Reactor Explodes Amid Soviet Silence

As fallout spreads across Europe, Soviet officials grudgingly begin to release information about the worst reactor accident on record

THE specter that has haunted the nuclear industry for years became a reality last week in the Soviet Union. A large, modern Soviet reactor—unit number 4 at Chernobyl, 80 miles north of Kiev, only 3 years old—blew out and burned, spewing radioactive debris over much of Europe. Why it did so is not known. Nor is it clear how much harm the accident did to the citizens, the land, and the water around Kiev. No threat to public health is expected in the United States.

The Soviet government has released only sketchy information. It announced, for example, that two people were killed and that about 25 others were in critical condition, presumably dying of heavy exposure to radiation. In all, close to 200 have been treated in hospitals and 47 released. About 49,000, according to a senior Communist Party official speaking in West Germany, were evacuated from the area and will have to stay away from home for an indefinite period, perhaps years.

Radiation levels increased throughout Europe, from Sweden to Britain, through Poland, and as far south as Italy. The levels detected in Sweden were about ten times above natural background at the peak, posing no danger to public health. The picture closer to the accident may not be so bright. Polish children were given potassium iodide to block absorption of radioactive iodine by the thyroid. But many did not get medicine.

U.S. citizens traveling as tourists in Kiev picked up some of the spilled radioactive debris, but not enough to endanger their health. Norman Cohen at New York University's Institute of Environmental Medicine examined two teenagers who were in Kiev for several days immediately after the accident. He reports that he found that the two were carrying internal burdens of iodine 131 and tellurium 132 of less than 5 nanocuries each. "We haven't seen exposures like this since the 1950's and 1960's, when we were all exposed to fallout from atmospheric testing," Cohen said. He added that the doses were "interesting, but not biologically significant."

More than a week after the accident, the Soviet Union invited experts from the International Atomic Energy Agency of Vienna to come review the situation. Hans Blix, the Swedish director-general of the IAEA, will lead the team. This was the first significant offer to grant technical information about the accident.

By every measure, this is the worst civil nuclear catastrophe on record. Readings taken 750 miles distant, at the Forsmark nuclear station outside Stockholm, quickly established that the fuel core had been destroyed and that a good share of the radioactive fission products had been dumped into the environment. The Swedes were confident of this, for by 29 April they had detected all types of isotopes that might come out of such a catastrophe. These included the noble gases xenon and krypton; fairly high levels of iodine and cesium; the heavy elements, including large readings of neptunium; and traces of strontium, technitium, and zirconium.

U.S. officials have not given exact data, but they are confident that at least 50% of the iodine and cesium escaped from the reactor (representing 30 to 40 million curies of iodine-131 and 3 million curies of cesium-137). This estimate comes from the Lawrence Livermore National Laboratory. The same figures are being used by the the new U.S. Task Force on the Soviet Nuclear Accident, created on 29 April and chaired by Lee Thomas, administrator of the Environmental Protection Agency.

Task force members also say that anyone within 3 miles of the reactor may have received a lethal exposure. The largest public health impact is likely to be a dramatic increase in thyroid problems, affecting hundreds of thousands of people. With proper treatment, thyroid cancer usually is not lethal.

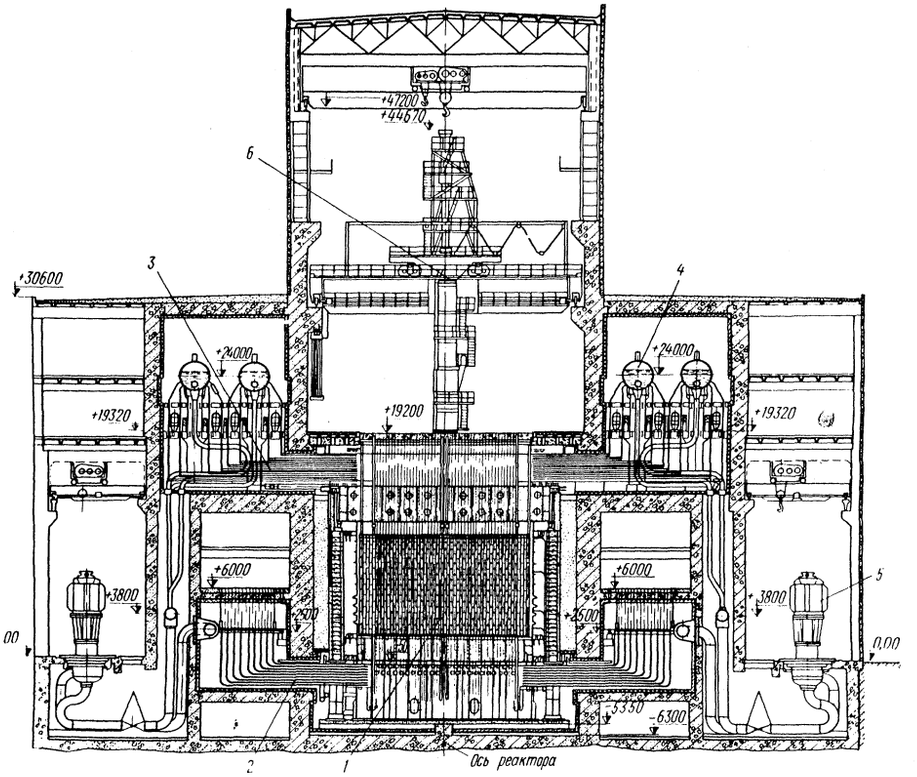
U.S. experts have proposed two broad scenarios to explain how the accident might have happened. Both assume that the trouble began with a leak in the cooling system, draining out the water and overheating the fuel. After this point, the experts divide. Most, including Harold Denton, director of regulation for the U.S. Nuclear Regulatory Commission, favor the theory that the chemical reactions generated by the hot core posed the critical danger. Steam around the pipes and fuel rods may have disocciated in the presence of zirconium, producing hydrogen. This would provide the fuel for a powerful hydrogen-oxygen explosion.

Denton, in technical matters the best informed member of the new task force, believes a hydrogen-oxygen explosion may have split open the shield around the core, exposing it to the air. At this point, the graphite used to moderate the neutron flux may have been exposed to air. Steam passing over the hot graphite could have produced carbon monoxide and hydrogen ("water gas"), adding more fuel for a fire or explosion. Finally, the graphite itself caught fire.

One knowledgeable federal scientist challenges this scenario. He says he knows of no plausible chemical reaction that would provide enough oxygen for a major explosion within the core. If the explosion took place outside the core, he doubts that it would have stripped away the 6-foot-thick concrete shell that surrounds the reactor. This scientist, an expert in reactor fuel, has been directed by the Energy Department not to discuss the Soviet accident with the press. However, he spoke with *Science* before the order went out, and later asked to remain anonymous.

He says the Soviet reactor probably went into a "power excursion." This occurs when the fuel is allowed to fission too rapidly, producing a sort of nuclear flash fire or detonation. A runaway reaction could overheat the core and mobilize all the gases and liquids in it in microseconds. The piston-like effect would be strong enough to drive the concrete shield out the roof, exposing the top of the core to the air.

Tass published a dispatch on the accident on 5 May, suggesting a conventional fire did much of the damage. Without naming the date (assumed to be 25 April) *Tass* reported: "An explosion destroyed structural elements of the building housing the reactor, and a fire broke out. That happened at night. After the explosion, the engine room coating took fire." *Tass* said firemen worked "courageously" while their boots stuck in the hot pitch on the roof. "Radioactivity was partially discharged upwards, and then a fire started inside." This probably refers to the superheated graphite fire, which caused water and chemicals sprayed



The RBMK-1000 reactor

There are approximately 20 of these "pressure tube" reactors in the Soviet Union, the newer ones rated at 1000 megawatts. All are said to be shut down at present, halving the Soviets' production of nuclear electricity. Unlike U.S. reactors, they have no pressure vessel or containment dome. The uranium dioxide fuel and cooling water are contained in hundreds of metal tubes, each linked to the coolant pumps and mounted in a core made of graphite blocks. The core is surrounded by inert gas and sits in the bottom of a concrete well. The blast at Chernobyl tore away the upper part of the building represented in this drawing.

on it to "evaporate instantaneously."

People in an 18-mile radius around the plant were evacuated in Kiev city buses, a process that began 36 hours after the reactor caught fire. "The situation remains complicated," according to *Tass*, but technicians are still manning three other reactors at Chernobyl.

At the outset, Soviet officials gave few details beyond acknowledging that there was an accident. Indeed, the Soviets went this far only when Swedish diplomats demanded to know why a radioactive cloud crossed into Sweden sometime on Sunday 27 April. At first, the Soviets denied that there had been an accident. Then Swedish officials in Moscow cited data that pointing irrefutably to a reactor blowout. On 28 April, the Soviets offered a terse confirmation. Also in this meeting, Soviet officials informally asked for advice on putting out a graphite reactor fire. They also sought advice from West Germany. The United States offered help the same day, but the offer was declined. However, Robert Gale, a bone marrow transplant specialist from the University of California at Los Angeles, flew to Russia on 2 May to offer private help.

The Soviets must have been aware that an accident was in progress as early as 25 April, observers say. In any event, the Soviets failed to warn neighboring countries of the impending crisis. This did at least as much harm to Soviet prestige as the fallout itself. In a belated effort to repair the damage, several Soviet officials have granted interviews to Western news media, but they have provided few additional details.

The Soviets were not the only ones embarrassed by the information blackout. With unbecoming haste, U.S. officials on 29 and 30 April repeated some confused rumors that flickered across the news wires in the early days. For example, they gave credence to reports that thousands had died. The director of the Arms Control and Disarmament Agency, Kenneth Adelman, said it would be "preposterous" to think otherwise. The Secretary of State said he would "bet $10" that the deaths were "far in excess of" the numbers given by the Soviets. The White House and State Department also gave authority to reports that a second reactor at Chernobyl (unit 3) had melted down, that the graphite fire would burn "for weeks," and that the reactor had been used to produce weapons material.

It may turn out that none of this is true. While it is difficult to be certain about the damage, U.S. scientists say that it is unlikely that 2000 people were killed outright.

"The Russian reports, sparse though they are, make sense," says Richard Wilson, the Harvard physicist who chaired the American Physical Society's 1985 study of severe nuclear accidents. "My guess is that we will get 80 dead. That's a lot, but it's not 2000. . . . They evacuated probably everyone within 10 miles downwind, and if you look at our emergency planning regulations, they say, evacuate people 12 miles downwind. . . . The Russians have done the same thing, probably got them out in time, so the number of prompt deaths in that area would not be particularly big."

Jan Beyea, an expert in radiation effects employed by the National Audubon Society, also thinks the casualty figures were exaggerated. "I remember the accident at Three Mile Island," he says. "All the early reports were wrong." Beyea would expect no more than several hundred early deaths. In the worst case, he added, his analysis of the potential damage to be done by a reactor like the one at Three Mile Island showed that 18,000 square miles of agricultural land might be contaminated. But if one assumes that less than all the radioactive isotopes escaped, the contaminated zone would be smaller. "If 10 percent or a few percent of the cesium got out, we may be talking about 1000 square miles, which isn't actually all that much."

Beyea warns that radioactive dust which has settled will become airborne again in strong winds. This may lead to the mistaken perception that the reactor has begun to leak again. It may cause alarm, but this second wave of radiation will not pose a major threat to public health, Beyea thinks.

According to one Soviet report, the level of radiation near the reactor on 2 May was 200 roentgens. If this was an hourly rate (which is not clear), anyone who remained in the area for a few hours would get a lethal dose. Clearly the Soviets face an enormous cleanup task whose dimensions may not be known for weeks. ■ **ELIOT MARSHALL**