

NUCLEAR POWER

Western Leaders Disagree on Soviet Reactor Safety Plan

When a Russian reactor sneezes these days, all Europe fears the flu. Such was the case when an old graphite reactor near St. Petersburg burst a pressure tube on 24 March and released a small amount of radioactivity to the atmosphere. Though there were no injuries and no serious radiation exposures, the "incident at Sosnovy Bor" conjured up images of Chernobyl, reminding the world that while the Soviet Union may have vanished, its technology is still a force to be reckoned with.

Sosnovy Bor is one of 15 high-risk, Chernobyl-type reactors still running in Russia, Ukraine, and Lithuania. Less threatening, but still risky enough to give Europeans nightmares, are 10 old Soviet pressurized water reactors, including four in Bulgaria. The Sosnovy Bor case raised a few urgent questions, namely: Who will lead the effort to fix these reactors, when will that effort begin, and who will pay for it?

The big industrial nations at their summit meeting this month in Munich tried to come up with answers. But the "G-7" (Britain, Canada, France, Germany, Italy, Japan, and the United States) could not agree on a joint management plan, and so decided to muddle along independently, as in the past. Germany is leading a European push for a major international effort to make these reactors safer. Considering how close German citizens are to the eastern European reactors, this may not come as a big surprise, but there may be more to it than that. The Americans have preferred to go their own way so far, explaining publicly that Germany wants to create a new bureaucracy, and the United States does not. But a well-placed government consultant has told *Science* that, privately, U.S. officials are leery of joining what they regard as a "market development" plan to prepare the way for equipment sales to eastern Europe by Framatome and Siemens, the French and German nuclear power companies. Whatever the true agendas may be, for now, independent safety efforts will go forward loosely coordinated by European Community staff.

The United States, according to Robert Gallucci, the State Department official coordinating U.S. nuclear safety aid, is preparing to spend several "tens of millions" of dollars



High-risk reactor. Sosnovy Bor on a good day.

over the next few years to improve Russian reactors (see sidebar). The Europeans—joined by Japan, if it settles a quarrel with Russia over the Kurile Islands—are talking about a larger commitment of \$700 million to \$1 billion. And if this sounds like big money, consider that international specialists, like Morris Rosen, chief of the safety staff at the International Atomic Energy Agency (IAEA), believe the job will take 5 years and

cost \$10 billion to \$15 billion.

The biggest threat, all experts agree, is posed by the RBMK reactors like those at Chernobyl and Sosnovy Bor. These are scaled-up copies of machines designed to produce plutonium for weapons. Their nuclear fuel is kept in 1600 tubes, each packed with graphite to "moderate" the pace of the nuclear reaction, and cooled by water. The design allows operators to shut down individual tubes, remove them, and replace the fuel while the reactor is still running. The RBMK has no containment structure. It's a great system for producing lots of plutonium, but not so good for public safety. A single blocked tube can cause trouble, as the leak at Sosnovy Bor proved. In that case, a valve got plugged, the flow of water stopped, the fuel overheated, the pressure rose, and the steam punched a hole in the tube. Radiation spewed into the building and out the stack to the neighborhood. It happened so fast the operators had no time to prevent it.

Still, the RBMK can handle a mishap like this without major catastrophe because its systems are designed to cope with a single tube failure—releasing only 2000 curies in the case of Sosnovy Bor, far less than the meltdown at Three Mile Island (17 million curies released). Chernobyl remains in a class of its own, with a record of 100 million curies released. Nevertheless, no one is sure what would happen at a reactor like Sosnovy Bor if five or six tubes failed at once. Even more worrying, as Chernobyl tragically demon-

Quick Fixes for \$810 Million

Until now, most Western efforts to reduce the risk of another reactor accident in the former Soviet Union have focused on "soft" projects, such as identifying weak points in management and improving operator training. But experts like Morris Rosen, safety chief at the International Atomic Energy Agency (IAEA), warn that the West must also be willing to finance some new hardware.

The list of proposed fixes is long and expensive, but for \$510 million over the next 5 years, according to Rosen, Western countries could correct the most glaring operational deficiencies at 57 nuclear plants in the former Soviet Union. For another \$300 million, Rosen estimates, it should be possible to take care of the "urgent, near-term technical hardware improvements" at the 25 most dangerous reactors. Visitors to the eastern European nuclear plants agree that the most important single objective is to install fire prevention systems—reported to be archaic or nonexistent by Western standards. Next on the list are redundant electrical lines and better emergency cooling systems. These are precisely the items Germany has focused on. The result is that Russian plant managers often specify German hardware in their wish lists.

The United States has spent \$15 million on technical cooperation with the Russians so far, and has agreed to put another \$25 million into new fire and cooling technology, and two new operator training centers—one in Russia and another in Ukraine. The U.S. Nuclear Regulatory Commission (NRC) has been exchanging technical information with Russia for the past 4 years, on topics ranging from reactor vessel embrittlement to corrosion studies. The goal, says NRC chairman Ivan Selin, is to help the Russians and others build a culture of regulation independent of the power supply system. However, the United States has not yet drawn up a plan for funding Russian hardware improvements, though officials say "tens of millions" of dollars will be made available for that purpose in the 1993 budget.

—E.M.

strated, the RBMKs have a design flaw that comes into play at certain power levels if water in the tubes evaporates and the control rods are not inserted. The nuclear reaction speeds up—instead of slowing down, as it would in a U.S. reactor. No one has come up with a failsafe solution yet, though the Russians have tried to make it less likely to occur by installing faster control rod mechanisms, adding neutron absorbers, replacing old tubes with stronger ones, and training operators better. In addition, some of the older RBMKs are being run at 70% power until they are “retubed.”

But graphite reactors aren't the only ones causing headaches. The other threat comes from a younger system known as the VVER 440-model 230, the first generation of technology styled on the U.S. pressurized water reactor. Ten of these reactors are now in operation. The fuel is located in a small core inside a heavy steel pressure vessel. Water flows around it, serving as a moderator, a coolant, and a means of transferring heat to the turbines. The VVER 440-230s are safer than RBMKs, and are reputed to be among the stablest reactors in the world—as long as they remain within normal pressure and temperature limits. But they, too, were designed with efficiency, not safety, in mind.

Also built without the heavy concrete containment structure that surrounds Western reactors, the VVER 440-230s again have no barrier to stop radiation leaks if other systems fail. And they lack redundant cooling systems, standby control cables, and adequate fire prevention systems. For efficiency, the Soviets often located as many as four in a single, thin-walled building. The consequence is that a serious accident could threaten all at once. Says Gallucci: “We believe these reactors cannot really be made safe in terms of what ‘safe’ means to us in the West.”

That puts the U.S. government in a “terrible ethical position,” says Gallucci. Doing nothing would be “like sticking your head in the sand,” but providing technical fixes may prolong the use of reactors that ought to be abandoned. By improving them, says Gallucci, “you become complicitous” in their operation.

The right thing to do, safety experts testified at a hearing before the Senate Energy and Natural Resources Committee on 16 June, would be to shut down these systems. “There is a growing international consensus that the remaining 15 RBMKs and 10 VVER 440-230s should not be operated any longer than absolutely necessary,” said Ivan Selin, an electrical engineer and chairman of the U.S. Nuclear Regulatory Commission. Indeed, the IAEA, in an unusual, radical decision, in 1991 urged that Bulgaria's four VVER-230 reactors at the Kozloduy plant near the Danube River be closed. These reactors are among the oldest of their type and because they are situated on one of Europe's main

waterways, they pose a greater potential threat than Chernobyl. After Soviet technicians departed, Bulgaria invited the IAEA in to take a look. Western experts found that the plant had fallen into a bad state of disrepair and lax management. Bulgaria agreed to shut down two of the reactors for technical fixes and operator retraining last year, but both are scheduled to come back on line later this year, to Europeans' dismay. The remaining two reactors have continued to run without significant changes, according to the IAEA's Rosen.

Bulgaria's problems are typical of the rest of eastern Europe. Bulgaria's citizens now depend on cheap electricity provided by the Kozloduy plants, Rosen told the Senate. The country has precious few other energy sources—or cash to exploit them. Bulgaria gets 40% of its electricity from Kozloduy; to make the repairs now under way, it has been forced to ration electricity. “For some time to come, I believe we are obliged to accept that all the plants at Kozloduy will be needed,” said Lord Marshall of Goring, Britain's former nuclear power chief, now head of the World Association of Nuclear Operators, who has been to Kozloduy.

Russian officials also are saying they cannot afford to close down older plants—not even the RBMKs. They have suggested, however, that it might be possible to phase them out by replacing them with the latest model Soviet reactor, called the VVER 1000. This is a modern pressurized water machine, comparable to the best in the United States and Europe. About 11 of them were under construction at the time the Chernobyl accident occurred. Work on them came to a halt, but now the Russian nuclear ministry would like to resume building them, with Western financial help.

This proposition—to rebuild the entire Russian nuclear industry—is what sends cost estimates into the billions of dollars, according to Gallucci. And he doubts that “that kind of money” will be available as foreign aid. Instead, if the Russians and other eastern European countries want money for new reactors, they will probably have to obtain commercial financing. And, to do that, they will have to prove that they can repay loans. That means restructuring economies to reduce energy subsidies.

In the meantime, says Lord Marshall, “we have no alternative but to make the existing reactors as good as possible,” even if it is distasteful to share responsibility for them. Marshall is more optimistic than other Western experts that the Soviet reactors can be run safely. The majority view, as expressed by Rosen, is that “we have put a lot of band-aids on” a dangerous situation, and that it will take a much stronger effort to reduce the risks of an accident—an effort that the Western leaders failed to agree on earlier this month.

—Eliot Marshall

Oil-Cleanup Method Questioned

The workers cleaning up after the 1989 Exxon Valdez oil spill in Prince William Sound dubbed it the “magic rectangle”: a swathe of oil-drenched beach, roughly the size of an Olympic swimming pool. The “magic” was that within days of undergoing an experimental oil-removal treatment back in 1989, the rectangle had been transformed into a much cleaner field of sand and cobblestones. The press loved it, seizing on this success story as dramatic proof of the power of the new technique, called “bioremediation,” because it aimed at cleansing Alaska's oiled beaches by using fertilizer solutions that stimulate the appetites of the state's native oil-munching microbes. Indeed, the magic rectangle helped persuade officials of the Environmental Protection Agency (EPA) and the state of Alaska to give Exxon the go-ahead to use bioremediation in its efforts to clean up the spill.

Some 3 years later, however, some scientists and oil cleanup workers are challenging not only the early enthusiasm but the claims that Exxon's larger scale bioremediation efforts have been generally effective. Two weeks ago, for example, the Science Advisory Board of the Environmental Protection Agency, which has been evaluating bioremediation experiments conducted by the EPA in Prince William Sound during 1989 and 1990, released an “unapproved working draft” of its review that concludes that the treatment's efficacy wasn't all it was cracked up to be. While the board's draft report calls the bioremediation study “a significant accomplishment,” it states that “only in some of the field studies was convincing evidence of bioremediation obtained.”

Publicly, most of the board members who performed the review have refused to comment until it's presented in final form to EPA administrator William Reilly. One particularly skeptical reviewer told *Science*, however: “You have to make a leap of faith [to say] we achieved anything. I think they may have overreached the data.”

That's just what several scientists familiar with the results of both the EPA experiments and Exxon's wider efforts to use bioremediation feel. “What I've feared all along,” says Ernie Piper, who was the on-site coordinator of the Oil Spill Response Division of Alaska's Department of Environmental Conservation (ADEC) during the cleanup, “is that people are going to come out of this experience in Alaska thinking that we've got the silver bul-