Chernobyl
The worst nuclear accident in history

With acknowledgements to Wikipedia

Introduction

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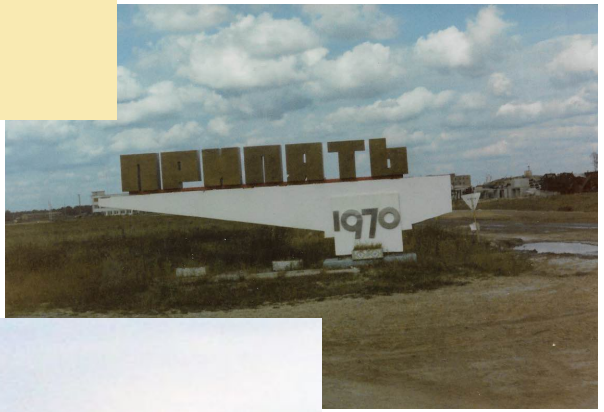
Angliyskiy Spetsialisty

- 6 English Specialists from the CEGB with Ludmilla our translator were invited to Chernobyl in 1987
- We had just successfully used a robot to do the world's first weld repairs inside the Magnox Reactor Core at Oldbury Power Station
- The Russians flew us out on a specially chartered Aeroflot plane
- We stayed in Kiev and had a KGB and Red Army escort out to Chernobyl on a single decker bus
- We were covered in radiation badges but got most radiation from the plane flight
- The bus had to be decontaminated 3 times at the 50km exclusion zone, at 25km and on arrival

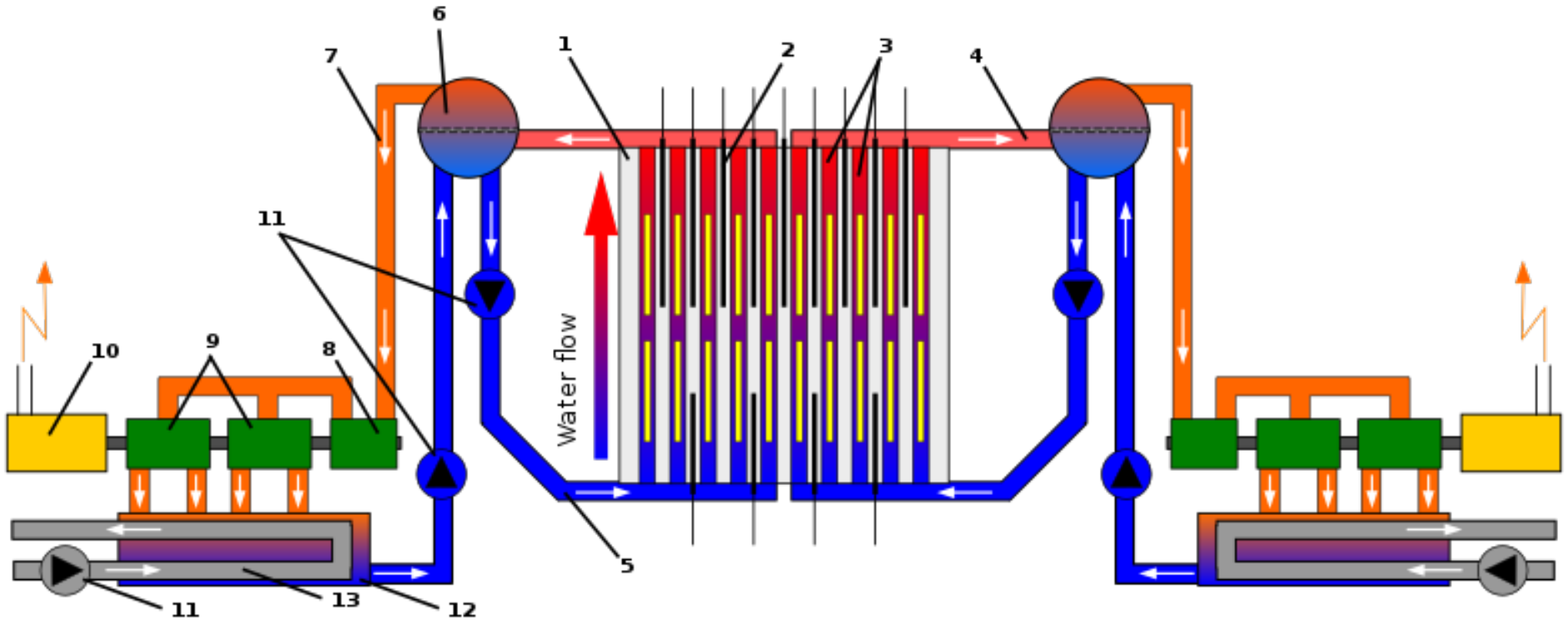
Location

- Chernobyl is located north of Kiev on the edge of the Pripet Marshes and next to the city of Pripyat and the Pripyat river which feeds into the river Dneiper which flows through Kiev
- There were “5” RBMK-1000 design reactors at Chernobyl during our visit
- 3 operational; 1 under construction; and one had the roof blown off



The RBMK Power Plant Visitors

The RBMK Power Plant Design



Legend :

1. Graphite moderated reactor core
2. Control rods
3. Pressure channels with fuel rods
4. Water/steam mixture
5. Water
6. Water/steam separator
7. Steam inlet
8. High-pressure steam turbine
9. Low-pressure steam turbine
10. Generator
11. Pump
12. Steam condenser
13. Cooling water (from river, sea, etc.)

The RBMK Power Plant Accident

- On 26 April 1986 the No 4 reactor exploded and caught fire – the worst disaster in nuclear history
- The explosion and fire released similar amounts of contamination 70% of which landed on Belarus
- The contamination spread north-east and some reached Sweden and Wales
- Around 120,000 people were evacuated from the initial 30km exclusion zone
- Around 24,000 small dams were built to prevent radioactive contamination getting into the marsh water and reaching Kiev (2.4m residents)

Why the “Accident” Occurred

- The “accident” happened during a low power safety test on the steam turbine where they were trying to use the steam turbine run-down energy to enable a black-start in the event of a grid collapse
- The test called for the emergency cooling system to be disabled
- RBMK reactors were known to be unstable at low power and not inherently safe but the Russians assumed that they could always SCRAM the reactor
- During the test local boiling occurred in less than 4 minutes
- RBMK reactors have a positive void coefficient which compounded the boiling
- Russian engineers removed too many control rods
- When the SCRAM event was finally initiated the reactivity actually increased and the excessive heating in the reactor caused the control rods to jam
- The reactor was now in an unstoppable runaway condition

The Accident

- The fuel rods and reactor core overheated and caused an initial steam over pressurisation which reduced the amount of cooling water so the graphite core quickly became red hot
- The red hot graphite reacted with the cooling water and generated steam together with hydrogen and carbon monoxide (water-gas reaction) and a second explosion occurred followed by a graphite fire which burnt for another 2 weeks and the fuel rods turned into radioactive lava
- The fire fighters were called but were not told that it was the reactor that was on fire and they wondered about the large hot bricks outside the plant
- The fire was eventually put out using 5000 tonnes of a sand-lead-clay mixture dropped by around 600 helicopter flights
- Radiation levels were around 20,000 R/h compared to a normal lethal dose of around 100 R/h but no one had any idea as the radiation meters were all off scale
- The firefighters all complained of sunburn after the event

Pripyat – evacuation & decontamination

- The Pripyat evacuation started 36 hours after the accident on 26 April
- The accident was initially denied by the Russians until the radiation alarms at the Forsmark power plant in Sweden went off on 28 April
- By this time 53,000 people had been evacuated followed by a further 80,000 over the following year
- The long term worry was that the molten core would burn through the foundations and into the water course causing further explosions
- This was countered by miners who dug a tunnel under the reactor to provide a crude cooling system but which was not needed in the end
- There were 100 tons of radioactive debris on the roof, so 60 robots were used to try to clear it but the robots “died” due to the high radiation levels so they had to use 5000 “bio-robots”

Pripyat – Decontamination

0.5m red army soldiers
A lot of sellotape
Bulldozed into a very large pit
and
Polyurethane foam

Local Consequences

- Work on Reactor 5 was stopped
- Reactor 6 proposals were abandoned
- Reactor 2 shut down in 1991
- Reactor 1 shut down in 1996
- Reactor 3 shut down in 2000
- A lead-concrete sarcophagus was installed on Reactor 4 in December 1986 designed with a 30-year life.
- It has recently been replaced by a new containment structure

Human Consequences

- 28 people died from radiation within 3 weeks
- Over 50 people were hospitalized but lived
- A further 14 people died from radiation effects over the next 10 years
- 4000 to 16,000 people are projected to have died (or will die) from associated or accelerated illnesses over the long term
- The total material cost, including de-contamination, is estimated to be around £60m

Global Consequences

- The inherent design and safety deficiencies of RBMK reactors were finally recognized and rectified
- The deficient Soviet safety culture was greatly improved
- Numerous studies of biological clean-up methods were initiated
- This single avoidable “accident” at Chernobyl does not rank in the top 100 international disasters in terms of short-term deaths; long term deaths; overall cost; long term environmental effects except in one respect:

The psychological impact on world-wide attitudes to nuclear power

- It effectively “shut down” the world-wide development of the nuclear industry after 1986
- We are now at a time when we need nuclear technology to try to reduce carbon dioxide emissions to positively impact climate change

Annual Deaths in Context

Cause	Annual Death Rate
Chernobyl	100 to 450 per year (Worldwide)
NHS Delays (Cardiac Causes only)	3000 per year (UK)
Car Related Deaths	1,700 per year (UK) and 46,000 per year (US)
Drug Related Deaths	5,000 per year (UK) and 110,000 per year (US)
Aeroplane Related Deaths	180 to 950 per year between 2006 and 2021 (Worldwide)
Covid	200,000 over 2 years (UK) and 12,000,000 over 2 years (Worldwide)
Starvation/Poor Nutrition	3,000,000 per year (Children)