EVACUATION BEHAVIOR AT THREE MILE ISLAND

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Evacuation behavior associated with the accident at Three Mile Island is described based upon data from field surveys. The question addressed is whether this evacuation was unique or whether it conformed to the pattern normally found in natural disasters. Demographic and social aspects of the evacuation are compared with those in the disaster literature. The conclusion is that the voluntary evacuation at Three Mile Island did not differ significantly from those taking place in natural disasters. Therefore, no special plans, policies, or procedures seem needed over and above those in place for other kinds of disaster evacuations. But in emergencies that are unusual and infrequent, where public officials must rely exclusively on experts who themselves disagree, and where the incident is part of an existing public controversy, forced evacuation may be a difficult action to take. This should not prevent officials from taking steps to make voluntary evacuation available to all citizens who choose to take such protective actions.

The accident at Unit 2 at the Three Mile Island nuclear power plant produced organizational and individual responses that were a mixture of those common to natural disasters and those that were unique. It is important to distinguish between these common and unique responses because the question of whether TMI was a new, one-of-a-kind emergency or whether it fit a pattern normally found in crisis situations has some serious policy implications.

The focus of this paper is on human behavior not mechanical devices or chemical reactions. Its specific concern is the evacuation process that occurred as events inside the containment building unfolded. First, a picture of the evacuation is pieced together from several surveys conducted at the time of the

accident and from secondary data. Next, the context in which individuals and families made their decisions to leave the area or to remain is reconstructed with particular emphasis on information available at the time. Finally, dilemmas likely to arise in future accidents involving nuclear energy, hazardous materials, and other new technologies are identified.

Evacuation as a Public Response to the Accident

The accident at TMI-2 may turn out to be one of the most studied in the disaster literature. Dozens of researchers began gathering data on individual actions and organizational responses right after the incident became widely known, some literally within a few hours. While not all these data were of good quality, they do provide us with enough information to describe the main features of the public response. An extensive, voluntary evacuation was one of the most important aspects of this response. It must be considered a voluntary evacuation because no official evacuation order was ever issued (see below, next section). In fact, most of the nearly 150,000 persons who left the area during the height of the emergency probably do not even consider themselves evacuees. Nevertheless, if evacuation means "a mass or collective movement of people, of a temporary nature, in the face of community disruptions, threats, or damages" (Quarantelli, 1979), then an evacuation did take place. Its characteristics are of special interest.

Most of the widely-held myths of human behavior in crises (see Wenger, et al., 1975) have been discredited by nearly half a century of social science research (see Quarantelli and Dynes, 1972). The vast bulk deals with natural disasters such as floods, tornadoes, and hurricanes. A nuclear reactor accident like the one at TMI-2 occurs in a very different social and political context than do natural events such as these (for background, see Stallings, 1973). Furthermore, major accidents at nuclear power plants are less frequent than floods, tornadoes, or hurricanes, and therefore there are few emergency adjustments built into the social and cultural structures of the affected region (cf. Moore, 1964; Anderson, 1965; Wenger and Weller, 1973). If this evacuation was different from those in natural disasters, then two distinct sets of preparedness plans may be needed, one for "normal" evacuations and another specially designed for nuclear emergencies.

The TMI Evacuation

On Wednesday, March 28, 1979, news of the pre-dawn problems

inside Unit 2 emerged in piecemeal fashion.[1] The various problems seemed managable, and by Thursday, March 29, the situation appeared to be improving. But during an attempt to transfer radioactive gas just after sunrise on Friday, March 30, some of the material escaped into the air outside the containment building.

For many people, news of the release of radioactive gases signaled a change in the nature of the emergency. Altogether, between March 28 and April 4 an estimated 144,000 people voluntarily left the area around TMI-2 (Flynn, 1979). At no time was the surrounding area completely deserted, however. The extent of evacuation was directly proportional to proximity to the reactor site. Estimates vary, but in general about half the residents living within five miles evacuated.[2] About one third of those living ten to fifteen miles from the reactor left. Beyond that distance the percentage was lower still. Data from the various studies taken together support the proposition that the closer one's residence to the reactor, the more likely he/she perceived the threat to personal safety to be real, and the more likely that person left temporarily. In other words, across households the probability of evacuating was inversely proportional to the distance of that household from the Unit 2 reactor. However, within households there was more disagreement (less consensus) over leaving the closer that household was to the reactor. Perceived credibility of public officials played a part in all of this. Interestingly, those who believed that officials were not being completely truthful were more likely to evacuate.

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1 A description of technical problems and the actions taken by plant personnel is beyond the scope of this paper; for an excellent non-technical overview, see Rogovin (1979); see also the President's Commission on the Accident at Three Mile Island (1979); for a complete description of the actions of all key emergency response organizations outside the plant, see the report prepared by the Emergency Preparedness and Response Task Force (1979:45-103).

2 The presentation in this section rests upon the author's synthesis and in some cases reanalysis of data found in the following five surveys: Barnes, et al. (1979); Brunn, et al. (1979); Flynn (1979); Kraybill (1979); and Smith (1979). This work was performed while the author served as a consultant to the Emergency Preparedness and Response Task Force of the President's Commission on the Accident at Three Mile Island. An earlier presentation may be found in Emergency Preparedness and Response Task Force (1979:141-152).

Demographic differences between those who remained behind and those who left the area for a short period of time are generally understood. Those who chose not to evacuate typically cited inability to leave their jobs as the primary reason for staying. The majority of these evidently were engaged in non-white collar occupations as the frequency of evacuation was directly related to occupational status. This is corroborated by the fact that those who evacuated tended to have higher incomes than those who stayed behind. It is also supported by the fact that retirees and those over 70 years of age were the least likely to evacuate regardless of their distance from the reactor.

The voluntary evacuation began on Friday afternoon (March 30). This timing is significant in two respects. Most obviously, events on Friday morning seemed to take a turn for the worse. After two days of increasing optimism, news of the accidental release of radioactive gases into the atmosphere created a different impression for many people. Less obvious but equally as important, the approach of the weekend meant that many families would be temporarily freed from their weeklong roles. With the normal work week coming to end (in some cases earlier than usual due to school and other closings), many families could now think in terms of spending the weekend with friends or relatives. In fact, few respondents who left the area even thought of themselves as evacuees when questioned afterward.

The presence of the weekend may also account for some of the other differences between evacuees and non-evacuees. Both occupational status, and to a lesser extent income as well, are related to the temporal organization of the work week. Those in white collar occupations are more likely to work a traditional eight-to-five, five-day-a-week pattern whereas other types of jobs are more likely to be organized into shifts that include some weekend hours or weekend overtime. Socioeconomic status differences in the frequency of evacuation may have as much to do with the ability to use the weekend to visit as to any cognitive or perceptual differences related to social class. And "staying over" an extra day or two at the beginning of the next work week is a fairly conventional way to extend these weekend roles to mid-week.

The wast bulk (72 per cent) of those who voluntarily evacuated did so with their families. An estimated 80 to 90 per cent stayed with friends or relatives; very few moved into public shelters. And there were no unusual numbers of injuries or fatalities on the highways caused by massive traffic accidents as many feared would result if people hastily took to the road in panic flight.

TMI in the Context of Other Evacuations

How does this voluntary evacuation compare with other evacuations in natural disasters? Evacuation is such a common occurrence in disaster that there is a rather large body of literature to turn to (for a recent review, see Quarantelli, 1980). The most interesting demographic description comes from data gathered by Hans and Sell (1974) for the Office of Radiation Programs of the Environmental Protection Agency.[3] Ironically, their research was a benefit-cost analysis of the risks associated with public evacuation as a protective measure "... (i)n the event of an incident at a fixed nuclear facility which can cause or potentially cause radiation exposure to the public in the vicinity of the facility."

From data supplied by all regional offices of the Federal Emergency Management Agency (then known as the Defense Civil Preparedness Agency), Hans and Sell identified 521 natural disasters between January 1960 and February 1973 in which at least 25 persons evacuated (their minimum requirement). For the United States as a whole, this represents an average of 40 disaster-related evacuations per year. Each year an average of more than 85,000 persons evacuated their residences. These evacuations ranged in scale from the minimum of 25 to a maximum of 501,000 persons. The "average" evacuation involved slightly more than 21,000 persons. Adjusting for the skew caused by a few unusually large evacuations, the median disaster evacuation involved slightly less than 1,000 persons. Ninety-four per cent of all evacuations studied involved fewer than 100,000 persons. The average distance travelled by all evacuees was thirteen miles with a range from one-fourth mile to 80 miles.

In the subsample of 54 evacuations focused on by Hans and Sell, a total of 1,142,336 persons were evacuated. Of this total, only ten people died as a result of evacuation, all but three of these in a single helicopter crash. Only two other major injuries were reported. These figures did not result from a sample of fortuitous evacuations benefiting from ideal conditions. Only 42 per cent of them took place totally during daylight hours. In 41 per cent it was either raining, snowing, or foggy. Only 33 per cent took place when roads were completely dry.

Compared to the statistical pattern of evacuations in natural disasters, demographic characteristics of the voluntary evacuation

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3 The Hans and Sell (1979) data were reanalyzed by the author for the President's Commission on the Accident at Three Mile Island. Many of these conclusions are not found in their report, but all are based upon their data.

at Three Mile Island were certainly not unusual. The scale of evacuation (estimated at 144,000 persons) was larger than both the mean and median in the Hans and Sell data but far from extreme. The proportion of the total population that evacuated (estimated at not more than 55 per cent even in the area adjacent to the site) is probably less than in a forced evacuation, but this figure underscores the fact that reluctance to leave is a more characteristic disaster response than panic flight at the first sign of trouble. The average distance between the place of residence and the host location for those who evacuated (i.e., 85 miles) was considerably higher than the mean for such distances but still not unheard of. It probably had more to do with the geography of central Pennsylvania than with any desire to get as far away from the plant as possible, although there are no data on this point. And there are also no data in the disaster literature to compare with the average duration of evacuation here or with the estimated cost per household, but five days and U.S. $146.15, respectively, do not seem outrageous figures. Demographically, then, this voluntary evacuation was clearly more like than different from those normally found in natural disasters.

Comparison of the Social Aspects of Evacuation

The bulk of the research literature deals with social psychological and sociological characteristics of evacuations in natural disasters. The following is a composite picture drawn primarily from three sources: from Mileti, et al. (1975:18-22), who organized the published literature prior to 1975 in propositional form; from Perry, et al. (1979: principally the summary chapter, pp. 259-279), who systematically tested many of these propositions in four flood disasters; and from the review by Quarantelli (1980) cited earlier.

Under normal conditions very few people think of evacuation as a response they might make in an emergency. This holds true even for residents of hazard-prone areas such as the Gulf Coast of the United States which is repeatedly subject to the threat of destructive hurricanes. When people do engage in mass evacuation (voluntarily or otherwise), they do so in a social rather than an anti-social or non-social manner. Instead of stampeding onto highways in wild panic flight, most are reluctant to do anything without first confirming the reality of the problem and the immediacy of the threat. When the decision to evacuate is made or the order given, most do so as families rather than as individuals. They tend to find their own accomodations, usually with friends and relatives, rather than relying on public shelters. Even those who do move into shelters such as those operated

by the Red Cross usually only remain overnight or until they find private accomodations.

Some of the reasons people choose to leave rather than to remain in a threatened area are reasonably well understood. Perhaps most important is an individual's perception that the threat is real and that he/she is personally at risk. Those who do not believe that they are in real danger are less likely to evacuate. Several factors relate to the formation of this belief. Being able to personally confirm the existence of the threat is one. Seeing other people behaving as if they believed the threat to be real is another. Both the accuracy and the consistency of emergency announcements and warnings increase the belief that the threat is both real and serious. The number of messages received about the threat has the same effect. There is also some support for a correlation between socioeconomic status and the likelihood of evacuation; the higher one's (and one's family's) status, the more likely he/she is to evacuate (presumably because he is more likely to believe public information about the threat). However, evidence regarding the effects of age is contradictory. Most studies find that older persons are reluctant to evacuate even when ordered to do so. But Perry and associates (1979:267) found the opposite to be true in their systematic study of four flood-threatened communities; that is, older respondents among the sample of 622 were more likely to evacuate than their younger counterparts.

In general, social properties of the TMI evacuation were nearly identical to those found in natural disasters. It easily fits Perry's "preventive evacuation" category--a short-term departure occurring before the effects of impact reach the population at risk (Perry, et al., 1979:6-8). Those who perceived the threat to be both real and serious were more likely to be among the voluntarily evacuated. As noted earlier, these perceptions were correlated with proximity to the reactor site. And those with higher occupational status and higher income were more likely to leave, but this may have had as much to do with the temporal organization of the work week as with processes of perception.

Findings did differ from the disaster literature in two respects. Inconsistency rather than consistency in reports of the accident was associated with the likelihood of evacuation. The most plausible interpretation in this case is that recipients of the information felt that the worst was being kept from them; the more discrepencies that appeared in the reports, the more it seemed that the really bad news was being withheld. And older residents--those 70 years of age or older--were less likely to leave. This finding is consistent with most disaster studies but not with Perry et al.

The general conclusion one reaches is that, in so far as the evacuation process itself is concerned, the accident at Three Mile Island was no different from any other disaster. No special policies, plans, or actions seem necessary to deal with evacuations as such in these situations. The same cannot be said about the rest of the public information and warning process, however.

Mixed Signals From Official Sources

Although events during the early morning hours of Wednesday, March 30, had officials discussing the possibility of issuing an evacuation order, by mid-morning it appeared that this would be unnecessary. Lieutenant Governor Scranton stated:

> "There is and was no danger to public health and safety ... There was a small release of radiation to the environment. All safety equipment functioned properly." (Allentown Morning Call, March 29, 1979).

However, later the same day he told reporters:

> "This situation is more complex than the company first led us to believe." (Allentown Morning Call, March 29, 1979).

No public evacuation was ordered, but it was reported that a nonessential personnel had been removed from the plant.

The next morning, a physicist speaking on a radio talk show advised all pregnant women within two miles of the plant to leave the area. His comments triggered discussions among state and local emergency preparedness officials about the possibility of evacuation, but no public action were taken. The radioactive release on Friday morning changed things slightly. Nuclear Regulatory Commission (NRC) officials recommended an evacuation, and the state emergency preparedness agency advised the public of possible evacuations. County preparedness officials notified schools in the area to keep students indoors.

At a mid-morning press briefing, the governor's press secretary read a prepared statement from the governor that advised all persons living within a ten-mile radius of TMI-2 to remain indoors with their windows closed. A local college dismissed classes for the remainder of that day (Friday) and for Monday and Tuesday of the following week as well. Several local schools closed early, air raid sirens sounded in the downtown area of the state capital, and officials in another city outside the immediate area prepared to receive evacuees. Later the governor issued another advisory that pregnant women and preschool children within a five-mile radius of the plant should leave. The evening edition of the capital's major newspaper carried

further reports: the National Guard was being readied for a possible alert; the state's fairgrounds were being prepared as an evacuation center; 130 evacuees had already moved into a municipal arena in a nearby town; and traffic jams had occurred in the capital as 15,000 state employees left work early after being notified of the release.

Reports of the unofficial evacuation continued in Saturday's newspapers. One quoted a councilman from a small village near the plant that forty per cent of the total village population--not just pregnant women and children--had already left. Emergency preparedness officials were reported to be preparing plans for evacuation of both five- and ten-mile areas around the plant. Another story described 300 senior citizens being moved from area retirement homes. Not reported were the facts that plans for the evacuation of prisons and detention homes were being made and that the state had advised local officials to draw up plans for an evacuation out to a twenty-mile radius of Unit 2. Meanwhile, the governor released the following statement:

> "My advisory that pregnant women and pre-school children stay out of the area within five miles of the plant site will remain in effect for a least another night. Evacuation of a broader nature continues to be unnecessary at this time. A decision regarding school closings and leave policy for state employees will be made and announced as soon as possible Sunday."

Sunday papers on April 1 contained more news of the evacuation. One story estimated that 50,000 people had left the county in which the Three Mile Island plant was located. Another quoted that county's emergency preparedness director as advising those who remained to leave if they felt "uncomfortable" about the situation. Those living within five miles of the plant who lacked their own means of transportation were urged to notify local officials so that there would be no last-minute problems if an evacuation was ordered. Local papers on both Monday and Tuesday continued to report evacuation-related stories. These included reports of plans being completed for evacuation out to a twenty-mile radius; absenteeism among state employees running 250 per cent above normal; local hospitals being "severely understaffed" do to absenteeism; plans to move newborn babies and other patients out of area hospitals; and estimates that 200,000 people living around the plant had evacuated so far.

On Wednesday, the nature of these news reports changed. Schools were reopening, and the elderly were being returned to retirement centers. An evacuation center was closing.

During the week of the emergency, no official order to evacuate was ever given. In fact, there were only three official public announcements related to evacuation reported by the media. One was the governor's advisory regarding pregnant women and preschool children. A second was a radio broadcast on Friday, March 30, during which a local emergency preparedness director mentioned that an evacuation notice might be shortly forthcoming. And finally there were reports of evacuation planning including details of routes of egress and official recommendations for individuals to make preparations for a possible evacuation.

The following general features of the public information available during this emergency are clear. First, early reports were not only inconsistent but contradictory regarding the extent of danger and what was happening. Public officials did not seem to know the full extent of the trouble. The situation seemed uncertain and subject to sudden, drastic changes from moment to moment. Second, it was obvious that evacuation plans were being prepared even if no evacuation order had been issued. Third, special precautions were being taken to reduce the potential risk to especially vulnerable populations such as children, the aged, pregnant women, hospital patients, and prisoners. And fourth, thousands had already left the area without waiting to be officially ordered to do so.

Future Dilemmas

Having described the nature of the evacuation that accompanied the accident at Three Mile Island and the information publicly available at the time, it is appropriate now to discuss the implications of this emergency for future disasters. The dilemmas raised here are most likely to arise in crises slightly different from the "normal" natural disaster. This does not mean that they are unique to incidents involving light water nuclear reactors. On the contrary, they are likely to appear in any type of emergency situation characterized by the following three properties: where the crisis is uncommon in the sense that there is no cultural residue for handling the situation built up from repeated previous experience; where the onset of the hazard is visible to only a few highly trained specialists with sophisticated measuring instruments; and where the hazard itself is somewhat of a controversial public issue. Technological disasters such as those involving spills, releases, and hazardous sites and short-term predictions of damaging earthquakes come closest to these analytical properties. In

other words, an examination of the responses to an accident like that at Three Mile Island raises issues that ordinarily do not appear in studies of natural disasters.

The principal dilemmas are those faced by public officials particularly at state and local levels. On the one hand they are responsible for protecting the safety and wellbeing of their constituents. On the other hand they must depend heavily on experts--experts who may disagree among themselves--to define for them what is safe and to tell them when the public is truly at risk. They may feel constrained by the false belief that to publicly overreact would set off the sort of panic flight portrayed in the movies or at least to cause unknown psychological harm. They probably are fully aware that there will be political ramifications from any actions they take when the incident involves a publicly controversial substance, process, or technology. They surely can guess that a response such as the evacuation and sheltering of large numbers of people for any length of time will be costly to all parties involved--to households, employers, and businesses as well as government.

Given all this, it would be surprising only if state and local officials were NOT hesitant to order an immediate evacuation. The terms "advisory" and "recommendation" may be common labels for any statement that might resemble an order to evacuate. Indeed, during the incident at Three Mile Island the situation was carefully referred to as an "accident" rather than a disaster. Federal officials from the White House to the regional offices of federal agencies insisted that a disaster declaration by the President (which would have labelled the area around the reactor as a "disaster area") was unnecessary while at the same time promising all the federal aid normally associated with such a declaration.

If the dilemma of what course of action to take is resolved as expected by making evacuation a matter of individual choice rather than mandatory, then the experience at Three Mile Island shows that two factors will act to inhibit the use of voluntary evacuation as a protective measure. One is the constraint imposed by everyday work and familial obligations. The other is the inability of those potentially at risk to independently confirm that the danger is real and serious. Both can be altered by public officials even in the absence of an evacuation order to increase the probability that this protective measure will be used voluntarily.

The fact that evacuation is a family rather than an individual process is well known (see, among others, Instituut voor Sociaal Onderzoek van het Nederlandse Volk, 1954; Quarantelli, 1960; and Drabek and Boggs, 1968). What this means is that most

families choose evacuation only when all their members are able to leave together. Mothers will not voluntarily leave home until children return from school; wives and children will not evacuate until husbands and fathers return home from work. Indeed, separation of family members is one of the major correlates of psychological stress in disaster (see Fritz and Marks, 1954). But neither husbands nor wives are likely to evacuate voluntarily if the demands of job or other work cannot be postponed. In other words, the likelihood that a family will chose to voluntary evacuation as a preventive measure is a function of the ability of EACH member to be free of non-familial role expectations.

In the case of Three Mile Island, state and local officials made voluntary evacuation more likely by closing schools early and releasing some state employees before the end of the workday. In future similar situations, government officials may in addition need to persauade private-sector employers to do likewise and to define the emergency in such a way that no pay or other benefits are lost by non-essential public employees who stay away from their jobs. Such actions can facilitate the use of preventive evacuation without the necessity of issueing an evacuation order.

The second constraint on the use of voluntary evacuation as a matter of individual choice, the perception that a real and serious threat exists, can also be influenced by the actions of public officials. Both the present case and the disaster literature show a strong relationship among the probability of individuals and families evacuating, the belief that the impending danger is real and life-threatening, and the information supplied by public officials. Normally evacuation will not occur spontaneously at the first sign of trouble. Several studies of so-called panic caused by accidental warnings or by fictional radio and television programs show that the first behavioral response was an attempt to confirm the reality of the threat such as by telephoning local police (see Danzig, et al., 1958; Katz, et al., 1960; Mack and Baker, 1961; Rosengren, et al., 1975). In the absence of any visual signs of danger, information supplied through the media increases in importance (for a related discussion of a similar type of warning situation, see Panel on the Public Policy Implications of Earthquake Prediction, 1975: especially pp. 47-66). Normally the more this information tends to give a clear, consistent, and accurate picture of the threat, the more likely people will evacuate. However, in the face of conflicting reports and lingering uncertainty about the safety of conditions in the Unit 2 reactor, the opposite seemed to happen. Most residents interpreted these mixed signals as

proof that public officials either were not being completely open about what was going on or, worse, were being deliberately kept in the dark by representatives of the utility company operating the plant. Coupled with widespread news coverage of the anticipated forced evacuation which seemed inevitable, many decided to leave home for the weekend "just to be safe" before any formal order was given.

If public officials expect to maintain their credibility and to have their advice and recommendations followed, then their concern should be for establishing and maintaining working channels of communication with all parties to the situation, with all the experts. What they do not or are not able to say will be as important a message as what is said. The decision to order an evacuation when there as a chance that its costs will outweigh its benefits will be a difficult one to make. This should not mean that public officials avoid taking steps to see that voluntary evacuation is a vialble alternative.

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