grams, rather than to attack problems that companies are reluctant to tackle alone.

Not only is the viability of this program likely to be questioned by long-time supporters of fossil energy research, such as Robert Byrd (D–WV), the Senate minority leader, but the motivations of the Administration also will be probed. Already, National Coal Association officials are wondering if the cutback does not reflect the White House frustration with Congress's passage of the Clean Coal Technology program.

EPRI's Yeager goes further: "I think the whole trend is to slowly disassemble DOE." Indeed, fossil research is not the only program being hit hard. The nuclear fission research program also is slated to be halved. Regardless of the motivation, DOE officials and congressional aides say DOE-operated labs and contractor facilities are almost certain to face significant cutbacks in the next fiscal year. ■ MARK CRAWFORD

Acid Rain Plan Draws Mixed Review

Envoys from the United States and Canada last week recommended that the U.S. government and industry spend $5 billion to develop new technologies to control sulfur emissions. The recommendation was a major disappointment to federal lawmakers and environmentalists on both sides of the border, who had hoped that the national representatives would press for specific reductions in sulfur emissions.

The recommendation was contained in a joint report on acid rain issued by former U.S. Secretary of Transportation Drew Lewis and former Ontario premier William Davis. Lewis acknowledged in a telephone interview that "The real issue is how to come up with the money." The President said that he would consider the report.

Lawmakers, especially those from the northeastern states, had been hoping for more. In a moment of unexpected candor last September, Lewis said that "it seems to me that saying sulfur does not cause acid rain is the same as saying that smoking does not cause lung cancer." Proponents of stronger sulfur emission controls on Midwest industry took the remark as a sign that Lewis might carry a message to the White House that reductions in sulfur pollution are needed immediately. The Administration has maintained that more research is needed before controls are imposed.

The report recommended that the U.S. government and industry each contribute $2.5 billion for a 5-year program to demonstrate new, lower cost technologies that industry supports, but did not go into much more detail. It did not say how the money should be raised. The report was also vague about what technologies should be pursued, other than to say that "special consideration" should be paid to industrial plants using high-sulfur coal.

Drew Lewis

"The real issue is how to come up with the money."

In fact, last month Congress appropriated $400 million over 3 years for demonstration projects to use "clean-coal" technology in which, for example, high-sulfur coal could be washed before burning to reduce its sulfur content. The program, which will be run by the Department of Energy, requires matching funds by industry and was pushed through Congress by Senator Robert Byrd (D–WV).

Byrd and the coal and utility industries welcomed the $5-billion plan. Susan Roth, a spokeswoman for the Edison Electric Institute, a trade association for utilities, said that the industry-supported research group, the Electric Power Research Institute, has already spent $500 million over the past several years on clean coal technology research and has budgeted $580 million for the next 3 years to continue the work.

Senator Robert Stafford (R–VT), chairman of the Environment and Public Works Committee, said in a statement that he was "disappointed" that the joint report did not urge reductions immediately and contended that "polluters should pay for the total cost of control." Congressional aides doubted whether legislators would support a new, expensive program, especially if they had to divert funds away from other programs. ■ MARJORIE SUN

Nuclear Testing Up Sharply Under Reagan

The number of U.S. nuclear weapons detonations each year has increased sharply during the 1980's, according to an estimate recently prepared by the Natural Resources Defense Council (NRDC). The exact size of the increase is unclear because the government does not announce every test. But seismological data, as well as some new information on weapons yields, indicate that the increase is between 11 and 33 percent.

Officials at the nuclear weapons laboratories, such as Paul Robinson, the former associate director for national security programs at Los Alamos, have previously acknowledged that the number of tests has increased, partly to accommodate more basic physics research, and partly as a result of the "Star Wars" missile shield program. But those connected with the effort have been studiously vague, because the Reagan Administration decided several years ago to keep a significant portion of the tests secret.

The reason for this decision is unclear, and speculation has been that the Administration wants either to hinder Soviet monitoring or to ensure that the program keeps a low domestic profile. A key Energy Department memorandum obtained by NRDC, dated 2 April 1982, states only that tests must be disclosed in advance if they will shake high-rise buildings and mines or disturb construction. But it provides no clear guidance regarding announcements after a test has been conducted, except to say that DOE public affairs officers—either in Washington or Nevada—can recommend that a blast remain secret "if they perceive a possible conflict with national interest."

As a result, any conclusion about the number of weapons detonations under the Reagan Administration has been stymied until now by missing data. The NRDC report, prepared by physicists Thomas Cochran and Milton Hoenig and political scientists Robert Norris and William Arkin, supplies the missing information. Drawing on a chart released by Livermore last year, which omitted absolute test numbers but portrayed the percentage conducted at various yields, and assuming that all of the unannounced tests were conducted at low yields, the authors deduce that between 12 and 19 tests were kept secret from 1980 to 1984. Eight of these had been detected independently by seismologists at the U.S. Geological Survey.

When combined with the 82 announced tests during this period, the NRDC estimate indicates that a total of 94–101 tests have occurred, or an average of 19–20 each year. (This is close to a vague estimate provided

last year by George Miller, Livermore's acting associate director for defense programs, who told *Science* that "on the order of a couple of dozen U.S.tests" are performed annually.) This total can be compared to that for the previous 5-year period, when 73 tests were announced and 3 others were detected by seismologists. Assuming that one or two additional unannounced tests remained undetected, the total from 1975 to 1979 is 77 to 78 tests, or an average of 15 each year. A portion of the increase in testing since 1980 can be ascribed to Britain, which conducted four tests in Nevada in the late 1970's, and eight between 1980 and 1984. When these are subtracted, it appears that annual U.S. testing has increased between 11 and 33 percent.

Robinson says that part of the increase was authorized by President Jimmy Carter. "Two weeks after his defeat in the 1980 election, Carter approved a schedule that would allow us to do more weapons physics tests," Robinson says. "It had been sitting on his desk for about 3 years." But others say that much of the increase occurred in 1984 and 1985, due to expansion of the "Star Wars" effort and the fact that a variety of strategic weapons entered the final stage of development. ■ R. JEFFREY SMITH

Rancho Seco Reactor Suffers Another Mishap

An "unusual event" at the Rancho Seco nuclear reactor 25 miles from Sacramento lasted only 4 hours, from 4:30 a.m. to 8:41 a.m. on 26 December, but it triggered a special inquiry by the Nuclear Regulatory Commission (NRC). According to a preliminary NRC report dated 5 January, all power to the plant's computerized control system was lost for 26 minutes. A pump burned out, spilling 450 gallons of radioactive water onto the floor of an auxiliary building, some of which escaped to the atmosphere as radioactive steam. A spokesman for the owner, the Sacramento Municipal Utility District, says that a person standing at the edge of the site boundary would have received no more than 0.2 millirem of extra radiation, a trivial amount. Two workers received small exposures to excess radiation.

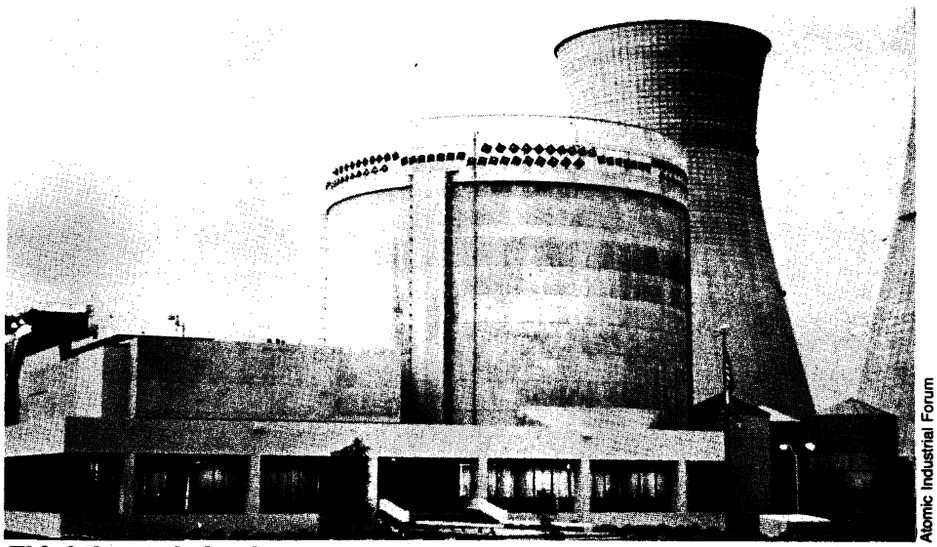
Despite the happy outcome, the incident aroused concern for two reasons. The chronicle of the 4-hour crisis indicates that the control room was thrown into confusion and that operators had only a tentative grasp of what was going on inside the plant when the electrical power was out.

Second, the steel reactor vessel was put through a kind of stress it is not supposed to endure. It was overheated, then rapidly cooled at high pressure, exposing it to the hazard known as "pressurized thermal shock." The NRC has been concerned for several years about the possibility that welds between the steel plates might crack under stresses such as these. Last July the Commission issued a rule asking utilities to guard against this risk. Rancho Seco has already had two cooldown events, a major one in 1978 and a minor one on 2 October 1985.

Judging by the NRC report, the environment in the control room was chaotic after the power went out. (The investigators have not yet discovered why the power failed.) Many indicators and controls are programmed to go to mid-value when power is lost. When this happened at Rancho Seco, water flow to the reactor decreased, leading to an increase in pressure and heat. Other systems went faster at mid-value. Within seconds, the reactor automatically shut down because of the pressure buildup. At this point "many fire alarms," a spray actuation alarm, a seismic alarm, and a high-temperature alarm for the spent fuel pool went off.

The operators made several false starts in attempting to bring the system under control. They attempted to close some valves using hand cranks, and when a couple of them apparently got stuck, they resorted to a wrench. It, too, proved inadequate to the task. Meanwhile, the emergency heating and cooling system sprang into action, "significantly" increasing the noise in the control room. Nine minutes later, someone shut this emergency system off to maintain sanity. A senior operator, possibly exhausted from his work on the hand cranks, collapsed on the floor and was taken away by ambulance. He left the hospital a few hours later reporting no ill effects. Finally, at 4:40 am, an operator noticed that the power could be restored by resetting some main switches, which he did, bringing the controls back to life. Nevertheless, it took several hours to bring the whole plant back to normal.

Brad Thomas, a spokesman for the plant owner, says that the rapid cooldown of the reactor exceeded the guidelines for cooldown stress drawn up by the manufacturer, Babcock & Wilcox. However, an "owners' group" met in mid-January, examined the record, and announced that the incident had no general implications for this type of reactor. They did agree, however, that Rancho Seco will need to take steps to ensure that loss of control power does not lead to a rapid cooldown again.



Atomic Industrial Forum

Third thermal shock

Rancho Seco has now had three mishaps resulting in excessively rapid cooldown.

An NRC official in California says a more extensive report will be published in February. The government's chief concern is that Rancho Seco seems to be able to get into trouble quite rapidly on its own, without any coaxing from operators. "We think it may be necessary to modify the control system design to make the plant more forgiving," the NRC official says. "We'd like to see a system where the operators don't have to take any actions for 10 to 20 minutes" into a crisis. In this recent case, the operators prevented the cooldown from becoming more severe by taking quick preventive steps, even though in retrospect, it is clear they could have stopped the cooldown even sooner than they did.

The NRC has not decided yet whether the incident has general implications, and no time has been set for restarting the plant. ■ ELIOT MARSHALL