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Scientific Instrument Makers

Responding after a big nuclear accident

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Basics: what is the **danger** from a **big nuclear reactor accident**?

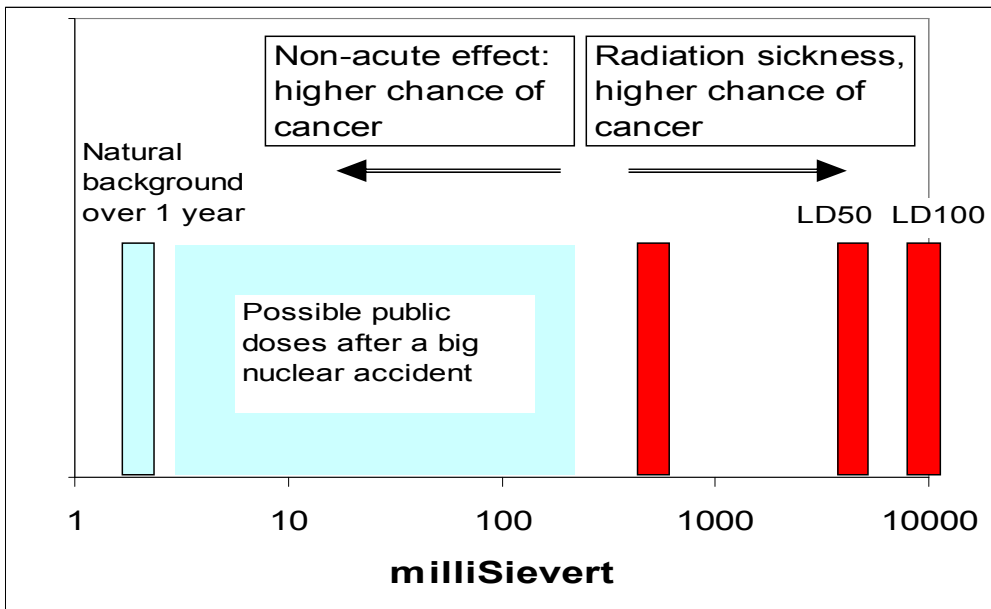
A commercial nuclear reactor **cannot explode** like an atom bomb.

But heat production does **not** stop immediately after shutdown – it takes 24 hours to fall from 7% to 1% of full power, **210 MW** → **30 MW** (thermal).

Big nuclear accidents happen when the cooling needed to take away the **nuclear decay heat** fails and the **core melts**.

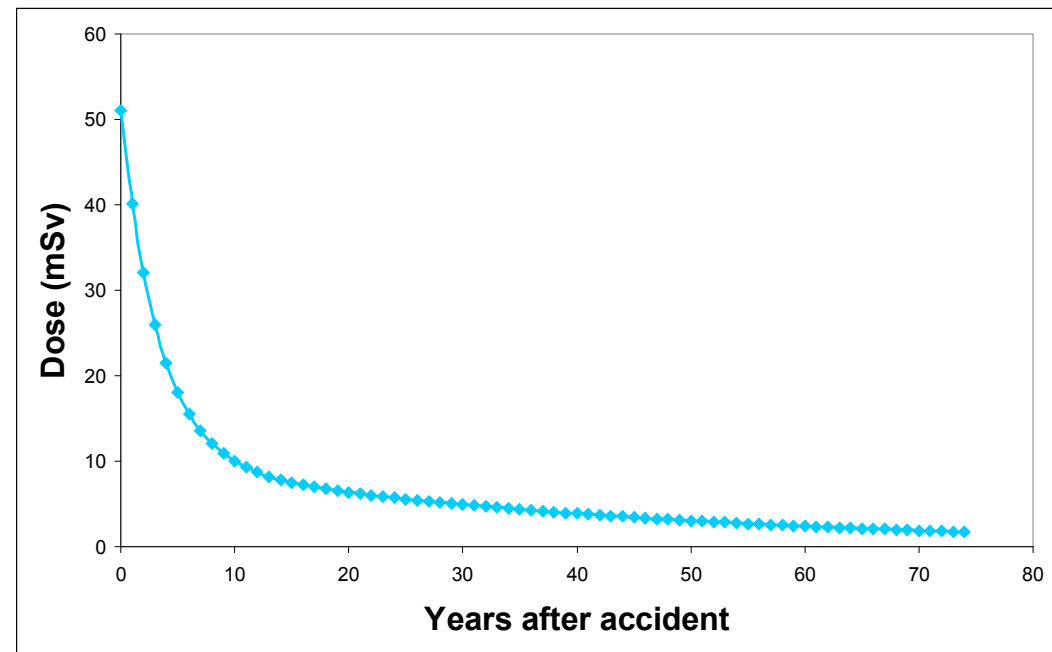
The melting core will **penetrate its containing vessel** and **open up a path** between the **highly radioactive core** and the **outside world**.

Radioactive gases, vapours and gas-borne particulate matter will escape and **nuclear fallout** will be deposited around the plant.



Danger to the public:
increased risk of cancer after
 a big nuclear accident

But note that the dose is
falling away rapidly over time



The **NREFS Project**: Management of **Nuclear Risk** Issues: **E**nvironmental, **F**inancial and **S**afety



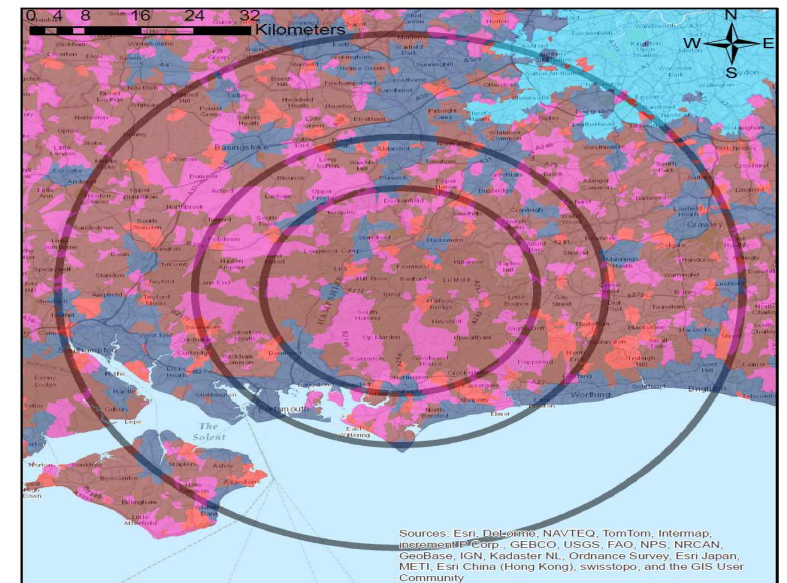
Method 1: **Optimal economic control** (including health effects) applied to **hundreds** of conceivable big nuclear, meltdown accidents worldwide (*led by Manchester University*)

- The **optimal strategy** avoided long-term relocation in **all base cases** and all but **2%** of the cases in the sensitivity studies.

Method 2. **Public Health England's nuclear accident consequence codes** (led by the Open University).

Core melt accident at a fictional pressurised water reactor on the South Downs of England

- **45 miles** from **Central London**
- **30 miles** from **Southampton**
- Release of fallout of the same order as **a single reactor at Fukushima Daiichi**.
- The expected number of people needing relocation was **only 620**.



Legend

- Rural: Hamlets and Isolated Dwellings
- Rural: Town and Fringe
- Rural: Village
- Urban: City and Town
- Urban: Major Conurbation

Method 3 **J-value** (J for Judgement) assessment applied to the **Chernobyl and Fukushima Daiichi** accidents *(led first from City, University of London then from the University of Bristol)*



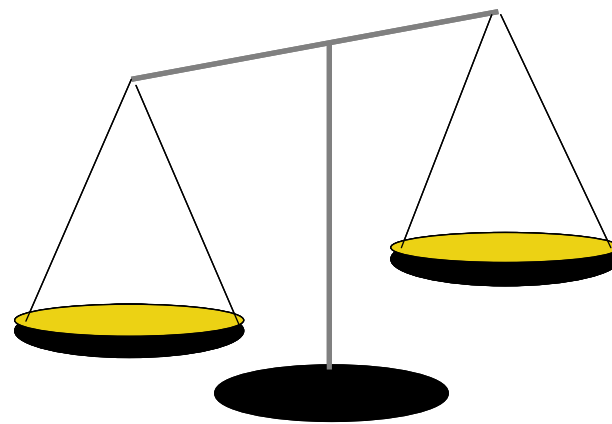
Principal policy response: **mass relocation**

The Judgement- or J-value

The J-value balances the gain in life expectancy that a safety measure brings against the cost of providing it.

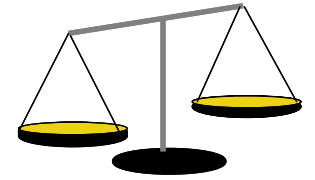
Unique features:

- i) the balance is **objective**
- ii) the J-value has been **validated** against empirical data covering 90% of the world's nations.



You are spending too much if J is bigger than 1.0

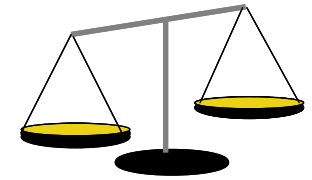
Results: the J-value balance point for Chernobyl



Results

- **335,000** people were moved away by the authorities, never to return.
- **265,000** to **305,000** of these people should have stayed in place.
- Staying put would have cost them about **3 months'** life expectancy.
- As a "sense check", the inhabitants of **London** are expected to lose **4 ½ months'** life expectancy **today** as a result of air pollution levels.

J-value analysis of Fukushima 2011



Results

- **111,000** people were moved out by the authorities.
- A further **49,000** self-evacuated making a total of **160,000**.
- **85,000** people had **not returned** to their homes after 5 years.
- **No-one should have moved out.**
- The loss of life expectancy in the worst affected settlement would have been **3 months** if everyone had stayed in their homes.

Conclusions

- The big lesson is **how small** the radiation damage has been to the members of the public from even the **biggest** nuclear reactor accidents.
- Most of the harm has come from what can now be seen to be **unjustified fear and worry** and from the **social disruption and dislocation** caused by relocation of hundreds of thousands of people.
- In the past, the **so-called solution** has become **the problem**.
- Remediation should be the watchword for any future big nuclear accidents **not** relocation.
- We should cope with any big nuclear accident in the future **more sensibly and effectively** than we have in the past.
- We will **protect the people better** and **save ourselves hundreds of billions of pounds** in the process.

See also

- <https://www.sciencedirect.com/journal/process-safety-and-environmental-protection/vol/112/part/PA>
- <https://southwestnuclearhub.ac.uk/research/case-studies/coping-with-a-big-nuclear-accident/>
- <https://theconversation.com/evacuating-a-nuclear-disaster-areas-is-usually-a-waste-of-time-and-money-says-study-87697>
- <https://www.thetimes.co.uk/article/nuclear-disaster-fallout-would-be-no-worse-than-living-in-london-706w9xc6h>
- <https://www.standard.co.uk/news/uk/living-in-london-equivalent-to-nuclear-disaster-for-health-risks-including-life-expectancy-and-a3699271.html>
- <https://www.ft.com/content/000f864e-22ba-11e8-add1-0e8958b189ea>
- <http://www.bbc.co.uk/programmes/p05p25nq>