



# The 25th Anniversary of the Chernobyl Accident

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# The Accident


- Operators conducted unauthorised experiments disabling safety devices when shutting down the plant
- Steam pipe burst blowing a hole in roof of reactor
- Graphite in reactor burned for ten days
- RBMK reactors do not have safety shields so radionuclides released as aerosols & particles

## Immediate Damage

- 23 emergency workers died of Acute Radiation Sickness then & 24 died later
- Fallout on 200,000 sq km of European territory damaging urban, agricultural, aquatic and forest environments
- 71% of fallout on Belarus, Ukraine or Russia
- Radiocaesium spread relatively evenly
- Most Strontium & Plutonium, heavier particles with longer half lives, fell in a 100km radius of plant ~ many have decayed by now
- Plutonium & Americium  $^{241}$  have long half lives and are long term concerns

## Thoracic cancer

- 6,000 cases in children (0-17yrs) from Ukraine, Belarus & Russia 1986-2005 ~ incidence increased 1/million/year to 40 /million/year
- Caused by internal radiation from radioiodine
- Children drank milk, smaller thyroid volume & thyroid still growing makes them more susceptible

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- Treatment
    - Total thyroidectomy
    - Radioiodine treatment
    - Thyroid stimulating hormone
    - Suppressive therapy
  - Deaths from thyroid cancer ~ 15 children
    - 6% permanent laryngeal nerve damage
    - 12% other types of complications
  - Latency issues mean death figures may turn out to be higher



- **Other Cancers**

- WHO(2006) concluded cancer rates in liquidators and other exposed populations were same as controls
- UNSEAR (2008) retracted former estimates agreeing with WHO (2006)
- Long latency times means uncertainty still exists

- **Cardiovascular Disease**


- Difficulties separating out heart disease from Chernobyl and from other causes. Break up of Soviet Union reduced life expectancy of Russian males from 71 to 61 and Ukrainian males from 67 to 61.
- WHO(2006) concluded heart disease rates in liquidators and other exposed populations were same as controls

## Evacuation and Relocation

- 1986-1990 118,000 people from 30km CEZ relocated
- 1991-2000 further 218,000 people relocated
- UNDP (2002) argues re-settlement was 'over cautious' by Soviet authorities

## Compensation

- Eventually paid to 7 million 'victims' including
  - Invalids from accident
  - People who participated in clean-up
  - People who were evacuated or re-settled
  - People who left areas of their own initiative
- Coincided with break up of USSR and high unemployment at that time ~ culture of dependency

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- Re-settled populations have had severe problems
    - Psychological problems ~ anxiety & drug abuse
    - Social & Economic Problems ~ dislocation and unemployment

UNDP (2002) 'A log jam has developed of expectations and assumptions that no longer reflect current realities. Breaking this log jam is the key to resolving the continuing problems that have followed from the Chernobyl accident.'

UNDP (2002) identifies 100,000 to 200,000 people still in need of support

## Final Mortality Figures

- Mortality estimates reduced since 1986 reflecting downgrading of forecast leukemia & heart disease deaths ~
- As latency periods expire forecast deaths have not occurred
- Figures
  - 20,000+ at time of accident
  - 10,000+ 1990s
  - 4,000+ Chernobyl Forum of 2003
  - 62 following UNSEAR (2008) ~ 47 from Acute Radiation Sickness & 15 from Thyroid cancer

## Reasons for declines in mortality figures between 1986 and 2006 (WHO, 2006)

- Risk coefficients based on much higher radiation exposures (Hiroshima etc)
- Studies did not take threshold effects into account ~ linear extrapolation of risk coefficients
- Radiation doses not measured correctly
- Affected groups examined by doctors more frequently than controls
- Autopsy rates in control groups fell after USSR collapse in 1991
- Elevated 'tumor expectancy' amongst doctors dealing with Chernobyl patients



## Chernobyl Today

- Why has the Chernobyl accident remained in peoples' consciousness all these years?
- Six possible reasons: human nature, irresponsible press reporting, historical reasons, the timing & nature of scientific errors, vested interest & political interest

## Reason 1: Human nature

- Individuals are likely to place too much importance on unlikely, extreme events such as the Chernobyl accident
- Quiggin (1993) 'Generalised Expected Utility Theory'
- Tversky & Kahneman (1992) 'Cumulative Prospect Theory'
- Explains why individuals who normally avoid losses buy lottery tickets or why they may be sanguine about road deaths while simultaneously worrying about earthquakes

## Reason 2: Irresponsible press reporting

- Early reports of the accident in the press were wildly wrong. Forecasts of deaths and environmental losses from the accident and resulted in a worldwide panic
- First impressions may be the strongest

## Reason 3: Historical reasons

- The accident occurred during a period of deep public distrust of the nuclear power industry following the Three Mile Island incident & movies like 'Silkwood' and 'China Syndrome'
- There was a general distrust of government authority and large corporations at that time from the Vietnam war era



## Reason 4: Nature & timing of scientific errors

- Incorrect forecasts of leukemia deaths released in 1986-88 made headlines because Chernobyl was still 'big' news then
- The full truth about losses took decades to emerge and, buried in United Nations reports, never attracted great publicity



## Reason 5: Vested interest

- The huge amounts paid in compensation to so many Chernobyl victims in a time of social upheaval as the USSR broke up created a constituency that benefited from overstatement of losses from the accident

## Reason 6: Politics

- The emergence of climate change galvanized and enriched conservation groups who traditionally oppose nuclear development and who benefit from *status quo* beliefs about Chernobyl

# What conclusions can we draw from the Chernobyl accident 25 years later?

1. Chernobyl is still very important for the victims many of whom still need care and support
2. Nuclear reactors are potentially very destructive so design, construction, maintenance and operation need to be tightly controlled
3. Losses arising from Chernobyl were not of sufficient magnitude and the event was so long ago it should not be definitive in decisions about investment in new reactors



## Future Research on Nuclear Safety

1. Will future accidents with reactors result in the same level of losses, or lower losses, than occurred at Chernobyl?
2. What will the human and environmental losses from accidents involving the storage of waste products be?
3. What are the (i) economic, (ii) political and (iii) engineering links between nuclear power production and proliferation of nuclear weapons?