

4. R. P. Feynman, *The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*, Basic Books (2005), p. 195.

Sadri Hassani

(sadri.d.hassani@gmail.com)

Illinois State University, Normal

Chernobyl nuclear-meltdown consequences

Thirty years after the Chernobyl accident, *PHYSICS TODAY* published an article, “What can Chernobyl teach us?” (April 2016, page 24), which unbelievably underplayed contemporary indications that no member of the public died as a result of the 1986 reactor meltdown. The four-page article was filled with bland reviews, images, and anecdotes of the type that for decades has dominated reporting, mostly unrelated to still-controversial consequences of the meltdown.

Although the accident resulted in destruction of the power plant, the medical consequences among the general population have been vastly and irresponsibly exaggerated. Long-term effects were not radiological but largely financial, institutional, and psychological.

Some early, never-validated estimates varied enormously, with total alleged fatalities from close to a million down to tens of thousands. For example, Frank von Hippel and Thomas Cochran, self-described public-interest physicists, estimated “2,000–40,000 thyroid tumor cases . . . of which a few percent might be fatal” and “3,500–70,000 cancer cases . . . of which approximately half might be fatal.”¹ Nothing like that grim forecast has ever come to pass.

Of 600 workers present, 134 received very high doses and suffered acute radiation sickness; 28 died in the first three months. Altogether, there were 31 fatalities from overwhelming radiation exposure, excessive heat burns, and direct mechanical trauma.² Also, a larger number of liquidators—personnel who dealt with the meltdown’s consequences—were subsequently subjected to above-normal radiation doses, possibly adding another dozen or so fatalities.

Media attention in the intervening decades has focused on the association

between radionuclide exposures and delayed medical effects. Initial thyroid radiation doses were particularly high in children and adolescents living in nearby regions; more than 6000 thyroid cancer cases have been diagnosed in that group. Although there’s been a tendency to attribute those incidences over time to the Chernobyl accident, cancer increases were also observed before the accident. Nevertheless, very few—perhaps a dozen or so—deaths from thyroid cancer can be clinically associated with radiation from Chernobyl.

An overall increase in mortality rates has since been reported in most areas of the former Soviet Union, and that must be taken into account when interpreting the accident studies. Apart from some thyroid cancer among those exposed at a young age, no increase in solid cancers or leukemia due to radiation has been clearly demonstrated. Nor has there been any proof of other nonmalignant disorders. However, widespread psychological reactions have been observed.

As for latent medical effects—including cancer—in adjacent nations, no casualties could be clinically confirmed: Contrary to estimates extrapolated from unproven theories about effects at low radiation doses, mortality among those exposed to the radioactive fallout cannot be distinguished statistically from normal morbidity. Nor have birth defects, radiation burns, or radiation sickness been verified.

When compared with other energy sources and industrial disasters, the Chernobyl reactor explosion resulted in far lower casualty rates. No postmortem data prove that any member of the public died of Chernobyl radiation. Decades after the accident, an international study team has continued to mention an unsubstantiated upper limit of 4000 induced public fatalities—a limit derived not from corroborative medical examinations but from doubtful extrapolations.² Yet, 30 years later the confirmed public death toll from Chernobyl remains near zero. The low rate of actual public fatalities is due in part to prompt post-accident national and international action.

Radiophobia, exacerbated by and after the accident, increased economic losses in the former Soviet Union and elsewhere in Europe. In Western nations, public apprehension about low-level radiation was stoked to encourage

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opposition to Cold War nuclear weapons testing. Moreover, misguided radiophobia tends to traumatize individuals who begin to fear natural radiation despite our ordinary daily exposure.

Inasmuch as the average dose of any substance does not determine average risk, particular care should be taken not to give credibility to the "ecological" or "collective-dose" fallacy. Simply put, a one-time dose of 400 aspirins can cause an individual's death, but that does not mean, in a group of 400 people taking one aspirin a day, one person will die. That logic fallacy is all too common among those who have excessive fear of radiation.

Investigative committees have acknowledged that nobody outside the reactor is likely to have died prematurely as a result of the accident. Under the umbrella of the Chernobyl Forum and World Health Organization, the conclusions are identical. There's no palpable evidence of statistically increased mortality—including thyroid cancer—from the spread of Chernobyl's radiation. Confusion about Chernobyl has arisen because many thousands of people in the affected areas of the former Soviet Union

have since died of natural causes. Also, local residents were misled by media-induced expectations of ill health attributable to radiation exposure.

The most expensive and harmful action in response to Chernobyl was the displacement of more than 300 000 people from contaminated regions, where the radiation dose from fallout was about twice the natural dose. The evacuation led to mass psychosomatic disturbances, great economic loss, and serious social consequences to the populations of Belarus, Russia, and Ukraine. For rural areas of the former Soviet Union, preventive, diagnostic, and curative treatments were not as routine as in the West. Better medical attention, diagnosis, and treatment since then have resulted in significantly improved detection of latent thyroid cancers at early, often treatable stages. The low rate of actual correlative fatalities is partly because of post-accident remedial action and health care.

Of course, the relatively limited medical impact of the Chernobyl accident does not warrant any reduction in nuclear safety or public vigilance. Nor does it discount the very real and fright-

ful psychological and economic trauma experienced by nearby inhabitants, as Toni Feder, author of the PHYSICS TODAY piece, compassionately described.

References

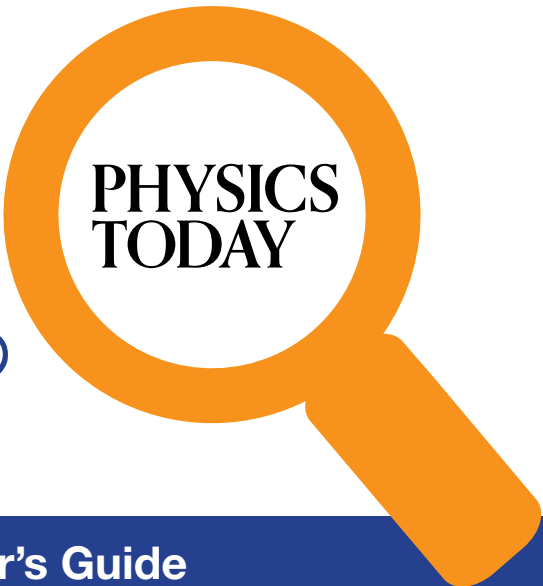
1. F. von Hippel, T. B. Cochran, *Bull. At. Sci.* **42**(7), 18 (1986).
2. Chernobyl Forum, *Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine*, 2nd rev. ed., International Atomic Energy Agency (April 2006). Subsequent World Health Organization reviews through and well past the 25th anniversary of the accident have reaffirmed these conclusions.

Alexander DeVolpi
(waterfoxg@gmail.com)
Oceanside, California

On the value of carbon-ion therapy

In PHYSICS TODAY's October 2015 Readers' Forum (page 8), Robert Schulz and A. Robert Kagan take the stance that there is no justification, in terms of cost

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