

VIEWS OF THE CHERNOBYL ACCIDENT FROM TWO SOVIET SCIENTISTS

The Legacy of Chernobyl

Zhores Medvedev
Norton, New York, 1990.
352 pp. \$24.59 hc
ISBN 0-393-02802-X

The Truth About Chernobyl

Grigori Medvedev
Basic Books, New York, 1991.
\$22.95 hc ISBN 0-465-08775-2

Reviewed by Richard Wilson

The Chernobyl accident has had an extraordinary effect on technology and politics. Mikhail Gorbachev used it as a dramatic demonstration that *glasnost* is essential in a modern society. It has been used by antinuclear activists to demonstrate that nuclear power will always be troublesome, and by nuclear proponents to argue that even the worst can be borne and eventually accepted. There have also been a large number of books about Chernobyl. Two recent books, one by Grigori Medvedev, an engineer, and the other by Zhores Medvedev, a biologist, belong on the bookshelves of every student of that accident.

Grigori had once been deputy chief engineer for operations at Chernobyl. At the time of the accident he was deputy chief of the Main Production Administration of USSR (Minergo) for nuclear power construction. His little book is an account from the inside of the Soviet nuclear industry of the accident itself: who was there, what they were doing and how they responded. It quotes official statements of the reactor operators and others who were present, but also adds semi-fictional accounts of what people (who are now dead) might have said. This makes the book, first published as an article in the Russian

literary magazine *Novy Mir* in July 1989, very readable, and it has the ring of truth. However, I have been warned by Soviet experts that there are inaccuracies—although I have not yet been told explicitly what they are, nor can I find important discrepancies with other information available to me.

Zhores was put in a psychiatric clinic in 1970 because he wrote a book critical of Lysenko. He immigrated to England soon after his release, which was instigated by Andrei Sakharov. In preparing *The Truth*, Zhores has taken pains to search out every published source, and many unpublished sources. For those who do not read Russian and are not as familiar as a Russian with the political nuances, his many descriptions from Soviet sources are important. The book is full of accounts that I had not previously known; since Zhores was born and lived in Russia, he provides political insights that have added considerably to my understanding. Nonetheless, his book is not a balanced and reliable account of the consequences of the accident.

Grigori's account of the activities of the various persons at Chernobyl on that fateful Saturday is fascinating. I find myself imagining what I would do if confronted with the same situation. The bravery and attention to duty of the men after the accident stands out; everyone who has studied Chernobyl marvels at it. Grigori complains about the emphasis in the Soviet Union and elsewhere on the bravery of the firemen, although a greater number of reactor staff bravely risked their lives to protect unit number 3, report on the accident, secure chemicals and so forth. Yet they are not so honored, and as a group they have been blamed for the accident. Grigori's complaint seems convincing and just.

Zhores also discusses their bravery, but questions whether all of this heroism was necessary. He goes too far. "Even highly responsible people

needlessly exposed themselves... Academician Yevgeni Velikhov climbed about unit 4 on 27 April to inspect the damage. He exposed himself to 25 rems." But putting out the fire and stopping the release of radioactivity was important and urgent; one should not scoff at the bravery of a man who had a job to do and knew what he was doing.

Grigori draws few conclusions, and his almost complete lack of detailed analysis leads to no problems. However, Zhores draws conclusions that should only have been drawn after completing a better analysis. He is properly skeptical about the idea that the accident was solely due to human error. But he incorrectly states that world experts have bought this idea—they have not. The main problem was the positive void coefficient (which makes the reactor weak)—a problem that Zhores does not mention. Subsidiary problems were lack of containment and a general failure to inculcate a safety culture in Soviet society.

Unfortunately even Zhores's factual statements must be checked. In discussing some of the post-accident changes in the reactors, Zhores notes that they increased the cost of electricity from existing graphite-moderated reactors. He states that they "reduced the maximal power from 1000 MWe to about 800 MWe." In June 1990 I saw the printouts for operation of all the power reactors in the USSR for the previous day; they were at the full 1000 MWe. Yet he may have been prophetic. A few days later, it was recommended that the power level of the older RBMK reactors be reduced.

One would not expect a biologist to be completely knowledgeable about reactor safety, but Zhores's analysis of the radiation doses and of the biological and medical effects is careless. It appears that Zhores has not talked, as I and many others have, to the Soviet scientists who actually made the estimates of the doses. He quotes several newspaper articles and

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includes maps released in a 1989 report that shows more radioactivity deposited northeast of Gomel than had been reported in 1986.

At first the 1989 report seemed like newly discovered information. But we now know that half a dozen pages describing the radioactive fallout in Byelorussia and the USSR were written for the official report in 1986 and then taken out at the last moment by an order from "higher up." But the radioactivity was included in the totals that the Russians presented in 1986. Zhores states that "it now seems likely that for the population of 40 million for which in the Il'in and Pavlowki report in 1987 an accumulated dose of 186 200 sievert was estimated in the next 70 years will be close to 1 000 000 sievert. And this is a conservative estimate." This is almost certainly wrong. These numbers will be confirmed or denied by the forthcoming report of an International Atomic Energy Agency study group. Zhores's bias here is a pity, because it would have been interesting to hear a Russian scientist's speculations on the political reasons for the suppression of information in 1986.

Zhores has an excellent set of illustrations: I was pleased to be able to provide two of them. Alas, the publisher eliminated a discussion of the reason that the solitary tree in one figure was left standing when all others had been removed because of their radioactivity. This area, the Pripjat marshes, lies along the line of the German advance in 1941. In 1942 and 1943 the forest was full of partisans. When one was caught, the Nazis found the horizontal branches of that tree to be convenient for the purpose of hanging. This information was not freely given because it was thought that foreigners might not understand. But as a schoolboy, I had followed every detail of the military action with interest and anguish. When I saw the tree, my heart went out to the brave Ukrainians of those years. The Chernobyl accident was a minuscule problem in comparison. Let us hope neither experience will ever be repeated.

The Early Universe

Edward W. Kolb and
Michael S. Turner

Addison-Wesley, Redwood
City, Calif., 1990. 547 pp.

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The Big Bang is alive and well. Despite press reports and the occa-

sional article or editorial in *Nature*, physicists can relax and appreciate the richness of this theory with little risk of running into any imminent paradigm shift. *The Early Universe*, intended for an audience of physicists and astronomers, presents a concise and comprehensive exploration of the interface of particle physics and cosmology. The authors, Edward Kolb and Michael Turner, are adept and distinguished theoretical astrophysicists who have made important contributions to our understanding of the early universe. Their intention is to describe the present status of a rapidly developing frontier field of research in a coherent monograph that will provide a thorough introduction for either the beginning graduate student or the curious physicist.

It is a remarkable achievement to have been able to trace our history back to a mere 10^{-43} seconds after the beginning of the universe. Skeptics may question the experimental evidence that underpins this evolutionary tale, and philosophers—or even particle physicists—may quibble at certain leaps of faith. Yet the effort is heroic, and the results are occasionally so appealing that one longs for a more definitive proof. The only reasonably secure artifact from the earliest epochs of the universe is the relative abundance of the light elements. Armed with a substantial amount of helium—about one quarter of the baryonic mass in the universe—and a seasoning of deuterium and lithium, one can concoct a reasonably robust record of cosmic history back to the first second or so after the Big Bang.

Some of the most important issues however are decided long before. The entropy of the universe and the density fluctuations that seeded large-scale structure were laid down somewhere between 10^{-43} and 10^{-10} seconds after the Big Bang. This represents the realm of unknown or at least highly speculative physics.

At 10^{-10} seconds, when the temperature of the universe was 100 GeV and the electromagnetic and weak nuclear interactions were distinctive forces, the physics is reasonably well understood. Particle accelerator experiments have thoroughly probed this energy range, where the standard model of elementary particles is described by the theory of quantum electrodynamics and crowned with success by the discovery at LEP of the W and Z bosons. The early universe has become a laboratory for testing particle physics theories. The number of neutrino species inferred from light-element abundances, where an

excessive number would speed up the expansion and overproduce helium, confirms the number measured by means of the width of the Z-boson decay channels. If a neutrino species were massive and unstable, its out-of-equilibrium decay products—if it decayed via weak-interaction channels—would produce unacceptable distortions in the cosmic microwave background, measured to be black-body-like to better than one percent near its peak intensity. Of course, one can adjust the decay time scale to be sufficiently short (less than a month) to hide any decay photons: Even then, only a narrow window remains; otherwise some of the fragile products of primordial nucleosynthesis, such as deuterium, would be destroyed. The ingenuity of particle theorists is such however that one can adjust the branching ratio into photons so that interesting astrophysical signatures are generated, thereby opening up new areas for the experimentalists to constrain.

It is at much higher energies—where the number of adjustable parameters in one's favorite particle theory is finite but embarrassingly large—that we have an overwhelming array of theoretical options from which to choose. Inflation promises to explain such questions as why the universe is as large as it is and as spatially flat as it appears, and it prescribes the form of the primordial density fluctuations, yet the nature of the phase transition that triggered the inflationary expansion phase is elusive. Adjust the details of the grand unification symmetry-breaking scheme, and one can produce widely differing descriptions of the universe when the inflation has subsided. This means that we do not yet have a fully predictive theory on hand. Not that this has inhibited theorists, of course, who launch into highly detailed scenarios of cosmic evolution that are based on inevitably subjective choices of initial conditions.

Invariably, it is the observed universe—its dark-matter content, its large-scale galaxy distribution, the peculiar motions of galaxies, the cosmic microwave background isotropy and distortion-free spectrum, the abundances of the light elements—that limit the initial parameter space. Nevertheless, the fact that we even have the possibility of retrodicting the universe today back to grand unification energy scales of 10^{15} GeV or beyond, no matter how non-uniquely, is a dramatic development in cosmology that has emerged over the past decade. *The Early Universe* is a long-anticipated guide to the new cosmol-