

# Age of Re-Enlightenment? Radiation Protection in a Post-Fukushima World

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# Overview

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- Background
- Developments in the US associated with radiation
- Related challenges and re-thinking in the international nuclear energy industry
- Questions and points to consider

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**"There is nothing new to be discovered in physics now.**

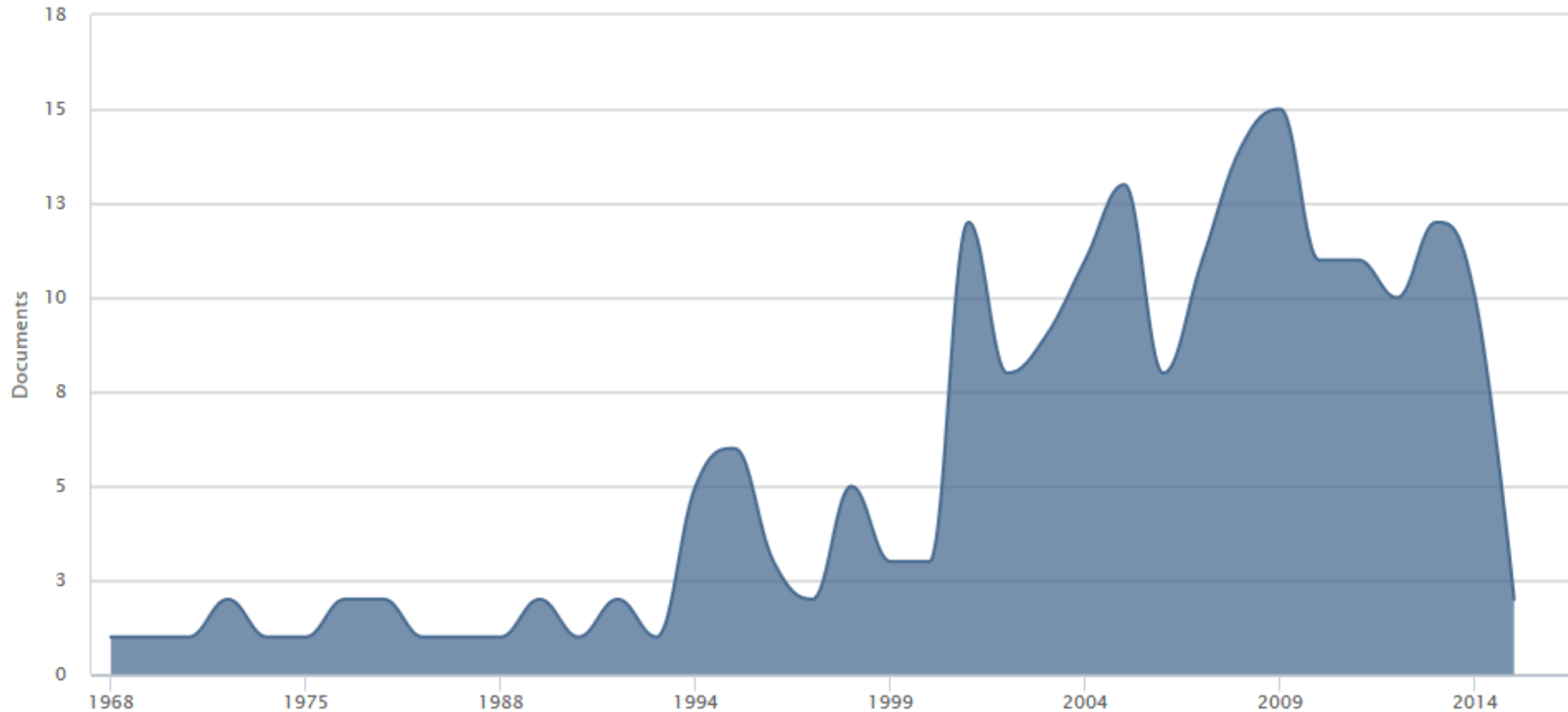
**All that remains is more and more precise measurement..."**

*Lord Kelvin, 1900*

*Gathering of physicists with the  
British Association for the Advancement of Science*

# Scholarly Writing on Ethics and Radiation Protection

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# Select Global Events in Radiation

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- **1928** – ICRP established; Geiger–Müller counter developed
  - **1945** – Major nuclear weapons testing begins; WW2 Atomic Bombings
  - **1950s → 1970s**
    - ‘As low as possible’ principle (ALAP) evolves to
    - ‘As low as reasonably achievable’ (ALARA)
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- **1977** – Publication 26: dose limit risks, occupational and common exposures
  - **1979** – TMI accident
  - **1986** – Chernobyl accident
  - **1990/1991** – Publication 60: acceptability of risk, multi-criteria
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- **2007** – Publication 103: exposure situation framework
- **2011** – Fukushima accident

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# **Ongoing Developments in the United States associated with Radiation**

# U.S. Radiation rule under review

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- **2007:** ICRP Publication 103 recommendations - dose assessment methodology and terminology
- **2014:** Notice of proposed rule revision to 10 CFR 20 to more closely align with Publication 103 recommendations
  - Revises tissue and radiation weighting factors, among elements
  - Possible age and gender-averaged approach for public values
  - Possible terminology change from TEDE to ED
- Opposition is challenging the basis for the change, highlighting the impacts on workers, organizational rules, and costs
- **2015:** Public comment has been extended -- set to close 6/22

## U.S. Expert reporting – Biological Effects of Ionizing Radiation, *National Academy of Sciences*

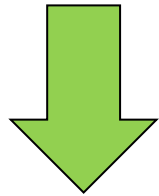
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- BEAR I (1956) (later renamed BEIR)

...

- BEIR VII part 2 (2006)

- Possible BEIR VIII



Major advances in sensing technology (i.e. detection of shifts in molecular structures of biological organisms)

### Recently:

- Scoping meeting for next BEIR report held Nov 2014
- Key questions on: the risk of childhood leukemia from CT scans, presence of hormesis, etc
- Results from studies in 2-3 years should inform BEIR VIII
- BEIR VIII - Not currently funded.



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# **Related Rethinking in the Nuclear Energy Playing Field**

# Nuclear energy playing field Post-Fukushima

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- **Concepts** like 'preparedness'- recalibrated to account for multiple events that may be followed by lengthy absences of power, water, and communications; in addition, more full accounting for portability and readiness of operation
- **Process:**  
Rethinking about the way that risk is scoped and measured
- For instance, high impact, low frequency events (HILF)  
(5-10% chance of a large-scale tsunami overwhelming a sea wall of a nuclear power plant)

Does an analyst (with scoping and modeled assumptions) or a senior decision-maker influence the extent to which HILF occurrences are factored in planning?

# Broader thinking with nuclear waste

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- What is an appropriate timescale for accountability on nuclear waste storage:  
100,000 years? ... 1 million? (basis?)
- How does one reasonably account for safety in such timescales?
- How do we communicate with future generations about stored nuclear waste when yet-to-emerge languages, knowledge, and values may be involved?

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# **Radiation Protection: Reconsidered**

# Ethics and Practice of Radiation Protection

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Radiation protection – knowledge, value choices, risk analysis

- What determines the order of values?
- How is knowledge legitimized and accepted?
- How is risk evaluated?



*At least part is done through the social contract*

# Ideas on the social contract

## ... relevance to radiation protection

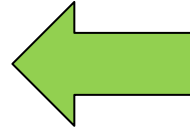
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- Individuals subordinate some of their freedoms in exchange for protection (Rousseau, 1762, Locke, 1689, Hobbes, 1651)
- Rational people set aside individual preferences under a 'veil of ignorance' and agree to general principles of fairness (Rawls, 1971)

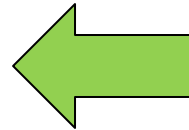
# Concepts often raised with Radiation Protection

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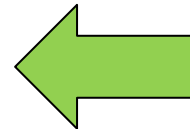
- Egalitarianism



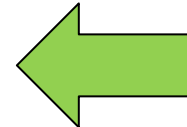
- Utilitarianism



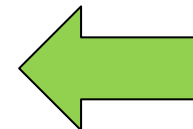
- Precaution



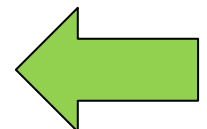
- Individual vs. society



- Urgency override (state of emergency)



- Competing interests in:  
Health, Cost, Security, Privacy...



# Linear Non Threshold hypothesis

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**Adopted in 1959:** Basis for radiation protection at low doses (<0.2 Gy)

**Assumes:** For each incremental increase in radiation dose there is an incremental increase in the probability of cancer

**Derived from:** Dose-response relationships between the radiation dose of survivors of WW2 bombings and observed health effects, principally hereditary disorders and cancer

Deemed conservative and prudent in the absence of measureable scientific evidence for low dose radiation

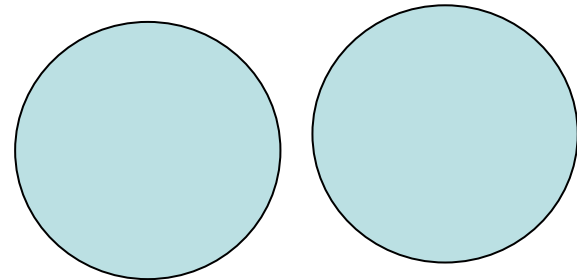
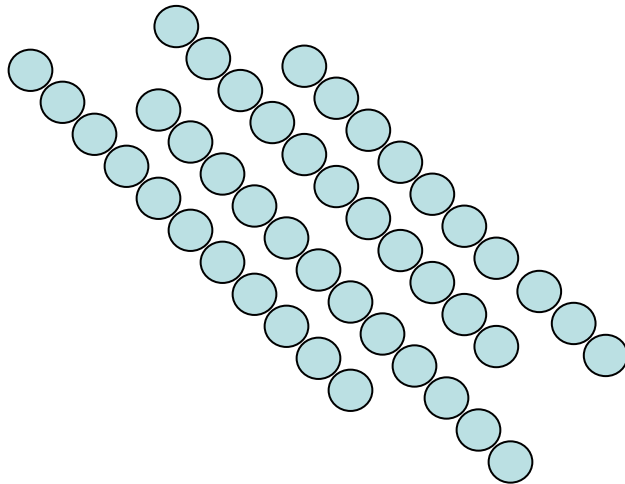
**Questioned areas:** Lack of human data at low doses, contradictory shape of dose-response curve at low doses, radiation phobia, resource waste, etc. (Aleta, 2009)



# Questions on 'Net' positive benefit

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How are aggregated, small-scale gains calibrated vs. individual large-scale gains?



Is this about greater gains for the gainers vs. losses for the losers?

# Questions on Quantification and Measurement

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Measurement:

An instrument of knowledge accrual and, arguably, legitimacy

Do numbers alleviate psychological concerns  
(fear, frustration)?

- To what extent do we develop false certainty w/ trivial numbers?
- Does the 'ease' of quantification and measurement predispose us to ignore elements of decisions that are more qualitative in nature?

# Questions on the Harmonization of Standards

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There is some degree of comfort in collective action, efficiency, and a one-size fits all nature

Moreover, some issues transcend political boundaries, necessitating address in a form that is easily translatable ...

- With more universal applications, do we risk oversimplifying/missing important idiosyncratic nuances?

# Questions about the Science/Knowledge

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Radiation protection can have an inherent urgency that does not allow for professional filtering practices to run their course....

- How is local knowledge vs. mainstream science valued?
- Is the ICRP system adequately nimble for the evolving knowledge frontier and different societies?

# Closing thoughts

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... in an age of accelerating and multiplying information flows, ongoing competition of values, and varying ideas on governance and accountability

Scientific and societal tensions tied to radiation protection can be expected to continue...

- Flexibility-precision
- Harmonization-local idiosyncrasies
- Variations in social contracts

# Thank you ...

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