pesticide?" Perhaps because of the formidable scientific, political, and economic factors involved, the issue has been stuck in a "backwater" as far as policy attention is concerned. Nevertheless, a decision on EDB will have to be made. EPA staff expect that the agency's office of pesticide programs will send its recommendations on EDB forward this spring and that a final decision will be reached by the Administrator this summer. The environmental stance of the new management of EPA will be tested by how it handles what is ultimately a judgment call.—JOHN WALSH

NRC Reviews Brittle Reactor Hazard

The staff would take some precautionary steps this summer, but the industry sees "no near term" risk at all

Although the United States generally leads the world in setting standards for nuclear safety, it has not been the first to act on the hazard known as pressurized thermal shock. This came to light during a review this March before the Nuclear Regulatory Commission (NRC), which must decide what to do about thermal shock, a problem that has received a lot of notice in the press.

The danger is essentially this: the steel vessel that contains the hot fuel and water in a pressurized water reactor is designed so that it should never crack during its expected 40-year lifetime. However, under high stresses, a vessel could burst apart, creating a severe leak of radioactive water. The possibility of this happening is remote, but recent discoveries make it seem less so. The most important new information is that the welds in certain vessels made of steel plates contain impurities, and these are causing the welds, in the presence of high neutron radiation, to become more brittle than the plates which they hold together. If cooled too rapidly, a flawed weld might crack. The original safety codes assumed that the welds would age at the same rate as the steel plates, but now it appears that welded vessels may have a shorter lifetime than anticipated.

Nunzio Palladino, chairman of the NRC, ordered a review of the thermal shock hazard last year. On 9 March, he and the other commissioners listened to two briefings on the problem, one prepared by the NRC staff and the other by industry spokesmen. Palladino asked, among other things, whether foreign governments were worried about reactor cracking. The staff briefers gave little information; the industry spokesmen, less. But one NRC employee in the audience said that West Germany has changed the way fuel is loaded in at least two reactors to reduce the risk of a thermal shock accident.

According to an engineer at the Oak Ridge National Laboratory, West Germany decided in 1975 that all reactor vessels would be made of forged steel cylinders with a steel cap at each end. The new design was intended to make vessels built after 1975 stronger, would require fewer welds, and the welds would not be near the middle of the vessel, where damaging neutron radiation is most intense.

NRC chairman Nunzio Palladino

Like the United States, West Germany operates some older reactors made of welded steel plates. In two of these, at Stade and Obrigheim, the Germans have reduced the amount of neutron radiation that reaches the walls of the vessel. Fuel bundles have been rearranged in the core with "dummy" elements near the outer edge to absorb neutrons moving from the center toward the steel walls. This has slowed the process of embrittlement.

Finland also has decided to shield the walls of a reactor at Lovisa, even though this vessel is made of forged steel. Apparently the Finns discovered that the radiation was so intense that it was weakening the steel to a hazardous degree.

The NRC has studied the problem of steel embrittlement with growing intensity for about a decade. The industry, too, has poured several million dollars into structural analysis during the last 5 years. And in the past year, stimulated by the NRC's concern, several plant owners have changed the way fuel is handled to reduce the neutron bombardment of the vessel walls. They have changed the fueling schedules so that fuel is used longer in the reactor, and more depleted fuel bundles are placed at the outer edge of the core to lower radiation levels near the wall. But no U.S. group has gone as far as the Germans in revamping construction or fueling procedures.

The NRC has not required any major change in vessel construction, except to raise the standard for weld quality. The NRC has not ordered a change in fuel arrangement, although the staff expects some new rules may be issued later this year, perhaps in June. Until now, the government has been reluctant to impose new requirements in this area, chiefly because the problem is ill defined. Meanwhile, the industry claims that safety procedures being considered now are unnecessary and expensive.

At the 9 March briefing, the industry was represented by Clark Gibbs, vice president of Middle South Services and chairman of the Atomic Industrial Forum's committee on reactor licensing and safety. He told the NRC that a recent Oak Ridge study on vessel cracking exaggerated the risks. The study reported that some vessels might be in danger of cracking within a few years. In fact, Gibbs said, the industry's own calculations made in December and January show "that there is no significant near-term safety concern" about vessel cracking. Gibbs said that "many utilities have instituted low [neutron] leakage fuel load designs which may reduce the overall rate of vessel embrittlement."

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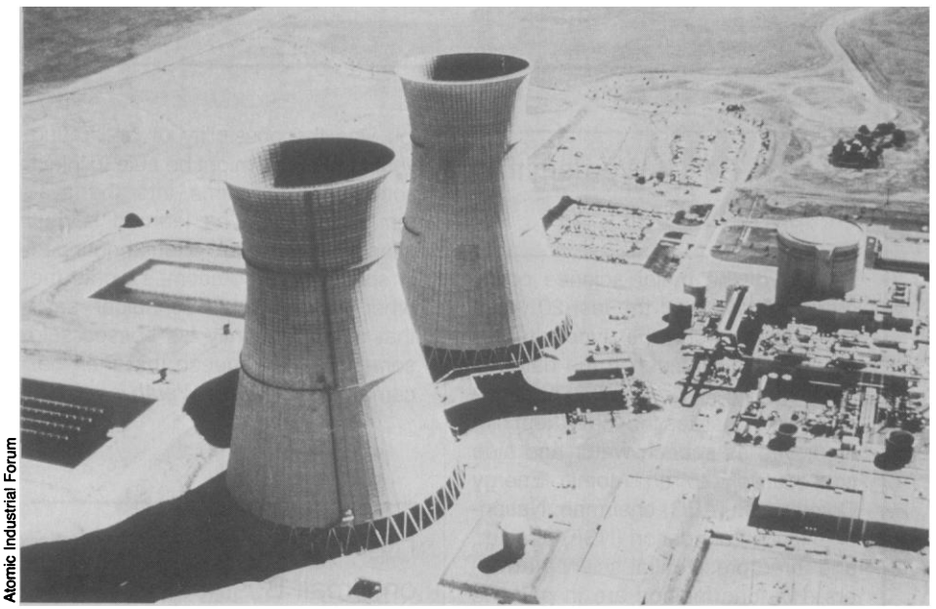
However, he could not give specifics when Palladino asked how many companies had done this. Gibbs also said that "operator training and awareness of thermal shock concerns has been improved and is continuing." He was not able to say whether operators could be given unambiguous instructions on how to avoid a thermal shock accident. This is an important point, for Palladino's staff said in a briefing earlier that day that the industry's optimism rests on the assumption that people in the control room will not make terrible mistakes. The NRC staff is not willing to make that assumption.

Several lines of evidence have persuaded the NRC that the situation may not be as safe as the industry has painted it. One is that steel samples recently taken from reactors show that the metal is being made brittle by neutron bombardment more rapidly than had been anticipated. At some point a weld might become brittle enough to give way if it contained a flaw and if it were exposed to a three-stage ordeal of high heat, sudden cooling, and high pressure. The NRC is trying to determine just how close to the danger zone those welds are and how quickly the neutron radiation is bringing them into a range of brittleness that would be considered unsafe. The NRC has requested metallurgical data from eight plant owners. Seven have reported that they foresee no danger during the plant's lifetime, and the eighth has not yet responded.

The second reason for concern is that some NRC staff have found records of incidents in which operators made precisely the mistakes that impose the three-stage ordeal on vessel walls. Fortunately in these cases the vessels were not brittle.

Finally, an inspection of one of the older reactors last year revealed that there were tiny imperfections in the vessel wall that might become significant later. This discovery, made during the first 10-year inspection of a commercial plant in the United States, was carried out last August at Duke Power's Oconee-1 station in South Carolina. According to standard engineering codes, there is no reason to worry about a crack less than a quarter of an inch long, for it will never penetrate the 8 inches of steel in the vessel wall. The flaws at Oconee are just three-sixteenths of an inch long. One NRC official says that the flaws are so close to the borderline of what is perceivable that they may be "noise" in the ultrasonic system used for this inspection. Indeed, Duke Power claims that the flaws are insignificant, first, because they are so small, and, second, because they are aligned in a way that suggests they were present in the steel before it was used to make the reactor. In short, the flaws probably were not produced by stresses in the reactor.



Atomic Industrial Forum

Rancho Seco: Shocked in 1978

Operators at this plant near Sacramento, California, overcooled the reactor at high pressure, lending credibility to the scenario for thermal shock.

Despite their apparently benign nature, the Oconee flaws have aroused interest. The NRC staff wants to watch them closely to learn whether they are growing.

The NRC staff's conclusion, presented by Director of Safety Technology Stephen Hanauer, is that no reactor vessel in the United States is presently in danger of cracking in "normal" or anticipated accidents. However, the people who run reactors may not behave predictably during a crisis. The accident at Three Mile Island gave proof of this, as did a minor mishap in 1978 at the Rancho Seco reactor near Sacramento, California. In the second instance, the operators overcooled and overpressurized the system in precisely the way that would put the most stress on brittle steel. Using this as a guide, Hanauer said, a Rancho Seco type of mistake would not cause any vessel in the United States to break today or anytime in "the next few years." He did not speculate about the effect of a mishap worse than Rancho Seco. When Palladino asked for a more specific estimate of the time involved, Hanauer said it "depends on whom you ask. It's at least 2 or 3 years."

Hanauer said it would be prudent to take some action this summer, perhaps to adopt rules on fuel placement and issue new guidelines for operating the seven or eight reactors considered to be at risk. In conclusion, Hanauer reassured the commissioners that the only big uncertainty now is what the operators might do in a crisis. He said the NRC staff is confident that it knows how the reactor vessels would behave.

Even this assurance has been challenged, however. George Sih, director of the Institute of Fracture and Solid Mechanics at Lehigh University, told Palladino in March that the NRC has no scientific basis for making any prediction, optimistic or otherwise, about aging reactor vessels. No one has developed a theory to govern the behavior of steel under long-term stress from radiation, thermal shifts, and pressure changes, Sih says. And he points out that our experience with pressurized reactors is limited, since the industry has only used them for about 12 years. No one has built and stressed a vessel to the cracking point. This leads Sih to charge that far less is known about the design of this controversial piece of equipment than about ships and airplanes, models of which are routinely tested to the breaking point. Sih urged the NRC to launch a broad program of basic research on the fracture mechanics of pressure vessels.

The NRC has listened, but has turned aside Sih's request on the grounds that there is not the time or the money to indulge a theoretical exploration of the problem. The immediate prospect, therefore, is for a period of negotiation between the industry and the NRC, culminating later this year in some mutually acceptable changes in the way fuel is loaded and operators trained at high-risk reactors. This will serve as an interim policy while the NRC tries to determine whether any reactors will have to be closed down. That decision will be confronted in 1983.—ELIOT MARSHALL