Proton decay search: A result of GUTS

In traditional physics the basis of the stability of matter is the proton. There is a principle called "conservation of baryons," which says that if a particle of the class called baryon decays radioactively, another particle of the baryon class must be among the decay products. Baryons decay merrily down the scale of mass until they reach the proton. There is no lighter baryon than the proton, so it can't decay. Protons are stable and so is the material world built out of them.

Not any more. The theorists who are trying to unite all of physics into a single "grand unified field theory" (GUTS) perceive that the next step in their unification procedure cancels conservation of baryons and predicts proton decay. So seriously is this development taken that the Department of Energy is now on the point of funding two large experiments dedicated to a search for proton decay. Two are necessary, says David B. Cline of the University of Wisconsin at Madison, a participant in one of them, so that physicists are properly convinced if this revolutionary decay is actually found. One group includes physicists from Wisconsin, Harvard, Purdue and the University of Minnesota. Principal investigators are Cline, Carlo Rubbia of Harvard, Marvin L. Marshak of Minnesota and James Gaidos of Purdue. The second group is a collaboration of the University of California at Irvine and the University of Michigan, with Frederick Reines of Irvine and John Vander Velde of Michigan as "spokesmen."

Both groups plan variations on the same idea. A large volume of water is the arena for proton decays. Water makes it easy to record the decay and to observe the decay products, Cline says. The water will be surrounded by arrays of detectors, different ones in each case. ("The DOE was particularly concerned that our detectors should be different from theirs," Cline says.) Cline's group will bury 1,000 tons of water in a mine in Park City, Utah. The Michigan-Irvine group will put 2,000 tons in a salt mine in Ohio.

Burial is necessary for shielding. Proton decays should still be extremely rare. The underlying interaction that unifies electromagnetic forces and the strong and weak nuclear forces can change baryons to leptons, the parallel and until now separate family of particles, but in the specific case, the quarks that make up a proton will change to an electron and a positron, say, only when they are close together. In a proton the quarks spend most of their time far apart (by their standards). Lacking a means for physical compression of a proton, physicists can only wait till chance brings the quarks together and a decay occurs. Present calculation is that the proton should have a half life of around 10^{30} years. These volumes of water and a few years' waiting time ought to show something if that number is correct. If they do, they will not only support the grand unification theories, they will provide a whole new laboratory for studying them. □

Mexico's endless spill: An ocean of oil

The runaway Mexican oil well, heralded last August as the worst spill in history, continues to gush up precious crude at the rate of about 5,000 barrels per day (SN: 8/11/79, p. 99). A relief well completed two weeks ago has been injecting water into the oil well at a rate of 40 to 120 barrels per minute, unsuccessfully trying to block the oil flow so that a plug can be cemented in to cap the damaged well. Hope now rests with a second relief well that could intersect the oil conduit by Christmas.

So far, damage from oil reaching Texas has been "minimal." Barrier islands along the Gulf Coast withstood the assault and protected the more ecologically sensitive estuaries. And since September, a reversal in Gulf currents has directed oil toward Mexico's Yucatan Peninsula. But if the spill is not halted by January or February, when the current again turns north, Texas may be in for more.

Below: Texas beach after being hit by Mexican tar balls last August.

Carter acts on TMI: A flood of changes

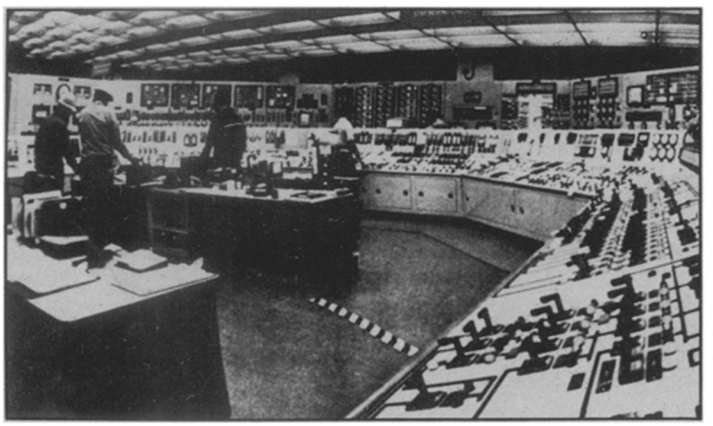
President Jimmy Carter announced plans last week to implement virtually all of the recommendations contained in the report of the Kemeny Commission, an investigatory panel he established earlier this year to look into the March 28 accident at the Three Mile Island nuclear plant.

The Kemeny report (SN: 11/3/79, p. 309), issued five weeks earlier, found serious deficiencies in the way that both the government and the utility industry regulate and manage nuclear power. "I agree fully with the spirit and intent of the Kemeny Commission's recommendations," Carter said last week, adding that he would carry out those within his power to implement and would ask "relevant government agencies to implement virtually all of the other recommendations."

Among immediate moves Carter announced December 7 were:

- Temporary substitution of John Aherne, a current member of the Nuclear Regulatory Commission, as chairman of the agency. Former chairman Joseph Hendrie, who was not asked to leave, will continue to serve as one of the NRC's five commissioners. Later, as a seat becomes open—either by retirement or by the term expiration of Commissioner Richard T. Kennedy next June—a new chairman will be appointed from outside the agency.
- Strengthening of the role of the NRC chairman, giving that person the power "to act on a daily basis as the chief executive officer." Carter, claiming that the chairman must be able to act on behalf of the agency during emergencies, would grant the chairman authority to put needed safety requirements and procedures in place and would give that person power to select key personnel. Carter said legislation to reorganize the NRC would be forwarded to Congress the first of next year.
- The direction of the Federal Emergency Management Agency to take control of emergency activities, such as evacuations, occurring off a powerplant's site. FEMA will also be required to review by June all state emergency plans.
- The direction of NRC and other agencies to speed placement of a resident federal inspector at every reactor site.
- Plans to establish a five-member "expert advisory committee" to keep the President and the public appraised of the progress by federal agencies, the states and the nuclear industry in improving reactor safety and implementing Kemeny Commission recommendations.

Carter's proposal to enhance the NRC chairman's executive powers comes in response to the Kemeny Commission's charge that confusion dominating the government's efforts to assess the severity of the accident and to coordinate emergency action was fostered by the fact that



AP

Control room in the TMI plant: Carter says utilities must modernize, standardize and simplify reactor-control panels for effective crisis management.

NRC was in effect a "headless" agency. During the accident, no one person was in charge, the Kemeny commissioners complained, adding that NRC's attempt to manage the accident "by committee" also proved unworkable. Although NRC did have an official whose duty was to command day-to-day operations, the official has since resigned (only days after release of the Kemeny report) following more than a year of internal inquiries regarding his performance. It appears that rather than strengthening this role, Carter will elevate responsibility for operations control to the agency's chairman.

To expedite the data collection and analysis necessary to transfer lessons learned from the accident into improved federal regulation of safety and accident management, the President is submitting a supplemental appropriation to Congress, including $49.2 million in additional money for NRC and $7 million for DOE. Carter said fiscal-year 1981 budget proposals, which he will send to Congress next month, will further fatten the budget for nuclear-safety programs.

"But responsibility to make nuclear power safer does not stop with the federal government," Carter said. Nuclear utilities must undertake safety-improvement programs "and demonstrate a commitment to safety that goes beyond mere compliance with regulation." Among the President's recommendations: Develop a concept of personal responsibility by making a competent and well-trained decision-maker at the plant site responsible at the corporate level for safety. Carter also said it is the utility's responsibility to see that control-room operators are better trained. But even well trained plant operators cannot be expected to act effectively, the President added, unless utilities modernize, standardize and simplify control-room panels. Under normal operations more than 50 warning alarms could trip; during the TMI accident, more than 100 did.

NRC has already been directed to evaluate and accredit industry safety reforms including operator training. And within four months it must brief the newly created nuclear-oversight panel on the progress made toward improving operator- and supervisor-qualifications criteria; expanding use of reactor simulators in training; testing and recertifying licensed plant operators; and accrediting training schools.

NRC recently enacted a self-imposed ban on licensing the construction or the operation of new plants while it analyzes lessons gleaned during its investigation of the Three Mile Island accident. Carter said last week that although he endorses the licensing moratorium, NRC had better not let it drag on more than an additional six months. Citing recent events in Iran, he said every domestic energy source, including nuclear power, must be harnessed to decrease the U.S. dependence on imported oil. □

Study pinpoints stress-illness link

To many, the notion that emotions can affect physical health, and vice versa, is little more than common sense. Most researchers, however, take nothing for granted until it is proved through scientific inquiry. Numerous studies have demonstrated links between psychological stress and physical illness (SN: 12/10/77, p. 394). But a consistent problem in this area is the paucity of *prospective* research — studies that trace the characteristics of an initially healthy population over time, rather than waiting for illness to strike and then trying to pinpoint the historical causes. Such predictive methods hold an advantage, scientists believe, because the researcher is not prejudiced by searching for contributors to an illness he or she knows has already occurred.

Perhaps the most significant prospective study on the interaction between mental and physical health has been published in the Dec. 6 NEW ENGLAND JOURNAL OF MEDICINE. From an original sample of 204 men in the sophomore classes of 1942 to 1944 at Harvard University, 185 have been followed more than four decades. Over the years the men have received a wide range of psychological and physical tests and interviews, as well as annual or biennial questionnaires. The psychological "predictors" in the tests included factors such as visits to a psychiatrist, little occupational progress, job dissatisfaction, unhappy marriage, little recreation or vacation time and poor psychological "soundness."

The results, reported by Harvard psychiatrist George E. Vaillant, appear to confirm not only that a mind-body health link exists, but that even physically healthy persons who react poorly to stress or have chronic mental health problems run a significantly higher risk than most people of developing serious health problems or dying by the time they reach their fifties. "Of 59 men with the best mental health, assessed from the age of 21 to 46 years, only two became chronically ill or died by the age of 53," Vaillant reports in the journal. "Of the 48 men with the worst mental health from the age of 21 to 46, 18 became chronically ill or died."

The results were "statistically significant" after Vaillant and his colleagues eliminated the possible effects of alcohol and tobacco use, obesity and the lifespan of the subjects' ancestors — indicating even more strongly that mental health deficiencies are causative factors in illness. Between 1940 and 1967, the terms used to describe poor adult adjustment were attributed "at least twice as frequently" to men who became chronically ill or died in 1975.

In what Vaillant cautions are "tentative conclusions," he says that "in this sample chronic anxiety, depression and emotional maladjustment, measured in a variety of ways, predicted early aging, defined by irreversible deterioration of health. ... The data suggest that positive mental health significantly retards irreversible midlife decline in physical health."

In an editorial in the same issue of the NEW ENGLAND JOURNAL OF MEDICINE, Leon Eisenberg of Children's Hospital Medical Center in Boston says that despite problems inherent in studies of such nature and scope, the correlations between scores on the mental health scales used in the Harvard research and "other indicators of psychopathology (defense structure, depression and psychiatric diagnosis) lend support to its credibility. ... There is a growing body of evidence that life stress predicts increased psychiatric and physical morbidity, and that social ties mitigate the pathologic effects of stress." A previous study in Alameda County, Calif., for instance, reported that men and women with few social ties run more than double the risk of death, compared with persons with many ties.

Eisenberg and Vaillant concur that such findings hold implications for possible preventive treatment, as well as future studies. "On the basis of this study and previous work," Vaillant says, "I have speculated that stress does not kill us so much as ingenious adaptation to stress ... facilitates our survival." □