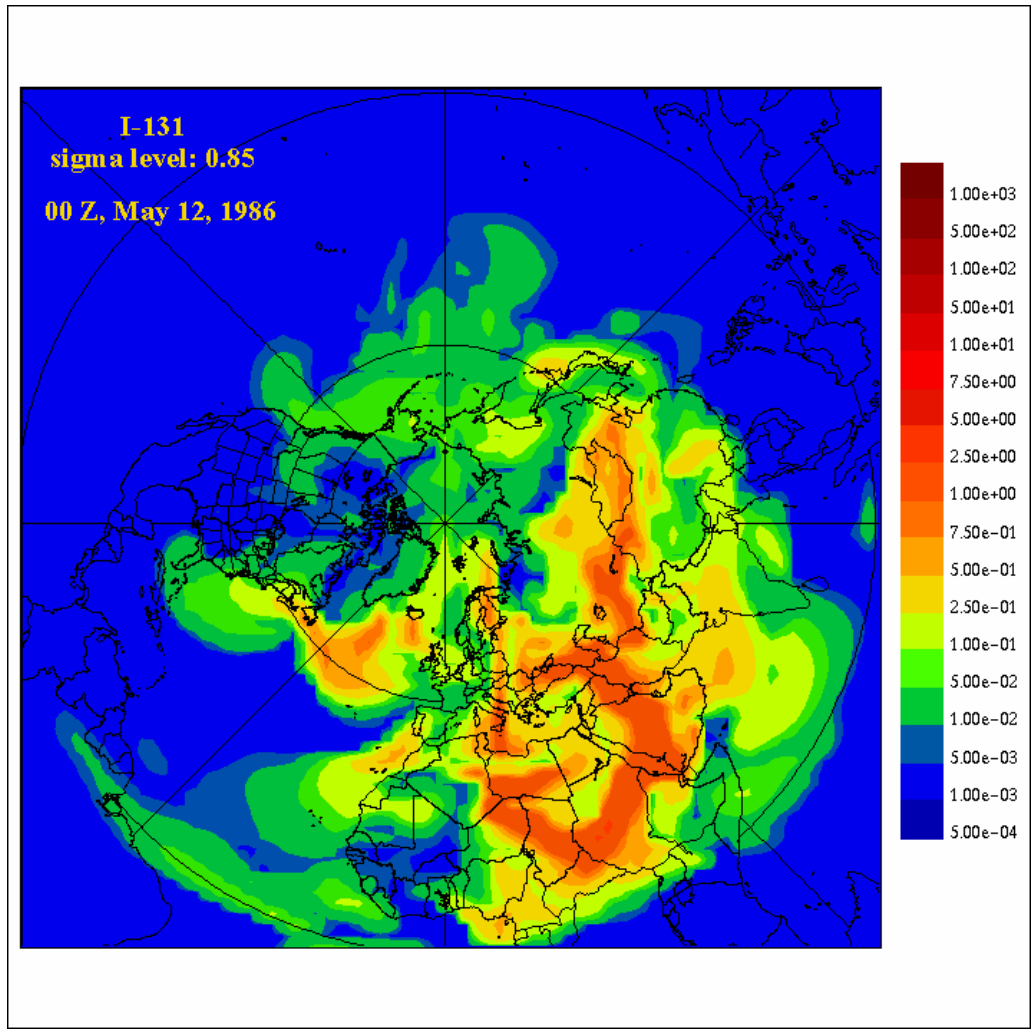
CYCLE OF RADIOACTIVE MATERIALS



Main environmental pathways of human radiation exposure

[Source : IAEA technical report ISBN 92-0-129191-4 Vienna 1991]

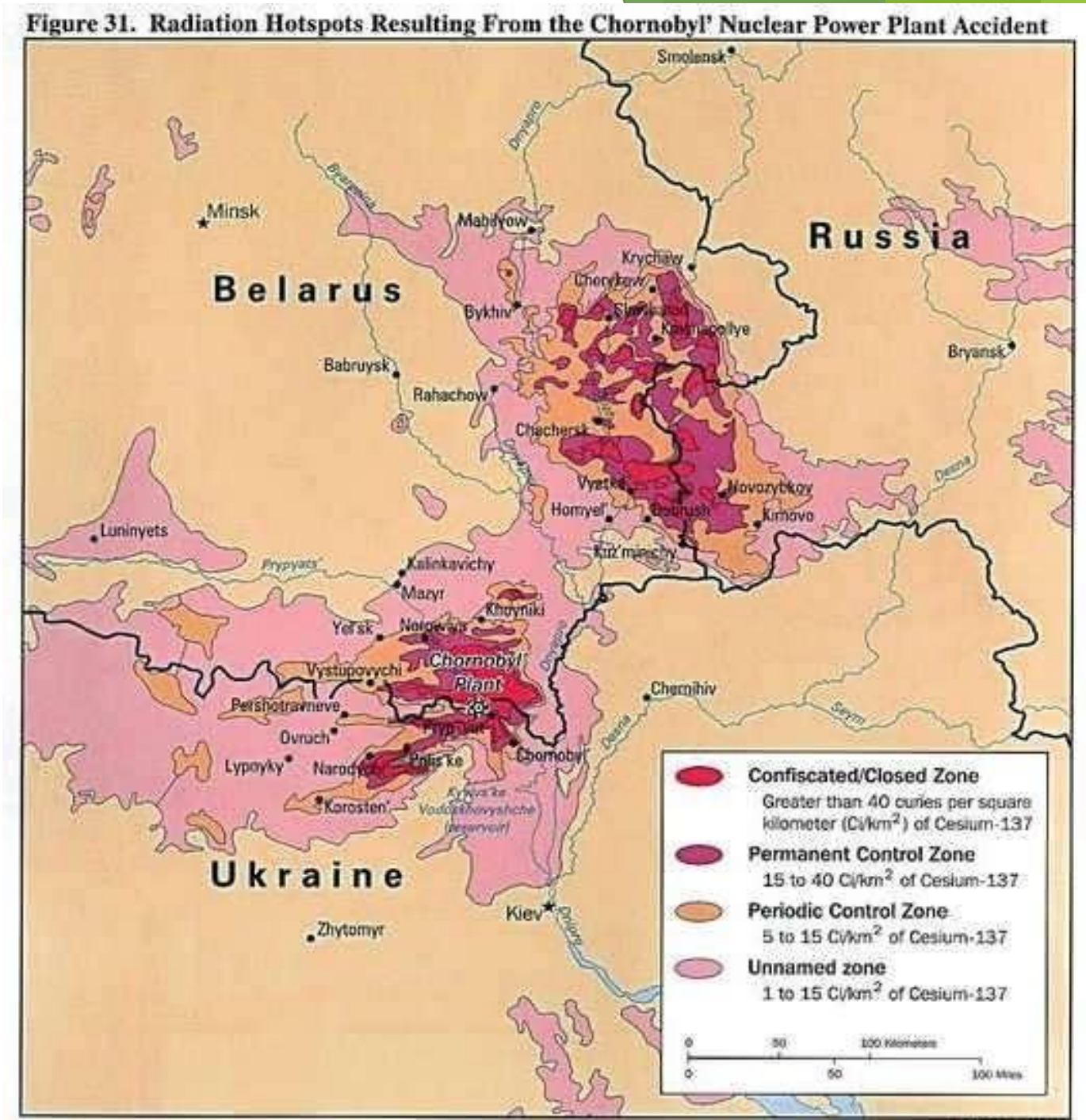
IMMEDIATE IMPACT



- 203 people were hospitalized immediately. 31 of them eventually died. Most of these people were workers in the plant or local firefighters.

- NW winds from the Black Sea carried the radiation for miles in the following days. Scandinavian detectors picked up on the abundance of radiation, but the Soviet government denied everything.

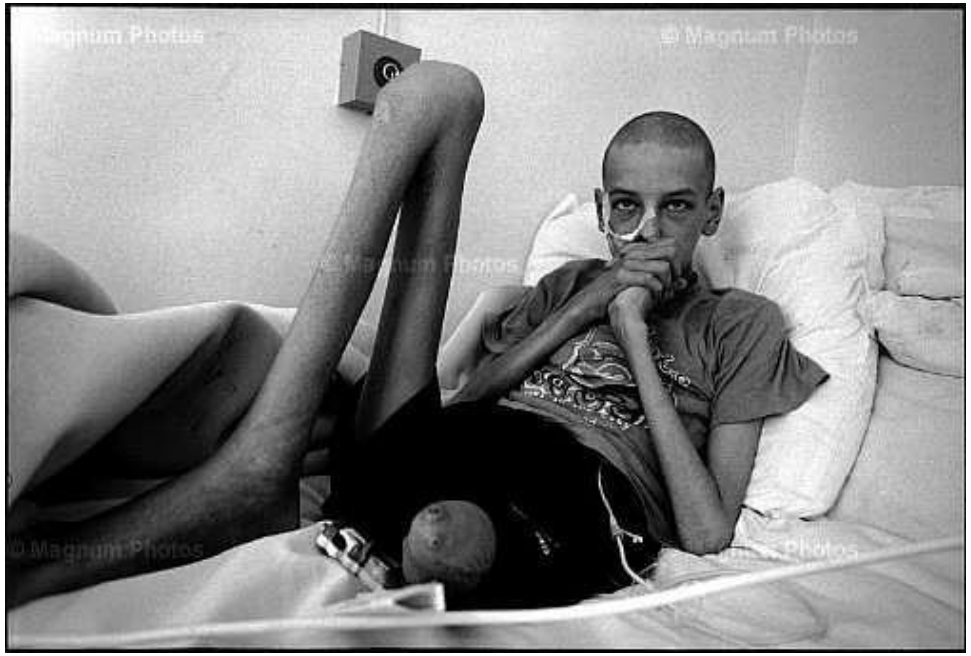
- People were evacuated the day after the explosion.
- A month later 116,000 people in an 18 mile radius of the plant were evacuated.
- Over 300,000 people were moved from the accident.
- Many still live in contaminated areas and the long term effect is not yet known.
- The Soviet Union has not been able to study effects due to lack of funds and secrecy.



EFFECTS ON THE ENVIRONMENT

- Fallout levels were very high right around explosion and affected all wildlife.
- Red Forest- was a forest right by the plant was named this because plants had a red hue after the explosion. These trees also died from the amount of radiation they received.

Effects of radiation



THYROID CANCER

- The thyroid gland is the most vulnerable organ to radiation in the human body.
- Thyroid cancer can take 10-30 years to show it's effects.
- There has been a 2,400% increase in the rates of thyroid cancer in Belarus since 1986.

EFFECTS ON ECONOMY

- Between 300,000 and 600,000 people were brought in to clean-up.
- Crops were destroyed, livestock was killed, everywhere there was radiation.
- Over 235 billion dollars has been spent to clean up the disaster.
- Belarus lost 1/5 of its farming lands(700 million dollars a year loss.)
- 350 industries were lost due to the disaster.

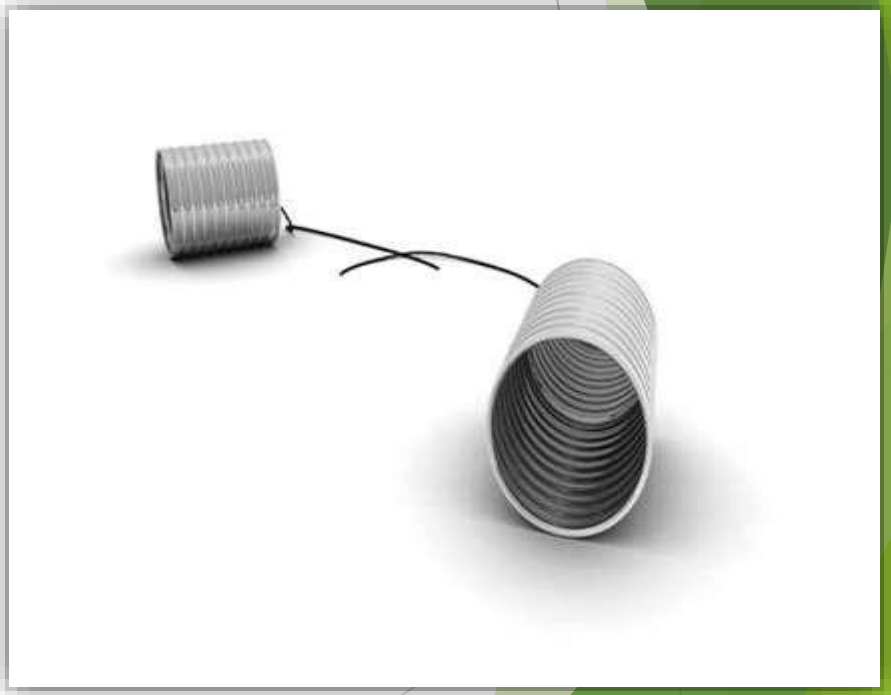
OTHER PROBLEMS..

- Food & Water
  - Milk—Farmers have to watch the radiation level in milk.
  - Fish—Cannot be eaten, as water absorbs radiation and fats concentrate it
  - Radioactive Floods every spring
- Lives ruined
  - Suicide and depression
  - Even healthy people were traumatized

CAUSES

The Disaster – Lack of Communication

- There are 2 users in diferent rooms, responsible of the reactor number 4
- The user on the reactor climbed up several control rods to recover the power
- The user that controls the water introduce more water than necessary (steam can't be produced)



The Disaster - The Explosion

- To achieve a balance of steam and water, more rods than allowed are climbed up
- The responsible of the water realize his error, and remove the excess of water
- Power excess and water absence resulted on an excess of heat that melt the reactor core and resulted on a explosion

Committed Errors

- The events preceding the explosion allow highlight three types of errors
  - **Human:** Lack of communication and making erroneous decisions
  - **Design:** Unstable reactors and separation of responsible users
  - **Automation:** The system allows actions that endanger security of the central
- Noting these errors and the critical effects of the explosion, the question of whether the disaster could have been avoided and with which ways arises

Proposed Solutions

- Based on the commited errors, and looking to other nuclear plants, we proposed different solutions for each type of error
  - **Human error**: its necessary give them sufficient instruction, as well as a communication device to know every taken action
  - **Design error**: Close the reactors of this type, and the new designs must have the controllers in the same room
  - **Automation error**: System can't afford to take dangerous actions

Proposed Solution I - Mobile Communication

- The users have to receive an adequate instruction
- Every action taken must be registered
- When it is registered, it is communicated to theother controllers
- The notification is made via mobile
- The user must read and confirm the messages before take ihis own decisions

Proposed Solution II - New Reactors and Rooms

- The RBMK reactors has problems in their design that makes them dangerous
- Currently, there are 6 operative reactors of this type trying to get closed
- The design of the most important parts have to be near and connected to favor the communication

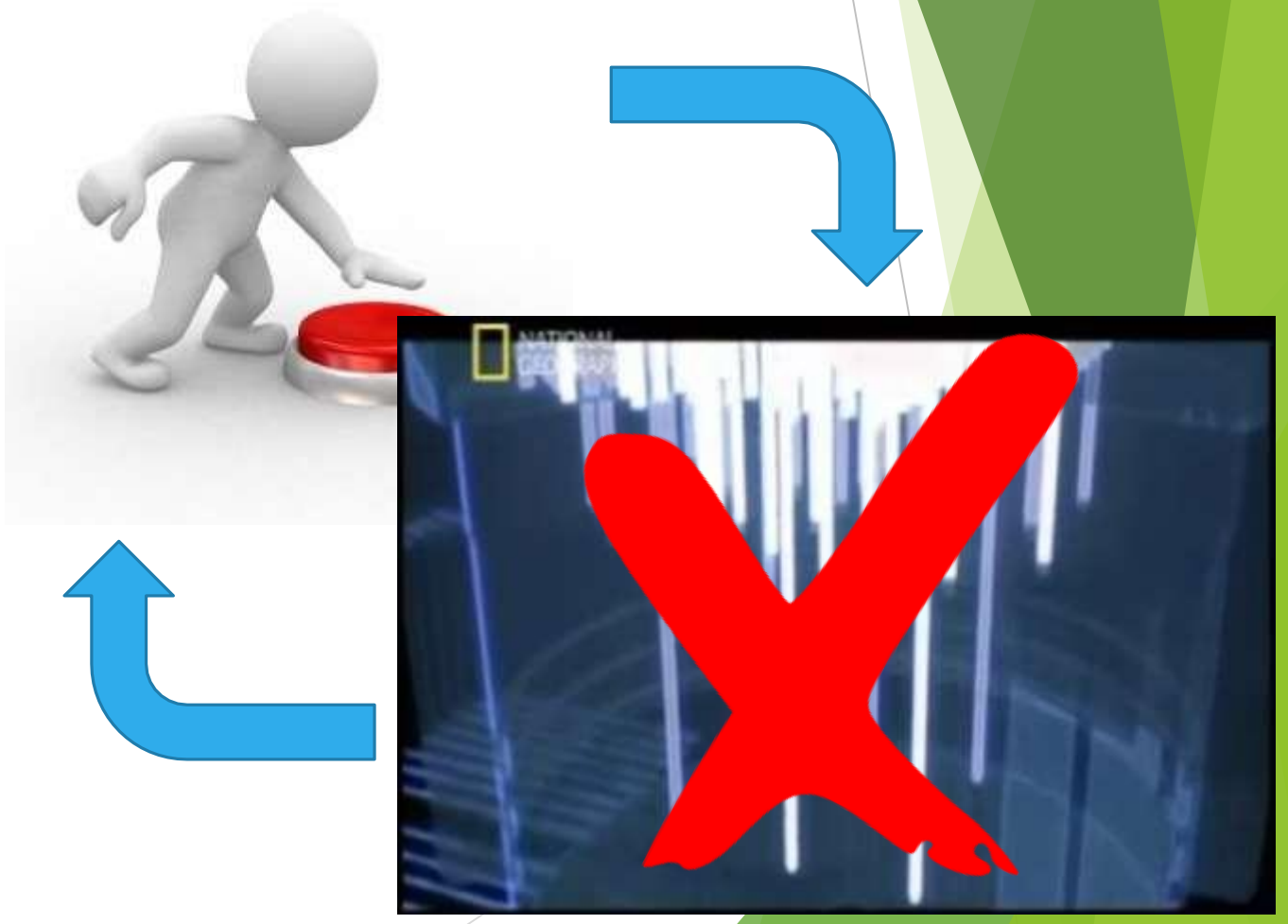
WATER CONTROL ROOM

REACTOR ROOM

MAIN CONTROL ROOM

Proposed Solution III - Ban dangerous actions

- The system have to be enough automated to ban actions that are dangerous
- Those actions must be previously specified
- The user is notified about it



Conclusions

- Chernobyl is a decommissioned nuclear power station where occurred one of the largest nuclear disasters in history
- The explosion was caused mainly due to three types of errors: humans, design and automation
- It could be avoided just with a good communication between users, despite of the bad design of the reactor and the nuclear plant

THANK YOU

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