The Crisis at Three Mile Island: Nuclear Risks Are Reconsidered

The reactor accident near Harrisburg produced the most serious emergency yet faced by the nuclear power industry in this country. The accident also raised crucial long-range questions about nuclear power development and national energy policy. The news section this week is devoted mainly to discussion of the accident and related matters. The Science *news deadline for this issue was 3 April, 6 days after the accident, and direct coverage is limited to events during that period. An important effect of the accident was to add fuel, if any were needed, to the controversy over the dangers of low-level ionizing radiation. A news article reviews political aspects of the controversy; a piece in the Research News section treats scientific issues involved.*

H_2 Bubble Is Unexpected Source of Trouble

Harrisburg, Pa. The breakdown of Metropolitan Edison's nuclear reactor 10 miles outside this state capital on 28 March created a crisis which took the local authorities quite by surprise.

For Met Ed, the biggest technical surprise was the sudden appearance of a large hydrogen bubble in the core of the reactor, a problem whose origin was unclear and whose remedy is still being worked on. For Pennsylvania Governor Richard Thornburgh, the shock came when he had to dust off an old civil defense plan and prepare for the possible evacuation of a section of his state. The governor also had to deal with hundreds of technical inquiries which he was ill-equipped to answer and sort out the experts' conflicting views about the seriousness of the radiation hazard.

No one has been seriously overexposed to radiation, injured, or killed, as utility officials reminded the press repeatedly. Some workers in the plant (no more than four at this writing) received excessive doses of radiation. But a utility company spokesman said that if they receive no more radiation this year, their doses will not exceed the average annual allowable limit of 5 rems (5000 millirems). Radiation levels in the immediate area around the plant and in a wider area downwind increased by roughly 1 millirem per hour over the background level. (A chest x-ray is estimated to give a dose of 20 to 25 millirems, so that a person standing downwind of the plant could receive the equivalent of an x-ray after 25 hours.) Occasional "puffs" of radioactive gas escaped during the first 5 days, causing sudden jumps or "spikes" in the level of radiation amounting to 14 or 15 millirems. One large uncontrolled puff escaped at 3 p.m. on Friday, 30 March, from the west side of Three Mile Island, where the plant is situated, causing a brief spike which sent the needle from 2 to 90 millirems and back down again. The puff appeared while two workers, trying to reroute plumbing at the plant, opened a pipe full of radioactive gas. The gas escaped, giving the workers 1500 millirems of radiation each. Similar but smaller releases continued throughout the weekend.

Utility company officials and 20 top-ranking, federal Nuclear Regulatory Commission (NRC) advisers, who helicoptered to the scene on 30 March, were trying to devise a way to contain these puffs. They were also trying to find a way to contain or reduce the level of "planned" releases of radioactive gases made necessary by the presence of a high-pressure bubble in the reactor fuel container. Shortly after the big puff of Friday afternoon, however, the bubble itself became their chief preoccupation.

Harold Denton, director of the NRC's office of nuclear reactor regulation, conceded on 31 March that the presence of a gas bubble over the nuclear reactor core was "a new twist" which had never been considered in any of the government's computerized accident simulations. The problem has "not been analyzed heretofore," he said, but the NRC staff has been working on it around the clock since learning of it. John Herbein, vice president of Met Ed and its chief technical spokesman, said the same day: "We're into something that's a different ball game than we expected. . . . The single thing we may not have anticipated was a buildup of a gas bubble over the uranium fuel."

The bubble, containing mostly hydrogen, represented a failure of planning and engineering. It was trapped in the dome of the vessel containing the reactor core and the coolant water. Why was there no valve in the dome to let trapped gas out? *Science* asked Herbein. He answered that there was a valve, but that it could not be activated by remote control. The entire area around the vessel is so intensely radioactive that workers could not go in to operate it manually.

The bubble, which remained a bit of a mystery all weekend, posed multiple dangers. The first concern, expressed by Denton on 30 March, was that it might expand, flow into the cooling pumps, and incapacitate them. This could have caused the fuel to reheat, leading to a meltdown of the fuel core and possibly to widespread radioactive pollution. For this reason, it was decided that pressure should be maintained at a fairly high level (1000 pounds per square inch) to prevent the bubble from expanding. However, as long as the pressure was kept high, the reactor produced radioactive gas.

As Denton explained it, the utility had the capacity to cool down the reactor rapidly at any time by injecting water at high pressure. This option was postponed because it was thought a sudden change in temperature and pressure might do more damage to the structure of the fuel core, risking a meltdown again, or some other unexpected event. Denton did not want to take this risk until all other approaches had been tried.

The chosen course of action, which appears to be working as this is written, was to reduce the size of the bubble slowly through a complicated process by which the trapped gas is dissolved in the coolant water just beneath it, extracted again from the water in an external pres-

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sure tank, then released by stages into the atmosphere. There was some risk here, too: this complicated procedure might not remove the gas safely or rapidly enough. Because hydrogen and oxygen were present, a mistake might set off an explosion. An explosion occurred on the first day of the accident, and the engineers were devising schemes to reduce the hydrogen concentration in the large containment building, where the gases collect before being released into the atmosphere. A hydrogen concentration of 4 percent is flammable, and 8 percent is explosive. The level increased from 1.7 to 2.4 percent over the weekend, but new equipment was being brought in Monday morning, 2 April, to attack the problem. It appears to have done the job.

The federal experts believe that the radiation released thus far, although undesirable, has not produced a serious health hazard. Most of the escaping gas is xenon, mixed with a smaller amount of krypton. Both are inert, meaning that they will not combine with other chemicals and will not become fixed in the soil, water, food, or the human body. The gases will decay and dissipate in the atmosphere. Although xenon and krypton pose no long-term threat, radioactive iodine, one ingredient in the soup inside the reactor, does pose a danger. Up until now, none has escaped.

Utility officials took comfort in the fact that no one had been overexposed to radiation in this, the most serious nuclear accident ever to occur in the United States. They stressed as well that three backup emergency cooling systems stood by, ready to spray water on the reactor core should things get worse. Herbein told the press over the weekend that the crisis was over, the safety systems had proved their effectiveness, and the reactor—while severely damaged—would be cleaned up in time and put back into operation. He was not anxious about the reactor, he said, because it seemed to be cooling slowly and was in a "stable" condition.

This adjective became a rallying point for optimists over the troubled weekend. Without denying that the outcome was uncertain, it conveyed a sense of calm and control. The term was not informative, however. A train running across country at 40 miles an hour with no brakes may be called stable; the technical briefings in Harrisburg revealed that this was the kind of stability that existed on Three Mile Island.

While some clues about the cause of the accident have come to light, it will be weeks and perhaps months before NRC investigators pin down the exact reasons why the cooling system went amok on 28 March, why an explosion occurred 10 hours later, why gas was produced inside the reactor, and why the gas leaked uncontrollably to the outside. Some general observations are possible, however.

'I repeat – there is no real cause for alarm . . .'

Oliphant, The Washington *Star*, Los Angeles *Times* Syndicate

This accident, and specifically the presence of a bubble in the reactor core, caught the local utility and the state unprepared. The world did not learn of the seriousness of the accident until NRC representative Denton appeared on the scene, at President Carter's instructions, on 30 March. His description of the accident made it plain that it was potentially a disastrous one, for which no contingency plan had been developed. Without this federal intervention, the situation might have developed quite differently.

State officials seemed equally unready for the accident. Jack Glouner, a spokesman for Pennsylvania's emergency management office, said that Metropolitan Edison first alerted his office of the danger at 7 o'clock on the morning of the accident, 3 hours after it had occurred. The governor was informed half an hour later. The utility justified its delay by saying that the accident did not approach the stage at which such notification is required until 6:50 a.m. Glouner estimated that it would take about 3 hours after notification of a radioactive release to evacuate the several hundred thousand people who live in a 20-mile wedge downwind of the plant. This seemed an optimistic guess, for if a general alert were sounded, probably most of the 630,000 people who live in the area would take to the roads, creating a monstrous traffic jam.

It was impossible to find out how well defined the evacuation plans were because they were being kept confidential until the moment they might be needed. The reason for this, Glouner explained, was that the plans shifted every day with changes in the wind. Giving out details prematurely might lead people to follow the wrong escape routes, he said. Three counties within a 5-mile radius of the plant were put on alert over the weekend and told to be ready to shelter evacuees in special centers, which were still being selected as Glouner spoke. There was no food and probably no water stored in the shelters, according to Glouner. He declined to say whether or not spare gasoline supplies had been procured.

In addition to these indications of unreadiness, there were less definable but equally unsettling signs of confusion in the way local officials dealt with the press and the public. Governor Thornburgh's earliest remarks minimized the importance of the accident, but by the second day, he told his constituents: "You are being subjected to a conflicting array of information from a variety of sources. So am I." The conflicting interpretations multiplied when federal officials arrived on the scene. Herbein and Denton disagreed about the seriousness of the accident, the size of the bubble, the extent of damage to the reactor, and several lesser details. The confusion did not abate until the utility announced on 31 March that it would hold no more press conferences, but would allow the NRC to speak for it on matters of fact. The federal government's decision to step in may have cleared up the communications snafu, but it remains to be seen whether it improved the technical management of this accident.—ELIOT MARSHALL