

state & society

Study blames "people-related problems" for TMI accident

The President's Commission on the Accident at Three Mile Island has completed its evaluation of what went wrong at the Pennsylvania nuclear power plant last March and has made its recommendations for ensuring that such an accident does not occur again (see following story). The Kemeny Commission, as it is called after its chairman, John Kemeny, president of Dartmouth College, was composed of 12 members drawn from all walks of life. The results of their study are published in a report, *The Need for Change: The Legacy of TMI*.

The Kemeny group concluded that the major cause that led up to the Three Mile Island accident was "people-related problems and not equipment problems." But the commission made it clear that the plant operators were not entirely to blame for the accident: "... while the major factor that turned this incident into a serious accident was inappropriate operator action, many factors contributed to the action of the operators, such as deficiencies in their training, lack of clarity in their operating procedures, failure of organizations to learn the proper lessons from previous incidents and deficiencies in the design of the control room. These shortcomings are attributable to the utility, to suppliers of equipment and to the NRC. Therefore—whether or not operator error 'explains' this particular case—given all the above deficiencies, we are convinced that an accident like Three Mile Island was eventually inevitable."

What went wrong? The Commission's primary charge was to determine what happened at TMI and why it did. The 12 commissioners' account of the accident sequence for the most part confirmed what had been reported earlier (PHYSICS TODAY, June 1979, page 77). The system designed to deal with a loss-of-coolant condition did, in fact, come on at Three Mile Island, but the operators didn't realize that they had this kind of accident taking place and turned it off. That led subsequently to overheating, formation of steam voids, various periods when the core was uncovered, extensive damage to the core, the famous hydrogen bubble, and all the rest.

The operators' problems were compounded by instrument failures and idiosyncrasies, by some elements of the de-



Maintenance tags on TMI-2 control panel covered one of two lights indicating that the two emergency feedwater valves were closed. No one knows why the second light was missed. The closed valves were discovered eight minutes into the accident. Photo courtesy Metropolitan Edison.

sign of the plant, and by deficiencies in their training.

The Kemeny group discovered some revealing things, however. It was not clear for months following the accident what precipitated the initial condensate pump trip. The Kemeny commission concluded that a maintenance crew using a mixture of air and water to break up resin that had clogged a resin transfer line allowed some of the water to leak into the air-controlled system that opens and closes certain valves. Those valves were closed just before the accident began. This malfunction probably triggered the initial pump trip (shutdown) that led to the accident. This same problem had occurred at least twice before at TMI-2. Had the utility, Metropolitan Edison, corrected the earlier problem, according to the report, the 28 March sequence of events might never have begun.

When the pumps stopped, Unit 2 underwent a loss of feedwater that led to a turbine trip and, eight seconds later, when the reactor pressure rose more than 200 psi above the normal operating level, a reactor trip. The auxiliary feedwater system then started upon loss of feedwater and should have delivered secondary coolant to the plant's two steam genera-

tors to remove heat, but the flow paths were blocked by closed valves. It was a flat violation of the license conditions for that plant to be in operation with those block valves closed.

"Fourteen seconds into the accident, an operator in TMI-2's control room noted the emergency feed pumps were running. He did not notice two lights that told him a valve was closed on each of the two emergency feedwater lines and thus no water could reach the steam generators. One light was covered by a yellow maintenance tag. No one knows why the second light was missed," the Kemeny report states. (See figure above.) It was eight minutes after the trip before the operators realized the auxiliary feedwater valves were closed and opened them.

A relief valve, which had opened when the reactor pressure rose, should have closed as reactor pressure decreased, but failed to do so. With the relief valve open, reactor pressure continued to fall rapidly until two minutes after turbine trip. At that point the pressure dropped so low that the high-pressure injection system, part of the reactor's emergency core cooling system, started automatically, as it should, and began to inject cold water into the reactor. After a few min-

utes, an indication of rising water level led the operators, who were conditioned to maintain a certain level, to turn off the high-pressure injection. Despite earlier conjectures that the water-level indicator was reading erroneously, the level indication was probably correct. However, the falling pressure, coupled with a constant reactor coolant temperature after the high-pressure injection system came on, should have clearly alerted the operators that TMI-2 had suffered a loss of coolant accident, and safety required they maintain high-pressure injection. But the operators did not realize their mistake for over four hours.

Isolation. The Kemeny Commission also discovered why the containment building did not isolate itself for nearly four hours after the start of the accident. Isolation is intended to help prevent radioactive material released by an accident from escaping to the environment. In 1975, the NRC instituted new criteria for isolation that listed three conditions—increased pressure, rising radiation levels, and emergency core cooling system activation—and required that containment buildings isolate on any two of the three. However, the plan was not applied to nuclear plants that had already received their construction permits, like TMI-2. In the TMI-2 design, isolation occurred only when pressure in the containment building reached 4 psi above the ambient pressure. Radiation releases alone, no matter how intense, would not initiate isolation. Even after isolation was in effect, pipes carrying coolant between the containment and auxiliary buildings could be opened manually by the operators. They were at TMI, and radioactive water flowed through these pipes, some of which leaked radioactive material into the auxiliary building. The radioactivity escaped from there into the atmosphere outside.

The Kemeny Commission also provided a numerical estimate of how much of the core was uncovered at the worst point. "... evidence indicates as much as two-thirds of the 12-foot high core stood uncovered" three hours after the start of the accident.

Among the other areas covered by the Kemeny group were public and worker health and safety and the handling of the emergency. "Based on our investigation of the health effects of the accident, we conclude that in spite of serious damage to the plant, most of the radiation was contained and the actual release will have a negligible effect on the physical health of individuals. The major health effect of the accident was found to be mental stress. . . . It is entirely possible that not a single extra cancer death will result. And for all our estimates, it is practically certain that the additional number of cancer deaths will be less than 10." The Commission called for further research on the consequences of radiation exposure as the

basis for new safety guidelines and stronger efforts by both the states and the utilities to keep workers and the public informed about health issues and preventive measures.

"We are disturbed both by the highly uneven quality of emergency plans and by the problems created by multiple jurisdictions in the case of radiation emergency. Most emergency plans rely on prompt action at the local level to initiate a needed evacuation or to take other protective action. We found an almost

total lack of detailed plans in the local communities around Three Mile Island. . . . The response to the emergency was dominated by an atmosphere of almost total confusion. . . . Those who managed the accident were slow to realize the significance and implications of the events that had taken place."

Copies of the Kemeny Commission's report are available for \$5.50 (order number 052-003-00718-51) from the Government Printing Office, Washington, D.C. 20401.

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Action on Kemeny recommendations

President Jimmy Carter announced in December his plans to ensure the safe operation of nuclear power plants in the US, based on the recommendations of the Kemeny Commission.

Carter introduced his plans by reiterating his position on nuclear power, saying that, although we can minimize our reliance on nuclear power, "we cannot shut the door on nuclear energy" completely. Nor do we have the "luxury" of imposing a lengthy moratorium on its further use, he said.

The President said that he agrees "fully with the spirit and intent of the Kemeny Commission's recommendations." To fund the increased safety measures the President is calling for, he is asking Congress for a supplemental appropriation for fiscal year 1980 totalling \$65 million. The NRC would receive \$49 million of this.

NRC. The Kemeny Commission's most controversial recommendation was to abolish the NRC as it now exists and replace the five-member commission with a new independent agency under the President, to be headed by a single administrator appointed by the President.

The Kemeny Commission found fault with both the normal operation of the NRC and its performance during the March accident. "We found serious managerial problems within the organization. These problems start at the very top."

The Kemeny Commission summed up its evaluation of the NRC's response to the Three Mile Island Accident in this way: "There was a serious lack of communication among the commissioners, those who were attempting to make the decisions about the accident in Bethesda,

Decontaminating Three Mile Island

The process of decontaminating TMI is now in progress. While the reactor itself has been brought to a "cold shutdown," there are vast amounts of radioactive material trapped within the containment and auxiliary buildings. The cleanup process carries its own potential dangers to public health. For this reason, the NRC is now preparing an environmental impact statement on the decontamination and disposal of radioactive wastes from TMI. So far, about 75 000 gallons of water from the auxiliary building's tanks have been put through the three-stage demineralization being used to process the contaminated water. NRC estimated the total volume of water in the auxiliary building alone to be about 400 000 gallons. Although radiation in the processed water has been reduced to levels that meet EPA drinking water standards except for tritium, which is not removable by the process being used, no disposal of that water will be permitted until the environmental impact statement is completed, probably in December. The water in the tanks in the auxiliary building is radiating between 1 and 30 microcuries per ml, attributed mainly to ra-

dioactive cesium in the water.

The cleanup process is expected to take another three years at the minimum, according to the NRC. Metropolitan Edison prepared a cost estimate of the cleanup process, including the costs of replacing the core and putting the plant back into operation. The figure they came up with was \$400 million.

Nothing has been done to the containment building yet. The first step there will be the removal of radioactive krypton gas. The cleanup of the reactor building will be much more complicated than that of the auxiliary building because the water there is much more radioactive than the water in the auxiliary building, and there is more of it—between 500 000 and 600 000 gallons. There are still many uncertainties concerning the precise conditions inside the containment building.

Although a video scan of the building's interior did not show any obvious problems, the condition of the reactor core is not known and won't be until the containment building has been entered and the reactor vessel opened.