USSR's key to nuclear progress: "Soviet Rickovers"

From Scientific Search to Atomic Industry: Modern Problems of Atomic Science and Technology in the USSR

A. M. Petrosyants
369 pp. Interstate, Danville, Ill., 1975.
$17.90

Reviewed by Alvin M. Weinberg

A. M. Petrosyants is chairman of the USSR State Committee on the Utilization of Atomic Energy. Because he was involved in founding the Soviet nuclear enterprise, his account of the development and state of nuclear energy and nuclear research in the Soviet Union, as of 1972, is both comprehensive and revealing.

Petrosyants deals with nuclear power, accelerators, isotopes, nuclear-research institutes and international aspects of nuclear energy, especially in the Communist states. Though the book is at times repetitious and suffers from uneven translation, it nevertheless presents an unsurpassed overview of the entire Soviet nuclear enterprise.

Does nuclear energy developed under socialist auspices differ in any essential respects from nuclear energy developed in a capitalist country? Are the questions that now trouble nuclear energy in the US, and indeed the West, mirrored in the Soviet Union? Have the developments proceeded along parallel lines? Can we say anything about the efficiency of developments in the US and USSR? These are the telling comparisons that Petrosyants's book makes possible.

Judging from Petrosyants's narrative, nuclear energy's troubles in the US are hardly apparent in the Soviet Union, though the book is largely based on the 1972 edition and at that time even in this country apprehensions about nuclear energy were still relatively muted. One finds little concern about reactor safety and waste disposal. Indeed, Soviet reactors even now are not housed in primary containment vessels, and Soviet engineers cannot understand why American reactors require such containment. But occasionally Petrosyants seems to imply that acceptability of nuclear power in the Soviet Union is not an entirely foregone conclusion: he goes to considerable length to compare the SO_2 emissions from a coal-fired plant with the essentially innocuous radioactive emissions from a normally operating nuclear power plant.

At the USSR's Nuclear Reactor Research Institute in Melekess, Viktor Bazyukin (right) and associates study irregularities in irradiated reactor materials and fuels. NOVOSTI from SOVFOTO.

The Soviet experience illuminates the balance between safe-as-possible versus cheap-as-possible, which in a sense underlies our nuclear debate. One might imagine that in a non-competitive socialist enterprise the balance would be struck further toward safety than in a capitalist enterprise: critics of nuclear power, at least, sometimes argue that safety is compromised in the interest of making a fast dollar. Petrosyants's book rather points to the opposite conclusion. Soviet reactors are not contained. The power density of the Soviet boiler, about 35 kW/l, is not far from that of the first-generation US boilers; and the operating parameters of the Soviet light-water reactors are close to those of the American LWR's.

On the other hand, one would expect, *a priori*, that our competitive system would lead to more diversity of approach than the Soviet system. Here, too, Petrosyants says otherwise. The primary American reactor systems are variants of a single type: light-water cooled and moderated. By contrast, the Soviets are deploying two entirely different systems: PWR's and water- and steam-cooled channel-type graphite reactors, in addition to one 50-MW BWR. Similarly, the Soviet approach to the fast breeder appears to be more diverse, and certainly more aggressive, than the American: three LMFBR's now operate, and a fourth—rated at 600 MW—is under construction. The first three plants are loop-type; the fourth is a pot-type. On the other hand, the Soviet Union has been much more leisurely than have we in the

actual deployment of nuclear reactors.

Petrosyants's book invites comparison of the US and Soviet systems of nuclear development. In the US we have a hybrid: "Private" enterprise is heavily regulated by the Nuclear Regulatory Commission and subsidized—and, in the case of the LMFBR, directed in detail—by the Energy Research and Development Administration. In the Soviet Union, all is done by the government, although, to be sure, Petrosyants implies he has his battles with the Ministry of Public Health. The evidence suggests that our system—open, responsive to public criticism and untidy—leads to greater concern for safety, but that it also, paradoxically, is less aggressive and less diverse.

How can this be? One explanation may be that the Soviets delegate more authority to the experts than do we. As far as I can gather, from Petrosyants and from other sources, the Soviets identify technical heroes and give them much sway; their projects seem to be run by Soviet Hyman Rickovers. Indeed, the whole Soviet nuclear development reminds me of Rickover's Naval Reactors Branch. There is a continuity in the Soviet nuclear development that is lacking in much of the American development. I. V. Kurchatov, when he was alive, enjoyed the full confidence of his government; he (with help to be sure) gave the Soviets atomic energy. This tradition persists: the Kurchatov Institute, the primary center for *applied* nuclear energy, includes nine full members and several corresponding members of the USSR Academy of Sciences. The Institute appears to go about its business much less encumbered by bureaucratic meddling than do the American National Laboratories. In nuclear energy, the Soviet system may have *less* red tape than does the American.

But something is lost in this approach. A full debate on nuclear energy, such as we are having in the US, is unthinkable in the Soviet Union. And secrecy goes much beyond this; for example, Petrosyants discusses uranium reserves throughout the world without a single allusion to the Soviet reserves. He all but omits the considerable Soviet development of nuclear submarines.

The lessons to be drawn from Petrosyants's book are important for all who are concerned with the current nuclear debate; and the messages it implies about our two systems cannot be ignored.

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A History of Engineering and Science in the Bell System: The Early Years (1875–1925)

M. D. Fagen, ed.
1073 pp. Bell Telephone Laboratories, Murray Hill, N.J., 1975. $15.00

"Only the Deity has so far been found competent to inspect His own work and find it good." The remark appears on page 860 of this survey of the Bell System's technical achievements during the telephone's first half-century. The assertion refers to the hazard inherent in allowing manufacturing people to inspect their own products. It might also be applied to the hazard inherent in allowing a company's researchers to write their own history.

In entrusting the writing of technical history to a team of insiders directed by editor Morton D. Fagen, the leaders of the Bell System have decided for completeness and against detached analysis. The result is a bit self-congratulatory. But, after all, the Bell Laboratories and their corporate ancestry do have a lot to congratulate themselves upon.

With the above qualification, this book can be heartily recommended to all concerned with the role of science and technology in the growth of American industry. Few will have the stamina to read the entire 1073-page volume, but most can sample it with profit. It is the most comprehensive account extant of the technical evolution of a major industrial corporation. The book does not, however, do justice to the complex web linking technology with the social and economic aspects of that corporation's development.

The book is organized by technical categories (such as "Station Apparatus" or "Materials and Components"), each covered chronologically. The overall story begins in 1875, when the entire plant of world telephony consisted of a single iron-wire circuit with Alexander Graham Bell at one end and Thomas J. Watson at the other. By book's end, the Bell System has virtually achieved its goal of a nationwide hookup and is on the threshold of connecting up worldwide.

At times the authors seem determined to describe every insulator design, handset modification and switchboard layout that contributed to the achievement. This overload of detail is a bit wearying. But it does succeed in conveying the increase in complexity that gave that much-overused phrase "systems approach" a real meaning in this application. Developing the ability to plan on the scale of a national system is an achievement of which Bell is justly proud.

Of more potential interest to readers of PHYSICS TODAY is the account of the diffusion of science into telephony. As early as 1884, Lord Rayleigh urged "practical electricians" to "rise above ohms and volts." Rise they did. Oliver Heaviside, working independently, devised a mathematical treatment of alternating current. George A. Campbell of Bell applied it to the practical problems of wire transmission—providing, in the process, an unsurpassed demonstration of the dollars-and-cents value of mathematical physics. It took a tip from a second academically trained scientist, John Stone, and the experiments of a third, Harold D. Arnold, to adapt the invention of Lee de Forest and bring the electronic amplifier into telephony. (De Forest, also a PhD physicist, began his career with Western Electric, but he left the Bell System after his supervisor told

Pioneers in electron diffraction. Clinton J. Davisson, Lester H. Germer and colleague C. J. Calbick (l to r) are shown with apparatus for studying electron scattering at Bell Laboratories, 1925.