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**THE EFFECTS OF THE ACCIDENT AT THREE MILE ISLAND ON THE MENTAL HEALTH
AND BEHAVIORAL RESPONSES OF THE GENERAL POPULATION AND NUCLEAR WORKERS¹**

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INTRODUCTION

At 4:00 a.m. on March 28th, 1979, the United States experienced the worst accident in the history of commercial nuclear power generation [TMI79a; NRC79a; NRC79b; NRC79c]. It occurred at the Three Mile Island nuclear power plant Unit No. 2 near Middletown, Pennsylvania. The accident was initiated by mechanical malfunctions in the plant and made much worse by a combination of human errors responding to it. During the next four days, the extent and gravity of the accident was unclear to the utility's nuclear power plant managers, to the federal and state officials, and to the general public. Two weeks later, President Jimmy Carter established a Commission to conduct a comprehensive study and investigation of the accident involving the nuclear power facility. In its Charter, the President's Commission on the Accident at Three Mile Island was given the responsibility to evaluate "the actual and potential impact of the events (of the accident) on the public health and safety and on the health and safety of the workers" [TMI79a].

Just how serious was the accident? Based on the investigations of the President's Commission into the health effects of the accident, it was concluded that, in spite of serious damage to the nuclear plant, most of the radiation was contained and the actual release of radioactivity would have a negligible effect on the physical health of individuals. The major health effect of the accident---in the general population and in the nuclear workers---was found to be mental stress [TMI79b].

The highly publicized events during the early days of the accident---the various releases of radioactivity into the atmosphere and into the Susquehanna River, the generation and accumulation of a large hydrogen bubble in the reactor-pressure vessel, the risk of major releases of large amounts of radio-

active debris from the damaged nuclear core, and the possibility of these events presenting a great threat to life---led to Pennsylvania's Governor Richard Thornburgh's advisories that all people living or working within a 10-mile radius of Three Mile Island remain indoors, and that all pregnant women and preschool age children living within 5 miles of the nuclear plant leave the area immediately. Nearby schools were closed. Plans were considered for evacuation of almost a third of a million residents. Although these plans were never carried out in the form of an official order, a large number of families decided to leave the area voluntarily. A main conclusion drawn from the investigation by the President's Commission was that the most serious health effect of the Three Mile Island nuclear accident was severe mental stress, which was short-lived. The highest levels of psychological distress were found among those living within 5 miles of Three Mile Island, in families with preschool age children, and among the Three Mile Island nuclear workers.

WHAT WERE THE FINDINGS OF THE PRESIDENT'S COMMISSION?

The Public Health and Safety Task Force of the President's Commission set out seven objectives in its investigation, one of the primary objectives being "to assess the mental health and behavioral responses of the general population during and following the accident." The Behavioral Effects Task Group was formed and comprised leading investigative psychologists, sociologists and physicians, ably assisted by a number of collaborating researchers [TMI79c]. The members of the Behavioral Effects Task Group were: B. E. Dohrenwend, Columbia University, chair; B. S. Dohrenwend, Columbia University; J. I. Fabrikant, University of California; S. V. Kasl, Yale University; and G. J. Warheit, University of Florida. The overall objective of the Task Group was

to examine the effects on the mental health of the general public and the nuclear workers directly involved in the nuclear accident at Three Mile Island. In examining effects on mental health, a distinction was made between short-term and long-term effects. Attention was also paid to the possible impact on the affected population and workers of a variety of studies, either underway or planned at that time [TMI79b; TMI79c; Ka81a; Ka81b; Br80a; Br80b; Ho80].

"Mental health" was considered a very broad topic by the Task Group, and the collection of data and limited time available for analysis made it possible to consider only narrow aspects of the overall behavioral effects experienced. Fortunately, although narrow, these behavioral aspects---centering on measures of psychological distress, upset and demoralization---were considered important and appropriate to what was known about the most characteristic responses to stress situations [TMI79c].

1. METHODS OF STUDY

The report of the Behavioral Effects Task Group was based on surveys of about 2,500 persons from four different study groups: (1) The general population of male and female heads of households located within 20 miles of Three Mile Island; (2) mothers of preschool age children from the same area and a similarly drawn control sample from Wilkes-Barre, Pennsylvania, which is about 90 miles away; (3) teenagers in the 7th, 9th and 11th grades from a school district within the 20-mile radius of Three Mile Island; and (4) nuclear workers employed at the Three Mile Island nuclear power plant at the time of the accident and a control group of nuclear workers from the Peach Bottom nuclear power plant about 40 miles away [TMI79c; Do79].

The usual procedures in these psychological studies was to draw strict probability samples of households and to conduct structured, half-hour interviews by telephone [GR79; Lu77; F179]. Early studies of household heads were conducted immediately after the accident by mail questionnaires, and the study of the teenagers was conducted by questionnaires distributed in classrooms. All analyses were done on data collected within the first seven months immediately following the accident---from April through October 1979.

A core of similar measures of mental health, attitudes, and behavior were used in each study except for that of teenagers, which was limited to specific measures of distress developed for the study. The areas covered by measures in the other three studies were: (1) living within, versus outside, the five-mile radius of Three Mile Island; (2) having preschool age children in one's family; (3) recall of immediate upset at the time of the accident; (4) staying in, or leaving, the Three Mile Island area at the time of the accident; (5) demoralization following the accident; (6) perceived threat to physical health; (7) attitude toward continuing to live in the TMI area; (8) attitude toward nuclear power, including Three Mile Island; and (9) trust in authorities. In addition, the study of the nuclear workers included: (10) measures of their concern about the future of their occupation; and (11) their perceptions of hostility from the wider community [Ka81a; Ka81b].

In all studies, the major measures of objective threat stemming from the accident were [TMI79c]: (1) living within, versus outside, the five-mile radius of Three Mile Island; and (2) having preschool age children in one's family. For the workers, an added measure of objective threat was (3) whether they worked at Three Mile Island rather than Peach Bottom at the time of the accident. For the teenagers, an additional measure of objective threat was

(4) whether or not their families left the area during the accident, because this was a factor outside of their control.

2. THE GENERAL POPULATION AND MOTHERS OF PRESCHOOL AGE CHILDREN

At 12:30 midday on Friday, March 30th, 1979, the third day of the nuclear accident, Pennsylvania Governor Thornburgh, following telephone advice from Nuclear Regulatory Commission Chairman Joseph Hendrie, advised pregnant women and preschool age children to leave the area within five miles of Three Mile Island. The governor reaffirmed this advice at a press conference later that evening and this received wide coverage by the news media---television, radio, and the press. No comparably authoritative definition of the chief targets of threat was made prior to that time or after the governor's message.

How upset were people at the time of the Three Mile Island accident? On the average, people living in the 20-mile area around Three Mile Island rated the accident fairly high. Women were found to be more upset than men, and people under 65 years of age were more upset than older people. However, all groups averaged fairly high. Mothers with a preschool age child living in the area around Three Mile Island were more upset than mothers living at a greater distance in Wilkes-Barre, Pennsylvania. In general, although people in the area found the Three Mile Island accident a relatively upsetting event no matter what their personal circumstances, the most upset were those who could infer from advice given about evacuation and safety precautions that they were in danger on two counts---living relatively close to the Three Mile Island nuclear plant and having a child in the preschool age range [TMI79c].

Who left the Three Mile Island area at the time of the accident? It was estimated that about 52% of the people living within 20 miles of the Three Mile Island nuclear power plant left the area at the time of the accident---the

majority of them on Friday, March 30th, 1979. More women than men, more married than nonmarried, more younger than older, and less educated than more, left the area. Some 62% of persons whose homes were situated five miles or less from Three Mile Island left the area, and about 77% of people with a preschool age child in the family left. Thus, over and above differences related to personal characteristics of sex, marital status, age and education, the decision to leave was influenced by the distance of the person's home from Three Mile Island, and whether there was a preschool age child in the family---presumably as a consequence of Governor Thornburgh's advice on Friday, March 30th, that preschool age children within five miles of Three Mile Island should leave the area. Of those in the general population who left, less than 5% left before Friday, March 30th, and the majority, almost 60%, left on that day. Among the 72% of mothers of preschool age children who left the Three Mile Island area, almost two-thirds left on Friday, March 30th [TM179c].

How demoralized were people in the Three Mile Island area? Demoralization is a common distress response when people find themselves in a serious predicament and can see no way out [Fr73; Do79; Do81; Li80]. Sometimes, this level of distress can approach that shown by persons suffering from mental disorders. Demoralization was far higher on the average in the population in April, 1979 closely following the accident, than in later months. About 26% of those interviewed in April showed severe demoralization. During May and later months, 15% or less of the general population exhibited elevated levels. This suggested that a substantial minority, perhaps 10%, experienced severe demoralization directly attributable to the Three Mile Island accident itself, both at the time of the accident and in the 2 or 3 weeks following the accident. Levels of demoralization were higher among those living within five

miles of Three Mile Island than those living at the greater 20-mile distance. Men and married persons were found to have lower levels of demoralization than women and those not currently married [TMI79c].

Was the Three Mile Island accident perceived as a threat to physical health? There was uncertainty about the matter in the general population. Any perceived threat declined by end of April, 1979, although some uncertainty remained, and people were becoming more reassured. Women and younger people perceived more threat to their health than men or older people. Those living within five miles of Three Mile Island, both in the general population and among mothers of young children, were less certain that their physical health was not affected by the nuclear accident than those living at a greater distance [TMI79c].

Was there a change in attitude about continuing to live in the Three Mile Island area? Did individuals devalue the area as a result of the Three Mile Island accident and want to move away? Women, more than men, held unfavorable attitudes, although on the average, they were still favorable toward continuing to live in the area. People in their twenties, were the least favorable; the oldest, those 75 years or older, were most favorable. All but those in their twenties were generally favorable toward continuing to live in the Three Mile Island area [TMI79c]. People in the general population and mothers who had a preschool age child in the family held more unfavorable attitudes toward continuing to live in the area than those without a child in this age range. Thus, only those people who could infer from advice given at the time of the Three Mile Island accident about evacuation and safety precautions---those living relatively close to Three Mile Island and having a child in the vulnerable age range---had negative attitudes regarding continuing to live in the area.

As a result of the accident, were attitudes changed toward nuclear power in general, and towards restarting the Three Mile Island-1 and Three Mile Island-2 nuclear power plants? Women in the Three Mile Island area had more negative attitudes than men. In the general population, those with preschool age children also had more negative attitudes. Among the relatively favorable groups---men, people without preschool age children, and mothers of preschool age children who were themselves college graduates---only men had favorable rather than unfavorable attitudes toward nuclear power [TMI79c].

Did people trust authorities---federal and state officials and utility companies---following the Three Mile Island accident? In April, 1979, there was strong distrust, greater than in national polls in April and early May. The level of distrust in the Three Mile Island area declined only gradually, and distrust persisted through July and August 1979, remaining above national levels. Distrust was greater among women. It was strongest among people in their thirties, declining steadily with increasing age, and was also lower among people under 30 years of age.

What were the main conclusions of these psychological studies? (1) The amount of immediate and, fortunately, short-lived demoralization produced by the accident among household heads, in general, and mothers of preschool age children, in particular, in the Three Mile Island area should not be underestimated. The increase in demoralization at the time of, and in the month following, the accident was sharp. It was estimated that, as a direct effect of the accident, approximately 10% of the April general-population sample experienced demoralization as severe as that reported by persons suffering from chronic mental disorders. In the general population, this represents elevations of measures of demoralization in normal people caught in situations of extreme distress [TMI79c].

(2) The reality of the objective stress situations in which people found themselves must be emphasized. People reacted negatively to uncontrollable circumstances that posed a clear and major threat so far as the available information indicated. This was evident in the higher levels of demoralization shown by persons living within five miles of Three Mile Island or having preschool age children at home. They were told that their situation was more threatening by a respected source of information, the Governor of the State, who advised them to leave the area. Sharp elevation of demoralization in situations of severe objective threat and its rapid dissipation when the threat diminished was consistent with most of the firm findings in reactions of previously normal persons to extreme situations, such as combat during wartime and natural disasters [Fr73; Do79; Do81; Li80; TMI79c].

(3) Although the unusually high levels of psychological demoralization apparent subsided in the general population soon after the accident, as early as April, 1979, some of the behavioral effects of the accident did not dissipate so rapidly. People gradually became more reassured about the threat of the nuclear accident to their physical health. Distrust of authorities, however, although declining after April, remained relatively constant from May on through the summer of 1979. At the end of the summer, it was still at a level that showed, on balance, more distrust than trust of government authorities and agencies and the electrical utility companies so far as information about, and policy toward, the safety of nuclear energy were concerned [TMI79c].

3. THE SEVENTH, NINTH AND ELEVENTH GRADE STUDENTS

The study of the 7th, 9th and 11th grade students in the Dauphin County School identified three main measures of threat as having potential for psychological distress and physical symptoms. Two were the same as for the

general population and mothers of preschool children, viz., (1) living within five miles of the Three Mile Island nuclear power plant, and (2) having one or more preschool children in the household. The third threat was whether or not they left the area during the nuclear accident [TMI79c].

The student groups who experienced the highest levels of distress were those who had preschool age siblings, those who lived within five miles of the Three Mile Island nuclear power plant and those whose families left the area. For those who had a preschool age sibling and for those who left the area, the level of psychological distress had not dissipated after two months, but persisted at an elevated level; by then, it had dissipated for the other groups. The female teenagers consistently tended to score higher in levels of distress during and following the Three Mile Island accident compared with male teenagers.

The main conclusions to be drawn and emphasized, as in the studies of adults, is that the psychological reactions of distress were related to the realistic threat that the youngsters faced. During the accident, students in general tended to experience some psychological distress, and the distress tended to be more pronounced for students in the more threatening circumstances. These reactions tended to disappear as the threat receded in time [TMI79c].

4. THE THREE MILE ISLAND NUCLEAR WORKERS

The nuclear plant workers presented a very special group to be studied [Ka81; Ka81b]. Arrangements were made with officers of the appropriate unions, and particularly of the International Brotherhood of Electrical Workers, so that cooperation with the workers could be established and maintained. The main measure of threat to the nuclear workers were: (1) the contrast between being employed at Three Mile Island, as opposed to being employed at the Peach

Bottom nuclear power plant in Pennsylvania, (2) whether the Three Mile Island nuclear workers reported being at the stricken nuclear plant, Three Mile Island Unit No. 2, during the first two weeks of the accident, (3) living within five miles of the Three Mile Island nuclear power plant, and (4) having a preschool age child in the family [TMI79c; Ka81a; Ka81b]. The main measures of mental health and behavioral effects paralleled those of the other studies, and included upset and demoralization, perceived threat to health, uncertainty about the future, and perceived hostility from the community.

The main conclusion, and one of the most important findings with regard to the nuclear plant workers, was that the two factors that affected the morale of the general population in the Three Mile Island area i.e., (1) living within five miles of Three Mile Island, and (2) having preschool age children in the household, also affected the morale of the workers [Ka81a; Ka81b]. However, the workers did not show distrusting attitudes towards state and federal officials nor towards the utility company's plant authorities; they felt their employer kept them fully informed about risks and unhealthful conditions of their jobs. There was a sharp contrast between the trust expressed by most of the workers and the distrust expressed by the general population in relation to utility companies. Clearly, in this regard, the nuclear workers did not feel threatened, particularly as regards their physical health, in the same way as most groups in the general population. Yet, the workers at Three Mile Island, especially the large majority who were not plant supervisors, were quite upset and showed higher levels of demoralization both during the accident and continuing even after six months at higher levels than their counterparts at the Peach Bottom nuclear power plant, and at higher levels than male household heads in the general population living in the Three

Mile Island area. Furthermore, the nuclear workers at Three Mile Island were uncertain or insecure about the future of their occupation in nuclear power plants. Like the Peach Bottom nuclear workers, the Three Mile Island workers believed that less than positive attitudes were held toward them by people in the wider communities; they believed the public was hostile toward them and was critical and unappreciative of their work. This belief was not unrealistic if attitudes in communities around Three Mile Island were like those reported in a national poll conducted within 3-4 weeks following the accident, when 55% of respondents blamed the Three Mile Island nuclear plant accident on human error rather than on the government or the governmental agencies, or on the electrical power industry [TMI79c; Ka81a; Ka81b].

Regarding the workers, a salient fact was that their psychological distress had not been resolved many months later. Their level of demoralization had not returned to normal following the accident, as had been the case with other studied groups of adults in the general population living in the Three Mile Island area at that time [Ka81a; Ka81b; TMI79c].

WHAT HAVE WE LEARNED FROM THE THREE MILE ISLAND EXPERIENCE?

The conclusions drawn from these studies, and from numerous parallel investigations of the health effects of the nuclear accident at Three Mile Island, were that, in spite of the very serious damage to the nuclear plant, most of the radiation was contained and the actual release of radioactivity was so low that it would have a negligible effect on the physical health of individuals [Fa81]. The major effect of the accident was found to be mental stress in both the general population and in the nuclear workers [TMI79a; TMI79b; TMI79c].

The President's Commission investigations found that the mental stress to which those living within the vicinity of Three Mile Island were subjected was quite severe. There were several factors that contributed to this psychological distress. Throughout the first week of the accident, there was extensive speculation---by the utility, by the government authorities, by the news media---on just how serious the accident might turn out to be. At various times, senior officials of the Nuclear Regulatory Commission, of the Public Health Service, and of the state government were considering the possibility of a major evacuation. Some significant fraction (more than half) of the population in the immediate vicinity voluntarily left the region. NRC officials contributed to the raising of anxiety and confusion in the period from Friday to Sunday, March 30th to April 1st, 1979. On Friday, a mistaken interpretation of a release of a burst of radiation from the stricken plant led some NRC officials on Friday morning to recommend immediate evacuation of the 20-mile region surrounding Three Mile Island---this would have involved over three-quarters of a million people, the entire State capitol and numerous hospitals, recovery and nursing homes, old-age homes, schools, orphanages, and prisons. On that Friday, after NRC Chairman Hendrie rescinded that recommendation, Governor Thornburgh advised pregnant women and preschool age children living within five miles of Three Mile Island to leave the area. On Saturday and Sunday, March 31st and April 1st, other NRC officials mistakenly believed that there was imminent danger of an explosion of a hydrogen bubble within the reactor vessel, and evacuation was again a major subject of discussion. The President's Commission investigations led to the conclusion, therefore, that the most serious health effect of the accident was severe mental stress. The investigations suggest that this mental stress was short-lived. The highest

levels of distress were found among those people living within five miles of Three Mile Island, in families with preschool age children, and the Three Mile Island workers [TMI79c].

EPILOGUE

At the present time, a petition for a review of a Washington D.C. Court of Appeals order to the Nuclear Regulatory Commission is before the United States Supreme Court [Su82]. In this petition, the utilities of General Public Utilities Corporation are attempting to reverse the Court of Appeals order for the NRC to consider psychological distress in the general population in connection with restarting the intact Three Mile Island nuclear power plant Unit No. 1. The Court order was based on hearings on the psychological distress that occurred in the general population in the area of Three Mile Island and in the nuclear workers during the Three Mile Island nuclear accident in March 1979 (Su82). This situation is an important one for the future of nuclear energy in the United States. What happened at Three Mile Island on March 1979 now has significance far beyond the events of the accident, since the Court of Appeals order would require the Nuclear Regulatory Commission, under the National Environmental Policy Act (Na70), to consider and evaluate effects on the psychological health of area residents resulting from their fears concerning the operation of a nuclear power plant, even if the Nuclear Regulatory Commission determines that the actual risk of the operation of TMI-1 would not be significant.

If upheld, that Court of Appeals order would also require the Nuclear Regulatory Commission to be faced with psychological distress contentions in its licensing activities at other nuclear plants. Since the decision is based on the National Environmental Policy Act (Na70), the decision may also be

applied to any other federal agency that undertakes or regulates activities capable of engendering fear, anxiety or psychological distress among members of the public. Thus, it could be related to coal mines, to urban housing, to jails, to low-income housing, to airport noise and to a myriad of similar situations.

Finally, if the Court of Appeals decision stands, the Nuclear Regulatory Commission could be faced with psychological distress contentions by itinerant intervenors in licensing actions at all nuclear power plants in the United States, regardless whether the plants are safe and regardless whether there is any basis in fact for the alleged fears or stress claimed by any intervenors. The courts and the attorneys recognize that throughout this country, and particularly surrounding any nuclear power plant, there is an identifiable segment of the population that fears and distrusts nuclear power. As long as such persons exist, there will inevitably be challenges by resourceful and energetic antinuclear groups throughout the country alleging anxiety, fears and psychological distress that is severe and medically recognizable, exactly as the intervenors have done in this matter of restarting the Three Mile Island nuclear power plant Unit No. 1. Indeed, following the lower court order of January, 1982, such challenges have already been made by intervenors in seven different NRC licensing proceedings. One dissenting opinion by the judges in the Washington, D.C. Court of Appeals decision was that the Court's decision would amount not only to a court-imposed paralysis of nuclear power at Three Mile Island, but potentially elsewhere in the United States and, perhaps, throughout the democracies of the Western World (Su82).

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