

***Three Mile Island—Ten Years Later*****NO HEALTH CONSEQUENCES SEEN,  
BUT STUDIES CONTINUE TO ASSESS  
POTENTIAL EFFECTS**

...“you do not expect increased incidences of cancers” or “major health consequences from the low doses of radiation received” during the TMI accident.

**T**he latest generation of studies concerning the effects of the accident at the Three Mile Island (TMI) nuclear power plant on March 28, 1979 indicate no significant increases in mortality, morbidity, or cancer incidence in the surrounding population, but follow-up continues to assess potential latent effects. Regulatory changes which have occurred in the decade since the accident attempt to prevent it from happening again.

“The mortality experiences, including all-causes and all-site cancers considered together, of the TMI cohort, are not significantly different from those expected” for both men and women, according to a study done by researchers at the the Pennsylvania Department of Health and the National Center for Health Statistics.

That study and four others were presented at the 116th Annual American Public Health Association Meeting last November. Three of the studies presented at the meeting were concerned with pregnancy outcomes, or maternal perceptions of their pregnancy outcomes after the TMI accident, which was caused by a malfunction in the plant’s cooling system. One ongoing cross-sectional study, by the Pennsylvania Department of

Health (PDH), which reviews data from 1970 through 1986, found that “the levels of post-TMI fetal, neonatal, perinatal, or infant mortalities in the vicinity of the TMI nuclear facility were neither significantly higher than expected nor significantly different from pre-TMI years. There is no clear evidence that the 1979 nuclear accident impacted significantly on the risk of late in-utero mortality or mortality during infancy; if there was an impact, it may have been too small to be detectable by the methods used in the present study.”

Another of the studies by the PDH in association with the Centers for Disease Control, the National Center for Health Statistics, and Hershey Pediatric Center and Center for Developmental Services examined the pregnancy outcomes of the cohort of about 4000 women pregnant during or within three months of the accident and another cohort pregnant during the same months the following year. The researchers concluded that extensive analyses of pregnancy outcome “did not provide clear evidence that the TMI nuclear accident had significant influences upon fetal and neonatal abnormalities, fetal maturity problems, congenital abnormalities, or low Apgar scores. Neither radiation nor psychological

stress as such was found to be significantly correlated with any of these short-term adverse pregnancy outcomes.” However, the researchers observed a “significant association . . . between low birthweight and stress-mediated ‘extra medications’ taken by pregnant women during the accident”, which, they say, warrants additional evaluation.

Maternal perceptions of pregnancy outcomes are being studied by the PDH in association with Pennsylvania State University College of Medicine. According to the study, which began in 1985, women pregnant at the time of the accident, show “a small, but persistent long-term effect” in that they perceive “their children as slightly less healthy” than they might be otherwise. However, this effect was observed “only in very general ratings of health”; it was not present in reports of specific health problems or developmental ratings.

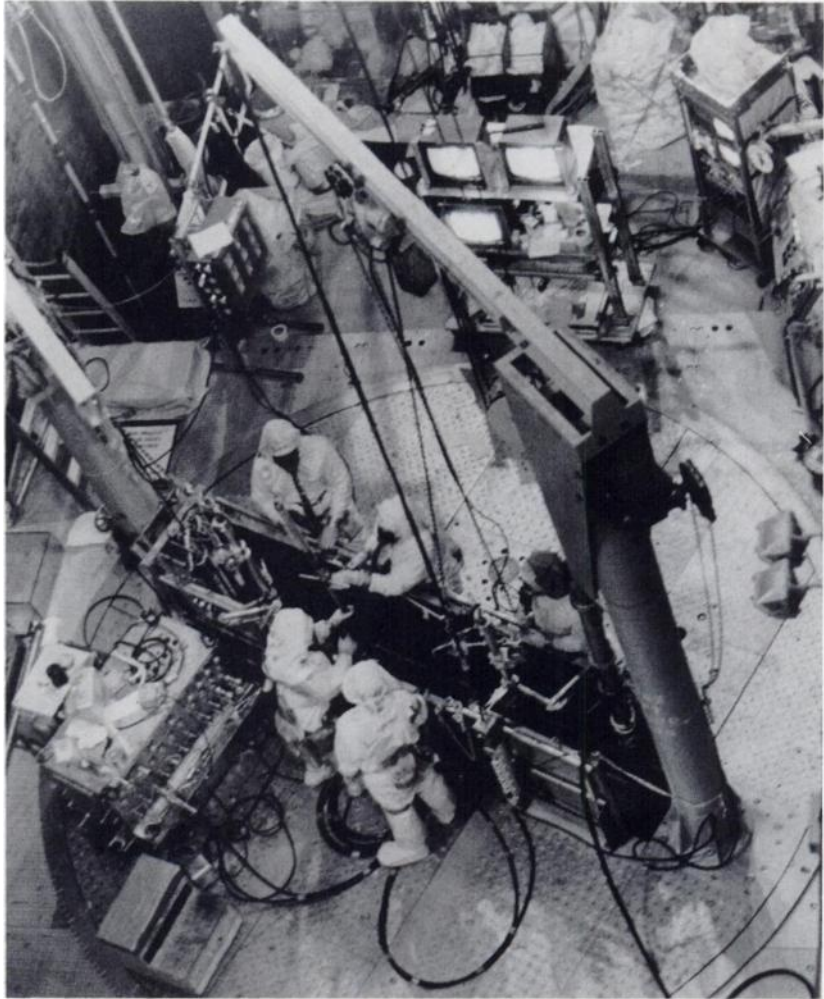
The researchers conclude, “Further analyses suggest that these differences may be the result of the study group mothers’ worrying about their children’s health rather than any objective differences in their health.” The researchers are examining the medical records of these children to verify their findings.

## Significant Effects Not Expected

George Tokuhata, PhD., director of the division of epidemiology research at PDH, told *Newsline*, the results of the studies are not surprising because "you do not expect increased incidences of cancers" or "...major health consequences from the low doses of radiation received" during the TMI accident. Dr. Tokuhata explained that a joint study between PDH and the University of Pittsburgh School of Public Health, found the maximum possible whole body gamma dose to those living within a five mile radius of the plant ranged from 12 mrem to 165 mrem (a few outliers), with an average of 24 mrem. When evacuation was taken into account—a realistic approach since most of the members of 65% of the households did evacuate—the range was lowered to 5–80 mrem, with an average of 10 mrem. When the residents within a 10 mile radius were studied, the maximum possible whole body gamma averaged 10 mrem and when evacuation was considered the mean value fell to 4 mrem. For comparison, the yearly natural background radiation in that area is about 100 mrem. Dr. Tokuhata added, in places such as India and Colorado, the natural background radiation is higher and yet "you don't see detrimental effects." Based on the results of studies done in those areas, as well as the many studies of the Hiroshima and Nagasaki victims, Dr. Tokuhata said, significant health effects are not expected to result from the radiation released during the TMI accident.

Henry N. Wagner, Jr., MD, professor of medicine, radiation, and environmental health sciences at Johns Hopkins Medical Institutions and a member of the Nuclear Regulatory Commission's (NRC) Citizens Advisory Committee for five years following the TMI accident, agrees.

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GPU Nuclear Corp

*The rotating work platform atop the open, water-filled TMI-2 reactor vessel. Working through an 18-inch wide slot, defueling crews using long-handled tools load core debris into canisters suspended underwater below the work platform.*

## Decontamination of TMI's Unit 2

According to Douglas Bedell, manager of public information for the GPU Nuclear Corporation at Three Mile Island, the crews are in the process of removing the damaged fuel, which amounts to 20 tons of original molten material that flowed down into the bottom structure during the accident and 10 tons of debris that has also dropped from various sources above the core. Mr. Bedell said GPU expects to complete the removal process this summer and to further decontaminate during the rest of 1989 and into 1990. In mid 1990, he continued, they expect to be at the stage of long-term monitored storage, in which the unit will be "locked and dry... better than 99% of the fuel will be removed... and it won't have the possibility of being assembled into a critical mass." TMI's Unit 1 reactor has been in operation since October 1985. ■



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"The biological effects have been negligible...not measurable and not significant."

David Mallie, PhD, associate professor of biophysics at the University of Rochester, also said the health effects of TMI were not significant. "There were no health effects to my knowledge," he said, "unless you count psychological effects," the fears of people who were exposed and did not know what would happen.

#### Disputes over Dosage Figures

Dr. Tokuhata acknowledges that the antinuclear community, some scientists included, dispute the dosage figures calculated in this study and comparable figures, which were released in a joint report of several federal agencies. Critics of the study, he said, which hold a minority view, have calculated their own figures, in which the received dosages are much higher. However, Dr. Tokuhata noted, the data used to calculate those dosages, unlike the PDH data, did not include the population-based cohort information—specific, comprehensive census and followup data on the entire population living in the area at the time of the accident—but was a cross-sectional study and is, therefore, not as reliable. The cohort method studies the entire population of the area at the time of the accident, even if they have moved, and thus better approximates "the real risk associated with radiation." While the cross-sectional study "does give some broad indication of the rise and decline of certain ratios," its shortcoming is that it omits those who have left the area (5 mile radius) since the accident (22.2% of the original cohort as of spring 1987), and it includes others who have moved into the area since the accident. Furthermore, said Dr. Tokuhata, if the higher dosage estimates were cor-

rect, more health effects than have been observed would have resulted. Thomas Gerusky, director of the Bureau of Radiation Protection of the Pennsylvania Department of Environmental Resources (DER), called the PDH dosage estimates "very, very good, and conservative."

#### Research Continues

In contrast to the cohort-based method used in most of the PDH studies, a study headed by Maureen Hatch, PhD., assistant professor of epidemiology at Columbia University School of Public Health, used a cross-sectional method to emphasize incident cancers, which are more

likely than cancer deaths to occur in a short period of time. Looking at cancers which are sensitive to low dosage and have a short induction time, the researchers, "predicted the geographic distribution of exposure" by dividing the 10 mile radius around TMI into 69 geographic units and analyzing them individually, Dr. Hatch told *Newsline*. The team, she added, "started with dose data from the few monitors that remained on scale during the accident...and developed a mathematical model of emissions, which predicted concentrations in various areas based on...geographic features," such as wind patterns and variations in the

### International Agreement to Assess Damage to TMI-2 Vessel

The NRC signed an international agreement January 31 to investigate the state of the TMI-2 reactor vessel damaged in the 1979 accident. The investigation, which is already underway, is expected to take three years and is estimated to cost \$7 million. Advanced cutting tools, developed as part of the joint effort, will be used to remove samples from the lower head of the reactor vessel. The samples will be examined in laboratories in the US and in other participating nations to determine the thermal and chemical effects on the reactor vessel and the amount of structural integrity remaining. Harold Denton, who is director of the NRC's Office of Governmental and Public Programs and was director of the Office of Nuclear Reactor Regulation at the time of the TMI accident, said the analysis of the samples will help "determine whether the reactor vessel itself was damaged...whether it was close to failing...and it will provide information on how severe accidents progress." The results, according to the NRC, will help determine a safety margin to apply in the evaluation of severe accidents and to develop improved accident management methods for light-water reactors, which all but one of the reactors in the US are, according to Mr Denton. Data from the samples also will be integrated with DOE research studies of the core debris to facilitate better understanding of core-melt sequences.

The agreement, between the United States and ten countries under the auspices of the Organization for Economic Co-Operation and Development's Nuclear Energy Agency (NEA), provides that Belgium, Finland, France, The Federal Republic of Germany, Italy, Japan, Spain, Sweden, Switzerland, and the United Kingdom pay up to 50% of the cost of the NRC-sponsored project. ■

terrain, taking background radiation into account. The data from the model compared favorably with the information from thermoluminescent dosimeters which gauge radiation emissions outside the plant. Dr. Hatch cites two advantages to the group's cross-sectional study design, the increased likelihood of observing incident cancers over cancer deaths and that "looking at rates in small geographic units is a much more sensitive approach" than looking at cancer rates for the entire population. While the study has been completed, the results will not be released until they are published, which, Dr. Hatch said, is expected to be in June.

Health officials continually monitor the TMI cohort since radiation dosage figures, even those calculated through a population-based cohort method, merely estimate the likelihood of an adverse health effect; they are not absolute and hold many unknowns. Certain effects, such as most cancers, would not appear for a decade or more after exposure. So, while the studies to date bear out the dosage figures put forth by the government and investigative agencies, more studies must be done in the future to rule out latent effects.

### Changes Since the Accident

Through the continuing studies of health consequences, the accident at the Unit 2 reactor at Three Mile Island has provided an opportunity to examine the possible effects of radiation exposure. In addition, it has prompted a re-examination of the safety of the world's nuclear power plants, which has led, particularly in the United States, to more stringent and extensive regulation and monitoring. David R. Brill, MD, assistant director of special imaging, radiology, and chief of nuclear medicine at Geisinger Medical Center, said "we dodged a

bullet with Three Mile Island... releases were very, very low and were over very quickly. The major downside was the psychological damage. The upside is that now we have some very stringent regulations and the NRC is enthusiastic about enforcing them... In the 10 years since the TMI accident a great deal has been done to make nuclear reactors safer than they were, not that they were unsafe before, but a lot was left to chance." Dr. Brill said the increased regulation in the wake of the TMI accident includes some "human proof contingencies" to ensure against human error as well as improved design specifications and training requirements. Also, Dr. Brill said the TMI Unit 2 control room design was poor and would not be acceptable under current standards.

Dr. Mallie said a major benefit of the TMI accident "was to wise up some utilities to the fact that they couldn't treat a nuclear power plant the way they treat a coal-burning plant."

Other nations have worked to improve their nuclear power operations and continue to do so. The International Symposium on Nuclear Power was held recently in Tokyo, and attendees represented The Netherlands, Switzerland, Great Britain, and other countries, in addition to the US. Discussions at the meeting centered around the need to improve the technical design of reactors, improve operator training, "streamline the licensure process... and educate the public on the relative risks of radiation compared to other forms of energy," said Dr. Tokuhata.

Changes in the standards and regulations in the wake of the accident at TMI came on both state and federal levels. Mr. Gerusky of the Pennsylvania DER told *Newsline* that in Pennsylvania the accident led to "a

major overhaul of the emergency response and emergency planning" programs. The state passed legislation requiring a nuclear safety program at each nuclear power plant directed by a nuclear engineer, as well as other safeguards now required in each plant. Additional legislation permits Pennsylvania's Governor to require, rather than merely recommend, an evacuation.

On the federal level, changes have been made affecting all aspects of reactor operations, from management through maintenance, over the 10 years since the accident, according to Harold Denton, director of the Nuclear Regulatory Commission's Office of Governmental and Public Programs. Mr. Denton, who was director of nuclear reactor regulation at the time of the TMI accident, said, the "focus [of regulatory changes] was on the recognition that severe accidents can occur if the plant isn't operated properly." The changes, he added, "were more on the human side" and included upgrading the training and emergency response programs. He said there are two direct lines between the NRC headquarters in Bethesda and each of the 108 nuclear power plants in operation in the US, to be used during emergencies and during each shift so that the NRC can keep abreast of each plant's daily operating history. In addition, the Federal Emergency Management Agency was established, which sets up drills in the localities in which there are nuclear plants. Mr. Denton concludes, "If you look at the operating history, [nuclear plants are] all operating a lot safer than they were before TMI" and "... federal, state and local governments are a lot better equipped" to handle emergency response.

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