
The Social and Economic Effects of the Accident at Three Mile Island

Findings to Date

Prepared by
C. B. Flynn, J. A. Chalmers

**Mountain West Research, Inc.
with Social Impact Research, Inc.**

**Prepared for
U.S. Nuclear Regulatory
Commission**

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Manuscript Completed: November 1979
Date Published: January 1980

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Washington, D.C. 20555
NRC Contract No. NRC-04-78-192**

ACKNOWLEDGEMENTS

This report presents the results of our research over the six-month period following the accident at Three Mile Island Nuclear Station as well as a synthesis of the findings of other researchers studying the response to, and the effects of, the accident. We are indebted to these other researchers for their cooperation with us and for the insights we have gained from them.

Special acknowledgement is due to agency personnel of the Commonwealth of Pennsylvania. Walter Plosila, Director of the Governor's Office of Policy and Planning, has management responsibility for the Pennsylvania TMI Social-Economic Impact Study and has provided frequent assistance throughout our work. In addition, members of his own staff as well as of other departments of state government have been consistently helpful in our efforts. The assistance of all these persons is very much appreciated.

Throughout our work, Peter Houts and Robert Miller of the Hershey Medical Center have provided important input with respect to the psychological implications of the accident for the residents of the area surrounding the TMI site. We have also benefited from interaction with study groups formed to support the work of the Presidential Commission; namely, the Economic Impact group headed by Fred Offensend of Stanford Research Institute, the Behavioral Effects group headed by Bruce Dohrenwend, and the Social Effects group headed by Charles Wolf. We also want to acknowledge the useful exchange of ideas we have had with Anita Summers, chairperson of the economic subcommittee of the Pennsylvania TMI Commission.

Finally, we appreciate the continuing efforts of Michael Kaltman and Donald Cleary of the Office of Nuclear Reactor Regulation, and Clark Prichard of the Office of Nuclear Regulatory Research, who have provided administrative support as well as important substantive input throughout the study process.

Cynthia Bullock Flynn
Seattle, November 1979

James A. Chalmers
Tempe, November 1979

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EXECUTIVE SUMMARY

Objectives

This report is part of a larger effort to describe the social and economic effects of siting, constructing, and operating nuclear power plants in the United States. This report covers the social and economic effects of the accident at Three Mile Island Nuclear Station (TMI) during the first six months after the accident. We recognize that there is considerable ongoing research into these effects; however, given the important policy discussions that will be made in the near future, we feel that it is important to present our findings to date. A more detailed discussion of the effects of the accident will be prepared in the summer of 1980.

Scope

The emphasis in this report is on effects of the accident on the region of southcentral Pennsylvania that surrounds the station site. A variety of data sources were utilized including published documents and statistics, household surveys, other research about the accident, newspaper files, and interviews with key informants. Our findings can be grouped into the effects on 1) the regional economy, 2) institutions, and 3) individuals. The report focuses on the two-week emergency period immediately following the accident and on continuing effects through the end of September 1979. The report ends with the identification of potential longer-term effects.

Findings

1. Summarization of the Economic Effects

The direct economic effects experienced during the emergency period following the accident were interrupted local production and reduced local income and employment. The losses were conspicuous during the first week of April but very minor subsequent to that time. The estimate of total accident-related income losses (and gains) derived from the NRC Telephone Survey is probably the best measure of short-term economic disruption. Net losses within fifteen miles of the site are estimated to be about \$9 million. The advantages of these estimates are that they include short-term income gains and proprietors' income as well as wage and salary income. When expressed relative to annual income in the area, the income loss amounts to about one-quarter of one percent of annual personal

income. As would be expected, the employment losses were estimated to be of the same order of magnitude.

The agriculture and tourism sectors of the economy were particularly vulnerable to the accident. Each was significantly affected during the emergency period, but continuing effects are not apparent; in fact, continuing disruption of economic activity due to the accident is conspicuous by its absence. There is no evidence of any continuing interruption of activity because of the accident. In fact, direct effects may eventually become positive if local expenditures that are necessary for the rehabilitation of Unit 2 increase.

Against this apparent backdrop of "return to normalcy," there is concern within the business community about the effect of the accident on the continued growth and development of the area--particularly the Metropolitan Edison Company's (and Pennsylvania Electric Company) service areas. Upon investigation, it appears that the concern is not so much based on abstract dimensions of the area's image, but rather on the potential effect of the accident on the cost of power. There is presently much confusion about the extent to which recent increases in the price of electricity are due to the accident. There is also a clear appreciation of the extent to which future prices depend on a complex set of political/regulatory decisions that will evolve in the future. There is apprehension that uncertainty with respect to future electricity prices may significantly affect relocation and expansion plans, even if higher prices (relative to what they would have been) never occur.

The short-term effect on area households comprised both income losses and extraordinary expenses. In addition, account must be taken of the fact that about \$1.2 million in insurance has been paid to area residents. Households in which someone evacuated incurred substantially greater costs than did other households. For the 15-mile ring, costs per household with evacuees averaged \$296, while for nonevacuating households they averaged \$41. Assuming average annual family income in the area is \$17,000 (Flynn, 1979), these costs amount to losses on an annual basis of 1.75 percent for evacuating households and 0.24 percent for nonevacuating households.

Many individuals reported that they had considered moving from the area, but presently few appear to have acted on this intention. The real estate market has shown no discernable reaction to the accident through the end of September. Thus, although there has clearly been thought given to moving from the immediate area of the plant, action that has been taken to date has not been sufficient to be noticeable in the market.

2. Summarization of the Institutional Effects

The accident at Three Mile Island strained existing institutions in several respects. First, because a formal emergency was not declared, the role of the Civil Defense coordinators was ambiguous. Given the already fragmented responsibility for public safety in most of the municipalities in the area, this ambiguity was quite difficult to handle in some cases. Even in municipalities that were able to handle the structural problems smoothly, the potential exists for future difficulties should other actors occupy the roles.

It appears that interinstitutional friction was much less common during the emergency declared during Hurricane Agnes in 1972 than during the accident at TMI. The major difference appears to be that an emergency clearly did exist and that a formal emergency was declared in the case of Agnes, but not in the case of TMI. Consequently, there was much less ambiguity about what needed to be done, who should do it, and when it should be done.

Second, it is clear that the lack of a specific evacuation plan prior to the accident complicated the work of local emergency agencies. Besides having responsibility for pre-operations planning and handling requests for information from the public, emergency operations center personnel had to develop ad hoc plans that normally require months of input. In fact, although it is now more than six months since the accident and all of the local municipalities have invested considerable time in preparing better plans, many people believe that local authorities still have not completed satisfactory, integrated plans.

Institutions other than emergency agencies were equally unprepared for the accident. Those with responsibility for special populations had no plans for evacuating them prior to the accident. Furthermore, there was no procedure for identifying and evacuating the institutions' important records.

Third, the expansion of the anti-nuclear movement in the TMI area has affected, and will continue to affect, federal, state, and local decision-makers. At the local levels, anti-nuclear groups have been instrumental in getting resolutions that oppose the reopening of TMI passed. They are in the process of working out affiliation interrelationships and will intervene in NRC and other regulatory hearings regarding restarting TMI Unit 1.

3. Summarization of the Individual Effects

The most significant effect of the accident on the people in the region was the evacuation experience. From newspaper accounts and interviews, it appears that the general public was not unduly alarmed during the first two days of the accident. However, on Friday, 30 March, some areas were scenes of chaos, with whole neighborhoods evacuating. Information regarding the plant was both threatening and confusing. Surveys show that much of the public was stressed and upset during the accident period. Approximately a third of the population of 370,000 within fifteen miles of the plant evacuated. Those who evacuated traveled a considerable distance, averaging 100 miles, were gone from home an average of five days, and spent an average of about \$300 extra. Many in the area lost work and/or pay. On the other hand, some residents appear to have been affected very little by the accident; they remained calm and did not alter their daily routines.

For most people, the effects of the accident were short-lived. Relative to the accident period, fewer people are worried today about emissions from Three Mile Island, fewer continue to see the station as a serious threat, and fewer show behavioral stress symptoms. But for others, the accident has caused a more permanent change in their day-to-day activities and levels of stress. This is particularly true of those who are active in anti-nuclear groups; but, in addition, a small proportion of the general public continues to experience economic effects or has made definite plans to move or to change jobs. These represent significant personal effects.

While the most conspicuous effects of the accident have clearly been transitory, residents of the area recognize the potential for continuing effects as decisions are made with respect to the future of the generating facility. Their continuing vulnerability is a cause for both concern and resentment. The extent of their continuing anxiety will depend on their participation in the decision-making process, on their ability to understand the logic of the decisions that are made, and on the credibility of the decision-making bodies.

I. INTRODUCTION

1.1 Purpose and Scope of this Report

1.1.1 Purpose

In October 1978, Mountain West Research, Inc. was awarded a contract to study the social and economic consequences of the construction and operation of twelve nuclear generating stations. One of these stations was the Metropolitan Edison generating facility at Three Mile Island. Research at Three Mile Island began in January 1979 and resulted in the submission of a Preliminary Site Visit Report in February 1979 (York, 1979). This report provided an introduction to the characteristics of the site and the station as well as an overview of economic, demographic, and community impacts associated with construction and operation of the facility.

In the absence of the accident, the next phase of the study would have begun in June 1979 and would have culminated in a Case Study Report six months later. The accident substantially changed these plans. Immediately following the accident, the scope of work was expanded to include analysis of the social and economic consequences of the accident on the residents of southcentral Pennsylvania. It was clear that a reliable primary data base would be necessary to support this effort. This led to the NRC Telephone Survey of 1,500 households during late July (Flynn, 1979). Since that time, we have been involved with additional field work, coordination with other researchers, and analysis of existing data.

Our work at Three Mile Island will culminate in a two-volume Case Study Report that will be published during the summer of 1980. Volume I will describe the preconstruction, construction, and operating experience of the station through March 1979. Volume I will be based on the same methodology being used at the other eleven nuclear station sites and will be comparable to those Case Study Reports. Volume II will describe the emergency and the post-emergency periods covering the year from 28 March 1979 to 1 April 1980. Reference to the chronology shown in Table I-1 shows, therefore, that Volume I will deal with the thirteen-year period from late 1966 through March 1979 and that Volume II will cover the first full year following the accident.

TABLE I-1
THREE MILE ISLAND UNITS 1 AND 2
CHRONOLOGY

PRECONSTRUCTION PERIOD

November 1966: Public Announcement of Unit #1

February 1967: Public Announcement of Unit #2

CONSTRUCTION PERIOD

May 1968: Construction Permit for Unit #1 issued

November 1969: Construction Permit for Unit #2 issued

April 1974: Operating License for Unit #1 issued

OPERATING PERIOD

September 1974: Unit #1 Begins Commercial Operation

February 1978: Operating License for Unit #2 issued

December 1978: Unit #2 Begins Commercial Operation

17 February 1979: Unit #1 Shut Down for Refueling

EMERGENCY PERIOD

Wednesday, 28 March 1979, 4:00 a.m.: Feedwater pumps supplying Unit #2 shut down

Wednesday, 28 March 1979, 9:06 a.m.: Associated Press files first wire-service story on the accident

Thursday, 29 March 1979: News accounts indicate situation increasingly under control

Friday, 30 March 1979, 8:00 a.m.: Unannounced radiation release

Friday, 30 March 1979, 10:30 a.m.: Governor recommends that persons near TMI remain indoors and close their windows

Friday, 30 March 1979, 12:30 p.m.: Governor Thornburgh issues advisory that pregnant women and preschool children leave the region within a 5-mile radius of the plant and that all schools in the area be closed

Friday, 30 March 1979, 2:00 p.m.: Harold Denton arrives at the plant site

Saturday, 31 March 1979, 8:23 p.m.: AP reports story from NRC that hydrogen bubble could explode

Sunday, 1 April 1979, 1:00 p.m.: President Carter arrives at the plant site

TABLE I-1 -- Continued

Monday, 2 April 1979, morning: Denton announces decrease in size of bubble and implies danger of explosion is less than originally thought

Wednesday, 4 April 1979: Schools outside 5-mile radius reopen, but they remain closed within 5-mile radius, and the governor's advisory remains in effect

Saturday, 7 April 1979: Evacuation shelter at the Hershey Park Arena closed

Monday, 9 April 1979: Governor's advisory withdrawn

Wednesday, 11 April 1979: Middletown Area Schools reopen

POST EMERGENCY PERIOD

April 1979: EPICOR-I used to begin decontaminating water containing low levels of radioactivity stored in auxiliary building

June 1979: PA Public Utility Commission refuses to allow TMI-Unit #2 to be included in Met Ed rate base

August 1979: Petitions filed to intervene in federal hearings on start-up of TMI Unit #1 (hearings scheduled for February, 1980)

October 1979: EPICOR-II used to begin to decontaminate water containing intermediate levels of radioactivity

31 October 1979: President's Commission on the Accident at Three Mile Island releases report

It remains, however, that important policy decisions are being made at the present time to which the results of our research are relevant. This document is intended, therefore, as an interim report that explains what is presently known with respect to the response to, and consequences of, the accident at Three Mile Island. Some of the conclusions are necessarily tentative at this time, but they reflect the best information presently available.

1.1.2 Scope and Organization

This report is bounded in four important respects. First, it is primarily concerned with the six-month period following the accident. Table I-1 shows that this includes the two-week period following the accident, which we have designated the emergency period, and the five and one-half months continuing through the end of September 1979. The late September, early October breaking point seems to be a reasonable point of transition. Much of the focus during the first six months has

been on the accident and its immediate consequences. By October, however, the start-up of EPICOR-II, the release of the Kemeny Commission report, and increased focus on the Unit #1 restart hearing combined to shift emphasis away from the accident itself and toward the decisions that will have to be made with respect to the future of the facility and to the way in which these decisions will affect the local area.

Second, this report deals only with the local consequences of the accident. It is widely recognized that the accident has had pervasive implications nationally and internationally, but our attention here will be restricted to effects on the region that surrounds the station site.

Third, the types of data used to prepare this report vary depending on the topic. For the regional analyses, much of the data are available from secondary sources or statistics compiled since the accident by the State of Pennsylvania. Institutional analyses for the local areas nearest TMI (Middletown, Royaltown, Goldsboro, Lower Swatara Township, Londonderry Township, and Newberry Township) are based on interviews with local officials. Analysis of the behavior and effects on individuals are based on personal interviews and available surveys. (See the Appendix for descriptions of the surveys cited).

Finally, this report is limited to the range of considerations that typically fall within the purview of socioeconomic analysis. These include analysis of the responses by, and effects on, individuals, businesses, and public and private institutions.

The report is organized chronologically. The analysis begins by describing what is known about the behavioral response of individuals, businesses, and public and private institutions during the two-week emergency period. Based on an understanding of what happened during the emergency period, the analysis turns to consider the effects of events during the emergency period on local individuals, businesses, and institutions. Consideration is then given to effects experienced in the local area in the five and one-half months since the emergency period. The report concludes by considering potential longer-run implications of the accident.

The remainder of this introduction provides background information on the region around Three Mile Island and on the historical relationship of the nuclear station to the communities that surround it. It is important that the regional context be understood if the consequences of the accident are to be properly assessed.

1.2 Regional Context

1.2.1 Location and Jurisdictional Relationships

The Three Mile Island Nuclear Generating Station is located in southcentral Pennsylvania in southern Dauphin County. The plant is located on a long, narrow island in the Susquehanna River, approximately ten miles south and east of the City of Harrisburg, the capital of Pennsylvania. The closest towns on the east bank are Middletown and Royalton, while the closest town on the west bank is Goldsboro. As shown in Figure I-1, the plant's location in Londonderry Township in Dauphin County is immediately adjacent to the Lancaster County boundary to the southeast and the York County boundary to the southwest.¹

Figure I-1 gives an indication of the jurisdictional complexity of the area. The general administrative responsibility for local government resides in counties, cities, boroughs, and townships. Boroughs are geographically limited areas, which are no longer permitted to annex. They tend to be more heavily settled than the surrounding, rural townships. Because boroughs serve as local trade centers and, in some cases, employment centers, and because their tax base is limited to an allotted acreage, they share many of the problems of larger urban areas though on a much smaller scale. Most of the suburban-type growth is in the townships, which are able to meet increasing demands on resources with the revenues from the increased valuation of property. The boroughs, however, are limited in the amount and types of growth that are possible.

Due to the long history of settlement in the area, there are very large numbers of sub-county areas with complex, interwoven responsibilities. For example, Dauphin County has twenty-three townships, one city, and sixteen incorporated boroughs. Moreover, although the school districts were reorganized

¹Figure I-1 is included as a foldout map inside the back cover. It is placed in that position so that it can be left unfolded and referred to as the report is read.

and consolidated in the 1960s, there are still ten independent school districts within the county. It will be shown below that the jurisdictional decentralization and its associated highly dispersed settlement patterns are particularly salient characteristics of the area surrounding Three Mile Island.

Parts of seven counties lie within twenty miles of the plant site. These seven counties plus Franklin County make up Uniform Region 6, designated as the Capitol Region. The Capitol Region provides an appropriate frame of reference for describing the general economic and demographic characteristics of the area within which the accident at Three Mile Island occurred.

1.2.2 Economic/Demographic Characteristics of the Counties Surrounding Three Mile Island

The counties of the Capitol Region are unique in Pennsylvania for the growth they have enjoyed in comparison with the remainder of Pennsylvania. Table I-2 shows that percentage growth of the region was two and one-half times that of the state from 1950 to 1970; from 1970 to 1975, the Capitol Region grew 6.7 percent while the population of the state as a whole only increased 0.5 percent. The principal exception to the growth experience of the region as a whole is Dauphin County, whose population has stabilized since 1960.

TABLE I-2
CAPITOL REGION COUNTIES:
POPULATION TRENDS

| | Population | Percentage Change | |
|----------------|-------------|-------------------|-----------|
| | 1975 | 1950-1970 | 1970-1975 |
| Adams | 61,842 | 28.8 | 8.6 |
| Cumberland | 171,294 | 67.5 | 8.3 |
| Dauphin | 223,343 | 13.1 | -0.2 |
| Franklin | 105,372 | 32.8 | 4.5 |
| Lancaster | 342,797 | 36.4 | 7.1 |
| Lebanon | 122,309 | 22.0 | 22.7 |
| Perry | 31,972 | 15.5 | 11.7 |
| York | 285,667 | 34.5 | 4.8 |
| Capitol Region | 1,344,596 | 31.8 | 6.7 |
| Pennsylvania | 11,863,711 | 12.4 | 0.5 |
| United States | 213,032,000 | 34.3 | 4.8 |

Source: U.S. Bureau of the Census.

A conspicuous characteristic of the region is its dispersed settlement patterns. Figure I-2 shows the locations of the larger urban areas in the region. Table I-3 shows that in 1975, in a region with 1.3 million persons, only four places had populations in excess of 25,000 persons. In 1975, Harrisburg was the largest city with a population of 58,274, followed by Lancaster (56,669), York (48,587), and Lebanon (28,470). Since 1960, all four cities have been losing population to the suburban and rural areas that surround them. The population of the region in 1970 was 45 percent rural (compared to 28 percent for Pennsylvania), and there is every indication that this characteristic persists in the area. From Harrisburg, the greatest expansion has been to the west from the river toward Carlisle, but the areas in Dauphin County to the east and south of Harrisburg have also been growing rapidly. Construction of Highways I-83, I-81, I-283, and the "Airport Extension" has drastically cut the commuting time from Harrisburg to its immediate suburbs. Prior to these improvements, there was some commuting to Harrisburg from the municipalities nearest TMI, but, for the most part, these areas were either rural in character, with agriculture forming an important sector of the political economy, or local trade and manufacturing centers.

TABLE I-3
CAPITOL REGION
URBAN SIZE DISTRIBUTION: 1975

| Size Class | Number of Places |
|-----------------|------------------|
| 50,000 + | 2 |
| 25,000 - 50,000 | 2 |
| 10,000 - 25,000 | 7 |
| 5,000 - 10,000 | 14 |
| 2,500 - 5,000 | 18 |
| 1,000 - 2,500 | 42 |
| 1,000 | 37 |
| TOTAL | 122 |

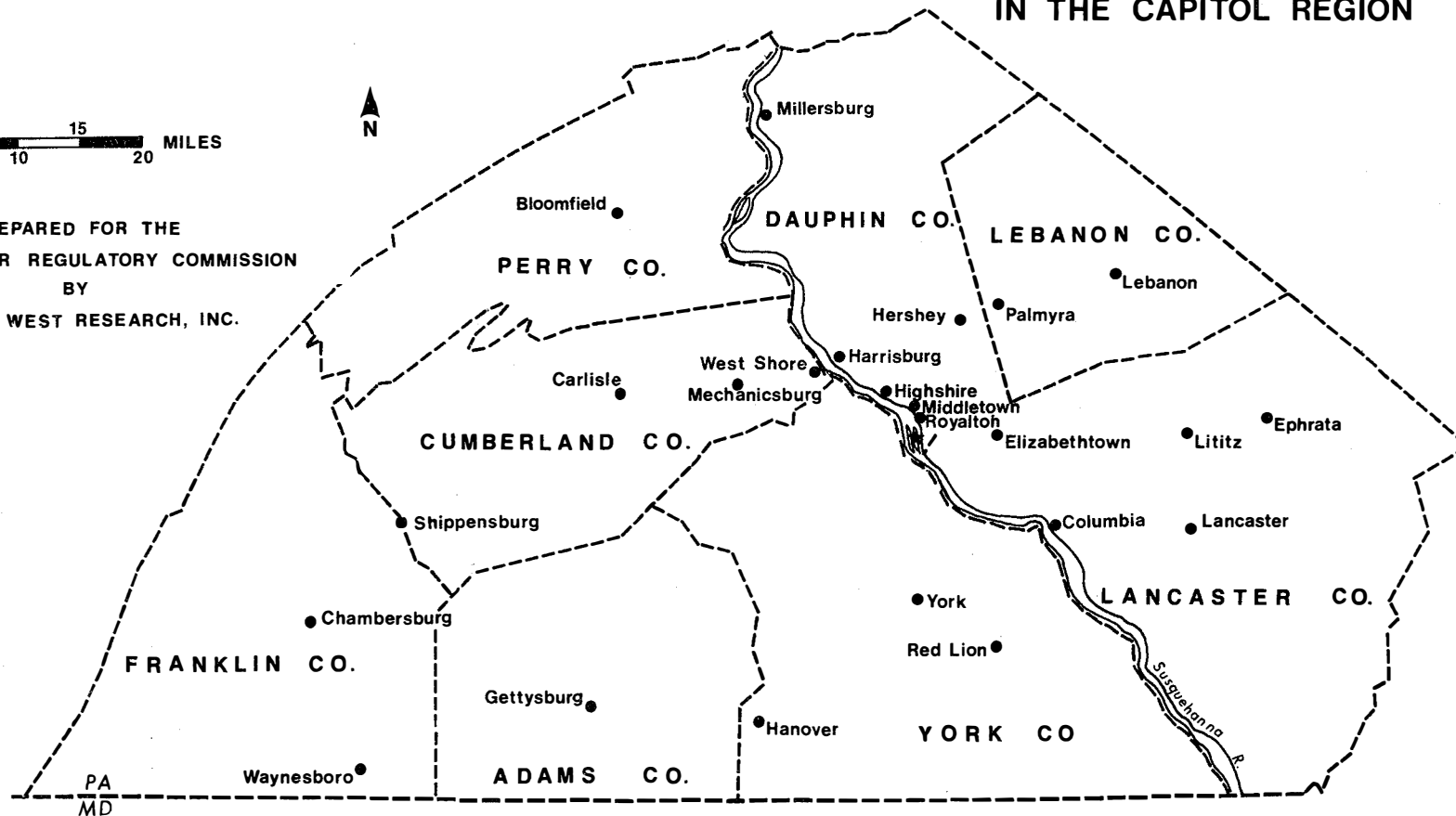
Source: Capitol Region Economic Development District, "Initial Overall Economic Development Program," (November, 1977), Harrisburg.

FIGURE I-2

PRINCIPAL URBAN CENTERS
IN THE CAPITOL REGION

1 0 4 8 15
2 2 6 10 20 MILES

PREPARED FOR THE
U.S. NUCLEAR REGULATORY COMMISSION
BY
MOUNTAIN WEST RESEARCH, INC.



In the townships, redistribution has been primarily to suburban housing developments with some of the growth occurring in mobile home parks. In the boroughs, the commuters tend to support the rental market. This is particularly true in Middletown, which has very low property taxes because of its other sources of income. Thus, it is less expensive to live in a modest one-bedroom apartment in a converted older house in Middletown and to commute to the state offices than it is to live in Harrisburg itself.

At the time of the emergency, estimates of the number of persons residing within five, ten, and twenty miles of TMI were prepared. It was recognized that the difficulty of implementing an evacuation order would depend on the number of persons covered by the order. The sizes of these populations continue to be important in attempts to assess the consequences of the accident. Unfortunately, because the distance rings cut across jurisdictional boundaries and because the 1975 special census is the latest source of reliable small-area population estimates, the problem of accurately establishing the population of the areas of interest is quite complicated.

Table I-4 shows estimates for different distance rings derived from the NRC Telephone Survey (Flynn, 1979), from the Department of Health Census (Pennsylvania Department of Health, 1979), and from the Pennsylvania Emergency Management Agency (Pennsylvania Emergency Management Agency, 1979). Unless noted otherwise, the population estimates used for the remainder of this report for the various distance rings around Three Mile Island are based on the NRC Telephone Survey.

The characteristics of the population of the region did not differ markedly from those of the state in 1970. The population is somewhat younger, has a higher percentage of whites (96.3 percent vs. 91.0 percent for Pennsylvania), and has slightly lower educational achievements than the state as a whole.

In summary, the area surrounding the Three Mile Island Nuclear Station has relatively high density (263 persons per square mile in 1975) combined with a highly dispersed settlement pattern. There are only four large cities, and even these have

TABLE I-4
POPULATION ESTIMATES FOR AREAS AT
DIFFERENT DISTANCES FROM THREE MILE ISLAND AT THE TIME OF THE ACCIDENT

| | Number of Households | | Population | | |
|-----------------|----------------------|-------------------------------|----------------------|-------------------------------|--------------------------------|
| | NRC Telephone Survey | PA Dept. of Health TMI Census | NRC Telephone Survey | PA Dept. of Health TMI Census | PA Emergency Management Agency |
| 0-5 Mile Ring | 11,927 ^a | 13,515 ^c | 35,000 ^d | 37,842 ^f | n.a. |
| 5-10 Mile Ring | 40,161 ^a | n.a. | 127,272 ^d | n.a. | n.a. |
| 10-15 Mile Ring | 72,262 ^a | n.a. | 209,375 ^d | n.a. | n.a. |
| 15-25 Mile Ring | 117,686 ^b | n.a. | 366,003 ^e | n.a. | n.a. |
| 0-20 Mile Ring | n.a. | n.a. | n.a. | n.a. | 635,973 ^g |

^aBased on households living in areas during late July and early August 1979. The estimates will systematically underestimate the population to the extent that households do not have phones. Nationally, six percent of households are estimated not to have phones.

^bBased on 1 July 1976 Census estimates for counties and subcounty areas in Pennsylvania. Derived by dividing total population estimates (366,003) by persons per household. The average persons per household is from the NRC Telephone Survey.

^cIncludes 147 households that have moved from the area since 28 March, 307 households that were temporarily absent at the time of the survey, and 70 households for which questionnaires are "missing."

^dSubject to the same systematic underestimate identified in footnote "a".

^eBased on 1 July 1976 Census estimates for counties and subcounty areas.

^fDerived by applying the persons-per-household estimate of 2.8 from completed questionnaires to the estimate of total occupied households (13,515) at the time of the accident.

^gEstimates prepared by the Pennsylvania Emergency Management Agency.

been steadily losing population to the large number of small communities and rural settlements that surround them. The population of the region as a whole has been expanding, however, which reflects the relative strength of the economic base of the region.

The economic base of the eight-county Capitol Region is notable for its diversity. Agriculture, manufacturing, recreation/tourism, and state/federal government have all contributed importantly to the strong economic performance of the region. Quantitatively, the manufacturing sector continues to be the dominant part of the economic base of the area, and, although it faces many of the problems faced by manufacturing throughout the northeast, it has recovered from the 1974-75 recession and seems to be stronger than the manufacturing sector in the state as a whole.²

Unemployment rates for the region have reflected the relative economic health of the area. Rates have consistently been lower than both state and national rates. The differential relative to Pennsylvania has usually been between 1.5 and 2 percent since 1970. Thus, a picture emerges of the economy of the area that is stronger than that of the state as a whole. Some of its older industrial facilities are becoming less competitive, but there is substantial diversification in manufacturing combined with strength in agriculture, in tourism, and in Harrisburg's role as a provider of governmental employment.

1.2.3 Historical Relationship of the Region to the Nuclear Generating Plant at Three Mile Island³

The late 1960s and early 1970s were a time of fundamental change in southern Dauphin County. The Department of Defense announced the closing of Olmsted Air Force Base on 19 November 1964. The base, which had been a principal part of the area's economy for almost fifty years (since its establishment in 1917), had provided more than 10,000 jobs to the local area (Merkle, p.c., 1979). The result of the closing of the base was a loss of confidence in Middletown's economy. By late 1966, there were 187 repossessed, vacant houses, as well as 450

²Regional manufacturing employment has risen from 13.3 percent of the Pennsylvania total in 1973 to 14.1 percent in 1976.

³Material in this section draws heavily on the Three Mile Island Preliminary Site Visit Report, which was prepared prior to the accident (York, 1979).

vacant dwelling units previously occupied by married enlisted military personnel. Homes that currently sell for about \$50,000 in Shopes Gardens, a suburban development, were available for \$11,500 with \$200 down. Row houses in Middletown were available for as little as \$3,500. In addition, many local residents who had traditionally been able to rent rooms to the weekly commuters from the state's economically depressed Wilkes-Barre coal-mining region, were deprived of this source of income. Many long-time residents of the area were faced with the prospect of either transferring to distant military installations to continue working or becoming unemployed in a locally depressed economy.

However, in the long run, the closing of the military base did not turn out to have the severely negative implications for the town that were first feared. The state, in cooperation with the Department of Defense, converted the air force base into an international airport to serve the Harrisburg region. The large repair and warehousing facilities that had been associated with the air force base were converted into an industrial park, which led to a diversification of the area's economic base. When the abandoned military enlisted housing was purchased by Middletown and redeveloped as a middle- and upper-income housing development, it added significantly to the town's tax base as well as to the community's retail trade base. The announcement that Pennsylvania State University would use one of the larger military facilities as its Capitol Campus served as an additional boost to the local economy.

A second major factor in reestablishing confidence in the local economy of southern Dauphin County was the announcement of construction of Unit 1 of TMI in November 1966. As indicated above, this announcement came at a time when the local economy was at a particularly traumatic juncture, and local sources indicate that the announcement symbolized the turning point in local economic fortunes. (Merkle, Sukle, p.c., 1979.)

The friendly relationship between the communities in the vicinity of Three Mile Island and Metropolitan Edison has other explanations as well. First, Three Mile Island had been owned by Metropolitan Edison and its predecessor companies for several decades; therefore, no land acquisition was necessary for the plant

itself. Second, the nuclear station was located in the same general vicinity as a coal- and oil-fired generating station that was the source of a great deal of air pollution, and the nuclear station was perceived as a way of ridding the town of this undesirable facility (Schneider, Bitner, p.c., 1979). In addition, the utility pursued a low-profile but, nevertheless, aggressive public relations policy. An observation center was built directly across the river from the plant site; tours of the plant site were given to local officials and other opinion leaders; existing summer-home cottages that had been leased from Metropolitan Edison were relocated to other islands on the river; and an extensive recreation complex was planned on Three Mile Island itself (Fabian, Schneider, p.c., 1979). Furthermore, the construction of TMI provided high-paying jobs, which served to mitigate the loss of Olmsted employment. The result was that the project had very limited local opposition prior to March 1979 (Herbein, Merkle, p.c., 1979).

The relationship between the construction work force and the community does not appear to have been much of an issue. When the former borough manager of Middletown was asked whether or not there had been conflict between the construction work force and the community, he replied, "No, never, none" (Merkle, p.c., 1979). This judgment was shared by other persons contacted in the community (Sukle, Graybill, p.c., 1979). In part, this may be attributed to the fact that much of the construction work force was local in origin. An additional factor may have been that the community was accustomed to a relatively high proportion of mobile people because of the high mobility of the military, which had long been an important part of the town. Third, a significant portion of the work force bought homes and brought their families to the area (Reid, p.c., 1979).

In general, the most significant impacts of the construction period were seen as entirely positive. Construction of the Three Mile Island facility injected basic economic activity into the local area at a time when the local economy sorely needed help. In addition to restoring confidence and providing badly needed demand for the local housing market, the project also helped to stabilize the enrollment of local schools (Sukle, Gross, p.c., 1979).

The first organized opposition to Three Mile Island appears to have formed in the summer of 1972. Citizens for a Safe Environment asked for a public hearing on

the issuance of an operating license for Unit 1. The group numbered about thirty members, with two or three from the immediate vicinity of Three Mile Island and most of the rest from Harrisburg proper. By April 1973, the Environmental Coalition for Nuclear Power (ECNP), a state-wide consortium of anti-nuclear groups, was also involved. In November 1973, both groups withdrew their opposition when the utility indicated that it would install additional filtering systems. Both groups mentioned lack of funds as an additional factor forcing them to discontinue their opposition.

Perhaps the most conspicuous issue regarding TMI prior to the accident was its location with respect to the Harrisburg International Airport. The end of the runway at the airport is approximately 2.3 miles from the plant site (AEC, 1972). Two concerns have been raised about this location: that the cooling towers and their vapor would interfere with the safe approach and takeoff of aircraft and that the risk of airplanes crashing into the generating station itself would increase the overall risk of nuclear accidents. As a result of these concerns, the reactor buildings were structurally strengthened by the utility. However, the risk associated with airplane crashes continued to be a subject of litigation between the interveners and the utility as late as 1978 (Intelligencer Journal, 12 December 1978).

A second major issue surrounding the plant has been the adequacy of security measures. This issue surfaced as early as June 1975 when Ralph Nader publicly charged that the security at Three Mile Island was so lax that sabotage was possible. (Harrisburg Evening News, 10 June 1975.) The question of security again arose in February 1976 when a disgruntled former employee was able to breach security at Three Mile Island and to successfully leave the plant without being apprehended by security guards (The Patriot, 20 February 1976 and Gross, p.c., 1979). The issue surfaced once more in July 1978 when a local political official's boat broke down near Three Mile Island. The official climbed the outer periphery fence of the plant site and tried to summon help from security guards. The fact that this person had a difficult time getting anyone on the island to pay any attention to his loud pleas for help cast doubt on the adequacy of the security enforced at the plant site (The Patriot, 19 July 1978).

A third major issue that has been raised has been the adequacy of evacuation plans. The major intervention groups in the area have repeatedly questioned the adequacy of such plans. However, the Civil Defense director for Dauphin County has repeatedly asserted the adequacy of such plans (York Daily Record, 11 April 1977). A number of other issues have been raised at one time or another in the station's history. Among these has been the adequacy of the emergency core cooling system, the health effects of low-level radiation emissions, structural deficiencies in the construction of the reactor buildings, and the creation of radioactive wastes with their long-term security implications (The Patriot, 24 September 1972). Prior to the flood associated with Hurricane Agnes in 1972, concerns were raised about the danger of flooding to the plant site. However, although some equipment stored on the island awaiting installation was damaged by the flood, flood waters from this unprecedentedly large flood did not reach the station site, and this appears to have allayed fears regarding this danger.

On the other hand, the majority of the public appears to have been unaware of any possible dangers from the plant. The general impressions derived with respect to pre-accident attitudes of area residents are reinforced by the results of the NRC Telephone Survey (Flynn, 1979).⁴ Approximately 75 percent of the population surveyed reported that, prior to the accident, they were either neutral or positive about the facility, and 62 percent of the population reported no concern about TMI emissions. Given the extent to which respondents had been sensitized by the accident, these are considered to be lower-bound estimates of pre-accident attitudes.

Respondents living within five miles of the plant site who had resided in the area since 1972 were asked additional questions about their recollection of adverse or positive consequences of plant construction. Approximately 80 percent of the 225 respondents that met the residence criterion reported that they remembered no

⁴It must be remembered that these questions on pre-accident attitudes from the telephone survey were answered after the accident occurred. It is quite likely that recollection of pre-accident attitudes were, to some unknown extent, affected by the accident.

adverse or negative effects associated with the construction period. Of the few negative effects mentioned, traffic and rowdiness of construction workers were most frequently noted. When asked if they remembered positive effects accruing to the area, more than two-thirds of the respondents mentioned that they thought there were beneficial effects on the local economy. (Flynn, 1979).

However, conversations with local residents on the west shore of the Susquehanna suggest that TMI had neither a positive nor a negative effect there prior to the accident. Both the real estate and the employment benefits were felt almost entirely on the east shore. At the time construction began, freeway linkages that are now heavily traveled were not in place, and much of the commuting from either the west shore or Harrisburg to TMI was over two-lane roads. Even today, although TMI and Goldsboro are less than two air miles apart, the commuting time is at least forty-five minutes. Thus, very few construction workers, and even fewer operating personnel, lived on the west shore (York, 1979). The result was that TMI was historically a far less salient issue on the west side of the river than on the east side. Although those in view of the island certainly knew a power station was being constructed, the construction had no known direct effects on west shore residents.

The picture that emerges, therefore, of the pre-accident relationship between the nuclear plant and the communities near which it is located is generally positive. There were a number of specific issues that had received public attention; but, in general, the plant had provided an economic stimulus at a time when it was needed, and area residents either recognized and appreciated these benefits or, for those residents on the west side of the river, were generally neutral about the plant.

One other general observation on the history of the area is important to understanding the consequences of, and reactions to, the accident. The residents of the communities in the immediate vicinity of the plant take pride in their ability to stand up to adversity (Wise, Bowman, p.c., 1979). The very earliest histories of Middletown remark on the toughness of the early Scotch-Irish and subsequent German immigrants. That these early settlers engaged in heroic struggles with the Indians and fearlessly signed petitions against colonial rule of the area is well-

known to area residents. The implied resiliency has become an even more important part of the regional personality in light of a succession of adverse events that have affected the area. The accident at Three Mile Island is simply the most recent of a sequence of hardships in which most residents would include the closing of Olmsted Air Force Base (mid 1960s), Hurricane Agnes (1972), and Hurricane Eloise (1975).

Hurricane Agnes had particularly severe effects, and many residents use it as a point of reference in describing the reaction to the accident at Three Mile Island. Harrisburg experienced record 24-hour rain falls in excess of 12 inches on 21 June 1972, and the Susquehanna crested at 16 feet above flood stage, 4 to 6 feet in excess of previous high water marks (Rahn, 1972). Total damages in Pennsylvania were estimated at \$2 billion, 50 persons died, and approximately 250,000 persons were driven from their homes. A total of 7 persons died in Dauphin and York Counties. Approximately 10,000 temporary living units were required. Public utility services were out in hardest hit areas for 2 to 3 weeks. A total of 142 school districts reported losses totaling \$40-50 million. These losses pertain to the state as a whole, but damage was concentrated along the Susquehanna, Juniata, and Schuylkill rivers in the southcentral portion of the state. The area near TMI was particularly hard hit: Royalton and Middletown lie at the confluence of Swatara Creek, which in many parts of the country would be called a river, and the Susquehanna. Both experienced extensive flooding. Goldsboro was entirely inundated. An entire shopping plaza in Lower Swatara Township was under several feet of water, and the sewage system was seriously damaged. Londonderry and Newberry townships also suffered extensive damage.

Again in 1975, the same areas were battered by a severe tropical storm. Hurricane Eloise followed a course nearly identical to that of Agnes, and it was reported that 20,000 persons were forced to flee their homes in central Pennsylvania (New York Times, 27 September 1975). Damage estimates for the state were \$85 million in lost farm crops and property and \$18.5 million in road damages.

Thus, it is significant that the accident at Three Mile Island happened in a region that was familiar with civil defense, with evacuation, and with the threats

posed by major natural disasters. This fact appears with specific reference to the plant at Three Mile Island in a newspaper article in April 1977. The article cites the contention of protestors that the evacuation plans for Three Mile Island were inadequate. It then quotes Mr. K. J. Molloy, director of Dauphin County Civil Defense, as saying that the plans were adequate. Molloy cited that fact that people in the area were accustomed to evacuating for floods as one reason that he felt the evacuation would not pose a problem (York Daily Record, 11 April 1977).

It is important to note, however, that these storms were not without their positive effects. Specifically, Agnes brought substantial amounts of federal aid into the towns of Middletown and Royalton, which allowed the people to upgrade their community facilities and led to the eventual removal of a substantial quantity of low-quality housing (Merkle, p.c., 1979). It is also important that in the face of these major natural disasters, local residents perceive that the experience had a unifying effect on the community. Local merchants who were flooded removed food and clothing to high ground and donated it to those in need. Volunteers throughout the area helped neighbors with clean-up efforts when the waters subsided.

II. EMERGENCY PERIOD BEHAVIOR

2.1 Introduction

The accident at Three Mile Island began at about 4:00 a.m. Wednesday, 28 March. The two-week period immediately following the accident was characterized by a gradual increase in concern on the part of officials and the general public through Monday, 2 April, followed by a gradual decrease in concern. Although the effects of the accident will continue to be felt in the area for some time, it seems appropriate to set apart the first two weeks for intensive study given the sense of urgency felt at that time.

In this chapter, we describe the immediate responses of individuals, businesses and industry, and institutions in the region surrounding Three Mile Island. The objective is to delineate the range of behavior observed and to indicate the prevalence of the reactions whenever possible.

2.2 Individual Response

Both the survey data and interviews with people living close to TMI indicate a substantial variation in the response of individuals to the accident. At the extremes, we find some who were virtually oblivious to the potential gravity of the situation and others who were traumatized.

Generally, the public appears not to have been alarmed on Wednesday, 28 March. This was due partly to the fact that many people were not aware that an accident had occurred until the evening. Exceptions to the general lack of early concern included those who had close friends or relatives working at Three Mile Island. Since those reporting for the 7:00 a.m. shift were not allowed on the island, some indication of the seriousness of the accident was apparent to these people. The NRC survey shows that some evacuation occurred as early as Wednesday, but this was unusual.

By Thursday, media reports indicated that the situation at TMI was under control, and the public seems to have been reassured. Ron Drake, a local radio personality for over twenty years, joked about the accident in his Thursday morning show (Wise, p.c., 1979). Again, a few people evacuated on Thursday, but the public generally remained calm (Flynn, 1979).

By Friday, 30 March, individuals began to react to the developments in vastly different ways. Those who appear to have been less affected continued in their normal activities. A Friday night card party at the Elks Club in Middletown was not cancelled, and other social activities later that night also continued, even though a curfew was in effect after 9:00 p.m. (Coble, p.c., 1979). Individuals who were less affected did not stay indoors or shut their windows; they shopped and went about their business as usual over the weekend. It did not occur to them to evacuate, and few of their friends evacuated. Some report being astonished to learn later how many had evacuated. Although by the weekend they were aware of a problem at TMI, the problem did not carry personal significance for them.

Others in the area did not evacuate but seemed to be more aware of the possibility of the necessity for evacuating. In some cases, women and children were evacuated so that their safety would be insured and so that those men with official responsibilities would not have to be concerned about them if a general evacuation were ordered. Individuals in this group who remained behind usually made preparations for leaving, such as filling the gas tank and packing, but never did evacuate.

The NRC survey showed that households in which some people evacuated and some did not were very sensitive to the danger of the situation (86 percent reported that the situation seemed dangerous). The primary reasons given for some persons remaining behind were that they were unable to leave their jobs or that they would have left only had they received an evacuation order. Many (45 percent) felt that whatever happened was in God's hands, and a third were concerned about looters. (Flynn, 1979).

The households where no one evacuated exhibit a quite different pattern. The overriding reason given for staying was that they were waiting for an evacuation order; this reason was followed by the feeling that whatever happened was in God's hands. The third reason for staying was that they saw no danger; this was mentioned two and a half times as frequently by households in which no one evacuated, as compared to households where some members evacuated and others did not. Together, these three reasons suggest greater confidence in authority in

the households where everyone stayed. Although the desire to remain for their jobs was something of a consideration for this group, it was not the overriding concern that it was for nonevacuees in households in which some persons evacuated.

Among those who did evacuate, there is variation in the response. It is clear from individual descriptions of behavior during the first days of the accident that the decision to evacuate was perceived as requiring individual choices. Individuals were left with the responsibility for deciding who would evacuate and when, where, and how they would evacuate. In some ways, the decision was more stressful for individuals whose children were in the elementary grades (but not preschool) or who lived just beyond the recommended five-mile limit because these individuals had more of the responsibility for the decisions themselves. The decision about whether or how to evacuate appears to have been particularly difficult for housewives who were at home alone, separated from their children at school, and were unable to reach their husbands because of jammed telephone lines. One resident, perhaps speaking for many who evacuated, reported:

On Friday a very frightening thing occurred in our area. A state policeman went door-to-door telling residents to stay indoors, close all windows, and turn all air conditioners off. I was alone, as were many other homemakers, and my thoughts were focused on how long I would remain a prisoner in my own home and whether my husband would be able to come home after teaching school that day.

Suddenly, I was scared, real scared. I decided to get out of there while I could. I ran to the car not knowing if I should breathe the air or not, and I threw the suitcases in the trunk and was on my way within one hour. If anything dreadful happened, I thought that I'd at least be with my girls. Although it was very hot in the car, I didn't trust myself to turn the air conditioners on. It felt good as my tense muscles relaxed the farther I drove. (Smith, Trinity Parish newsletter, 1979.)

Decisions had to be made about which, if any, of the normal day-to-day responsibilities would be met. For instance, one informant baked, decorated, and delivered a promised cake for a birthday party for Saturday on her way out of town.

In a few households, the absence of a clear order for everyone to evacuate resulted in disagreement over whether to evacuate. About 12 percent of the respondents in the NRC survey said that members of their families disagreed somewhat or strongly over the decision. Most of these families did not, in fact, evacuate; given the general level of tension in the area, the family members who favored evacuation were undoubtedly upset.

Considering the limited nature of the governor's advisory, the extent of the evacuation was substantial. The advisory was just that; it was not an order to evacuate. Further, it only applied to pregnant women and preschool children within 5 miles of the station. Less than 6 percent of the NRC sample had family members who fell under these criteria specified by the governor. However, the surveys by the NRC and by the Pennsylvania Department of Health both indicate that 60 percent of those within 5 miles of TMI evacuated; this amounts to approximately 21,000 persons. In the 5-10 mile ring, 56,000 persons (44 percent) evacuated. In the 10-15 mile ring, which contains most of the Harrisburg SMSA, 67,000 persons (32 percent) evacuated. Thus, within 15 miles of TMI, it appears that a total of 144,000 persons, or about 39 percent of the total population living within 15 miles of the station, evacuated. Other estimates of the extent of the evacuation are summarized in Table II-L. Given the differences in target population and methodology, one would not expect these estimates to be identical. Taking into account those differences, however, these data suggest that well over half of the population left from within the 5 mile area, and about a third left from the 5-15 mile area. These data imply that a significant number of persons made individual decisions to evacuate although they had not been formally advised nor ordered to do so. Figure II-1 shows the distribution of evacuation by both distance and direction from the plant as estimated in the NRC survey.

TABLE II 1
PERCENT OF POPULATION EVACUATING BY VARIOUS DISTANCES FROM TMI

| Survey | 0-5 Miles | Distance from TMI | | Total |
|-----------------------------------|-----------------|-------------------|-------------|-------|
| | | 5-10 Miles | 10-15 Miles | |
| NRC | 60 | 44 | 32 | 39 |
| Pennsylvania Department of Health | 60 | | | |
| Smith | 50 | | | |
| Kraybill | | | | 42 |
| Rutgers | 33 (0-10 miles) | | | |
| Goldsteen | | | | 52 |
| Brunn | 55 | 54 | 28 | |

Source: These surveys are identified in more detail and their procedures briefly described in the Appendix.

FIGURE II-1

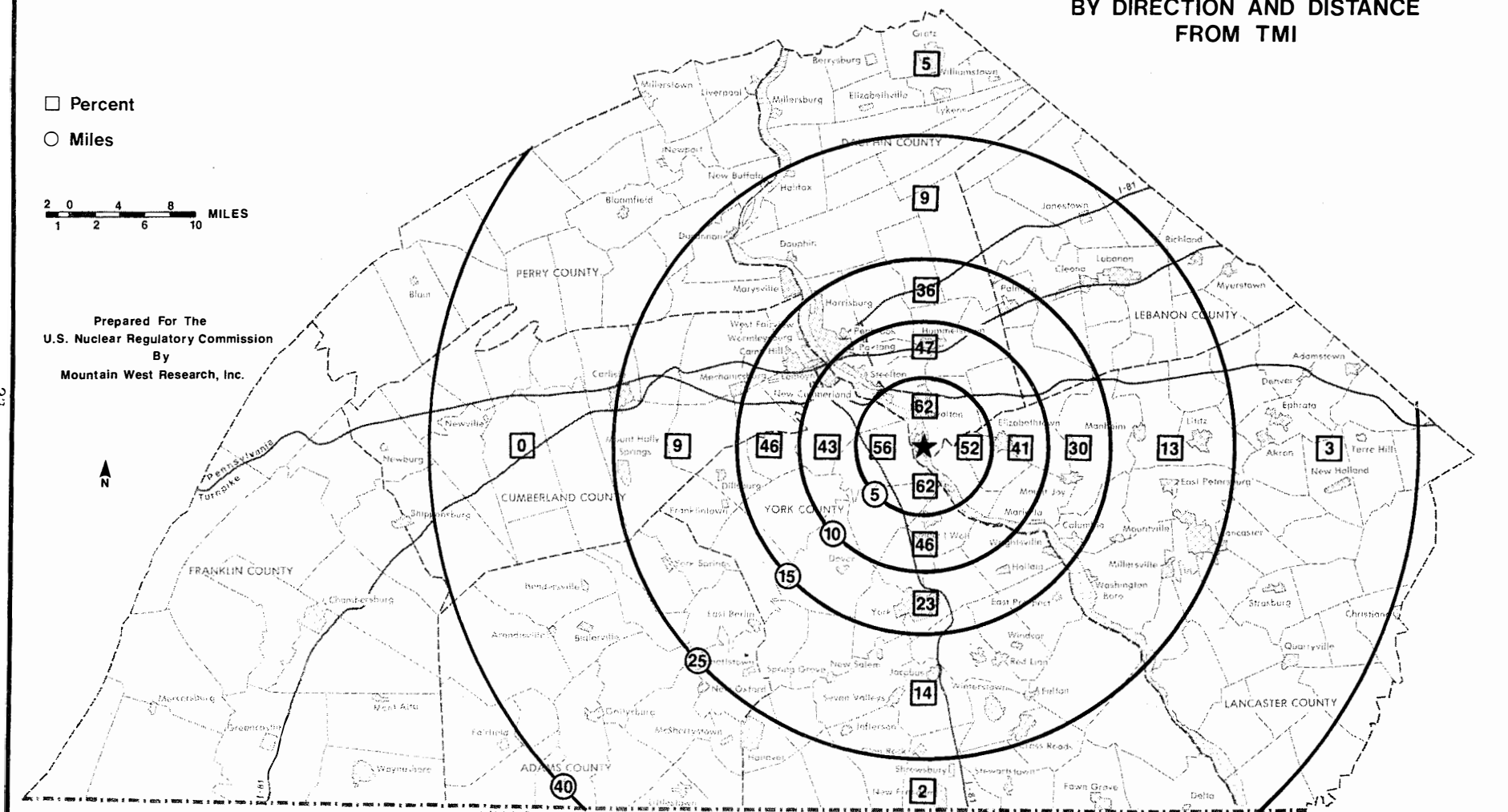
PERCENT OF PERSONS WHO EVACUATED
BY DIRECTION AND DISTANCE
FROM TMI

□ Percent

○ Miles

2 0 4 8
1 2 6 10 MILES

Prepared For The
U.S. Nuclear Regulatory Commission
By
Mountain West Research, Inc.



Since the majority of persons who evacuated were not doing so because of the governor's order, why did they decide to leave? The main reason given in four surveys (NRC, Pennsylvania Department of Health, Kraybill, Smith) was that the situation seemed dangerous. In personal interviews, evacuees said they were frightened by the reports they received (Lesniak, Light, Kinney, p.c., 1979). Another major reason for evacuating was the confusing information about the situation. Many assumed it was better to be safe than sorry, and in the absence of conclusive reassurance of the plant's safety, many chose to evacuate. A related reason for voluntarily evacuating was the desire to avoid the danger or confusion of a forced evacuation.

The surveys showed that some types of people were more likely than others to evacuate. The NRC survey showed that females were more likely than males to evacuate. Two-thirds of the children aged five and under were evacuated, and it appears that 90 percent of the pregnant women evacuated. In the NRC study, no systematic relationship was found between income, education, and occupation and evacuation behavior. However, according to the Kraybill study, the more highly educated were more likely to have evacuated. Both of the surveys and the personal interviews indicated that older persons were less likely to have evacuated. In part, this was because they were less likely to be included, directly or indirectly, in the governor's advisory.

The greatest number of those who did evacuate left on Friday, 30 March. Estimates of the percentage who left on Friday range from 55 percent (Rutgers, Flynn, 1979), to 72 percent (Smith, 1979). It appears that most of the people who left then had not considered doing so prior to Friday. Although a few households stayed in motels and hotels, the overwhelming majority of the evacuees stayed with friends and relatives (estimates range from 74 percent to 90 percent). Because most people decided to leave on such short notice, their friends and relatives had not expected a visit. In some cases, facilities were less than ideal for unexpectedly accommodating entire families -- complete with pets. Most of the evacuees went to friends and relatives in Pennsylvania (67 percent, Rutgers; 72 percent, Flynn); for those who evacuated a significant distance within the state, the most likely destinations were in and near Shamokin, Altoona, or Pittsburgh.

The NRC study included only one respondent who went to the evacuation center at Hershey. It appears that the maximum number of people at Hershey in one day was about 180, and that a total of as many as 800 may have stayed there for a short time. On at least one occasion, there were more reporters than evacuees at the center. Although their parents were undoubtedly concerned about the accident, the children at the Hershey evacuation center were entertained by clowns, given coloring books, and taken to the zoo. Generally, persons in the center remained calm (Serff, p.c., 1979).

By the middle of the week following the accident, the perception of danger was considerably lessened. The median date of return to the area was Wednesday, 4 April. However, the governor's advisory to pregnant women and preschool children was not lifted until 9 April, and schools within 5 miles of TMI did not open until the 11th. There was considerable variation in the amount of time spent out of the area, but there has been no systematic study of the decision-making process for returning to the area. Local informants cited the need to return to their jobs and a perception that the situation was under control as reasons for returning (Sides, Kelley, p.c., 1979).

During the two-week emergency period, the activities of at least half of the people in the area were disrupted (Flynn, 1979). During the week following 30 March, curfews were in effect over much of the area, and evening meetings were cancelled. Schools were closed, many of the children had evacuated, and, therefore, daytime activities involving children were cancelled as well. The main changes in day-to-day activities mentioned by NRC respondents were staying indoors, cancelling plans, being on edge, and getting ready to leave. Other frequently mentioned responses were that someone was out of work, children were home from school, extra time was spent listening to the news, or they worked more than usual.

2.3 Business Response

As would be expected given the substantial evacuation that took place on Friday and Saturday, 30 and 31 March, businesses in the vicinity of Three Mile Island faced a dual problem--a loss of customers and a loss of labor force. Nevertheless, most businesses kept operating throughout the emergency period and reported that by Thursday or Friday (5 and 6 April) their situations had returned to near normal.

A large grocer in Middletown told the following story, which is indicative of more seriously affected businesses. Business was slow (about 75 percent of normal) on Thursday following the accident, but on Friday it dropped off to only 30 percent of normal. The store remained open, but during the course of the day, 60 of the store's 80 employees went home. On Friday evening only 4 employees out of a usual night shift of 15 showed up. On Saturday the store remained open despite the fact that only 20-25 of the normal crew of 70 was on hand. Business on Saturday was estimated at about 40 percent of normal. The store closed as usual on Sunday and then opened on Monday with only 25 percent of its workers present. The grocer reported that the situation remained much the same on Tuesday and that business was only 20 percent of usual. On Wednesday the situation changed markedly. Many employees were back, and business was about 80 percent of usual. The situation continued to improve until Saturday, when business was reported back to normal, and all but 3 or 4 employees had returned. (Fox, p.c., 1979).

The Freuhauf Corporation was a conspicuous exception to the pattern of trying to remain open. The plant is located on the western edge of Middletown about three miles directly north of Three Mile Island. The plant was in full operation on Friday morning, 30 March, but by midday so many calls had been received and so many rumors were circulating that employees were advised that they could go home if they wished. Approximately 50 percent of the first shift exercised the option to leave, and only about 20 of 300 workers showed up for the second shift. The plant closed as usual over the weekend, and then remained closed through Wednesday, 4 April. The plant reopened on Thursday, and conditions were reported as being close to normal. Hourly employees were not paid for hours not worked during the emergency period; however, because Freuhauf was effectively shut down, the workers were eligible for unemployment compensation provided they remained in the area. (Miller, p.c., 1979).

Much more common among large firms in the area was that they remained open and attempted to maintain regular production despite substantial absenteeism over the period Friday through Wednesday. Treatment of employees was highly variable. Evacuation does not seem to have been encouraged by employers, but individual decisions to leave seem not to have been resisted. Three basic patterns of compensation policy appear to have been used by firms. Some firms did not pay

any employees who missed work, other firms compensated workers who fell within the definition of the governor's advisory, but did not pay any other workers, and a third group of firms compensated all of their employees who evacuated. The most prevalent policy appears to have been the first--no work, no pay. This was often rationalized by the observation that workers within the definition of the governor's advisory were eligible for insurance compensation. If other workers wished to leave, that was fine, but the businesses could not afford to subsidize their evacuation.

The business-interruption claims filed with the Nuclear Insurers¹ support the interpretation that extraordinary costs (i.e., wages paid to absent workers) were not commonly incurred. The claims data show that more than three-quarters of the claims are for loss of sales. In addition to foregone sales, there are a few claims for interruption or loss of production and some for extraordinary expenses in preparation for evacuation or in product testing. (Pennsylvania Insurance Department, 1979.)

In addition to coping with high absenteeism and, in many cases, low sales, many firms had to contend with two more problems--evacuation preparations and product (or input) protection. The possibility of a complete evacuation raised a difficult proposition for many of the area's large industrial facilities. Some of these industries have production processes that can neither be easily shut down nor be left unattended. The result, in the event of a forced evacuation, would have been damaged equipment and loss of goods-in-process. Contingency evacuation plans were worked out by some firms, but the shutdown times would have been relatively long (up to six or eight hours), and losses would have been large.

Another set of businesses that faced severe evacuation problems were those with livestock. On a recent television documentary, an area resident is reported saying:

"It is very difficult to walk away from seventy-five head of cattle and five goats and seven ducks and thirty cats and two dogs and leave these animals at the mercy of whatever. We couldn't bring ourselves to shoot them, and we couldn't bring ourselves to leave them, and we just didn't know what to do."
(WITF-TV, 1979.)

¹Nuclear Insurers is the title used to refer to the pool of 253 companies that carry the property and liability coverage at Three Mile Island.

A second activity occupying the attention of many local businesses was testing their ingredients and their output to insure that there was no radioactive contamination of their product. The agricultural and food-processing industries were under particular pressure to be able to certify the purity of their products. This required extensive testing and special handling of suspect materials. The dairy industry, particularly important in Lancaster County, came under the heaviest scrutiny.

The banking sector played a particularly important role in responding to the emergency. There were large demands for cash for the purpose of evacuation and in anticipation of possible evacuation. The situation was particularly dramatic in Middletown. The Commonwealth National Bank holds the deposits of a large proportion of the town's residents. According to a spokesperson of the bank, by Saturday about 500 of its depositors had withdrawn enough to last them for a 4-5 day evacuation. The banking community recognized their necessary role in facilitating the plans of residents to evacuate. As a result, most banks reported little or no absenteeism among their employees, and many remained open longer hours than usual. (Ulsh, p.c., 1979).

2.4 Institutional Response

2.4.1 Emergency Preparedness Agencies

Introduction. The accident at Three Mile Island strained existing emergency plans at all levels of government. Provisions at the federal level for interagency coordination in the event of an emergency were not effective in dealing with the accident at TMI. For instance, ad hoc communication strategies had to be devised during the emergency period. Also, federal agencies felt the necessity to assume responsibilities not specified in the existing plans, such as whether to recommend the administration of potassium iodide to the general public. Finally, responsibility for radiological monitoring and disaster assistance were the subject of "turf" disputes. (Human Sciences Research, 1979; Gorinson and Kane, 1979).

The State of Pennsylvania was also hampered in the early days of the crisis by inadequate communication networks. It was difficult to transmit information between state agencies, from the site to the state, from the state to the NRC, and from the state to county officials.

It appears from existing evidence that the county directors of emergency management were less plagued by interinstitutional frictions and communication problems than were other levels of government. There was no ambiguity at the county level about what agencies should assume particular functions. Vertical communications in both directions were limited mainly by difficulties above and below the county level, although there were cases of intercounty friction.

In order to understand the response of local agencies to the accident, it is necessary to understand the institutional context in which it occurred. Two aspects of the context are especially relevant. First, evacuation plans in existence prior to the accident were inadequate for dealing with the specific necessities occasioned by the accident. An emergency response plan had existed for the five-mile area around TMI for more than two years and had been updated in April 1978. In the case of Dauphin County, this plan is described by Human Sciences Research as follows:

Dauphin County's 5-mile plan was basically a policy and reference document. It contained lists of possible resource suppliers (bus companies, ambulance services, etc.), phone listings for people and agencies to be contacted in case of an accident at TMI, and policy/guidance statements. It did not contain listings of evacuation routes, mass care centers beyond the 5-mile ring, or any of several other specific topics that would receive detailed attention in the plans produced during the TMI emergency. This brief county plan was descriptive rather than prescriptive, more a planning document than a working plan. Unlike the plan produced after 30 March, it was not written in response to a clearly stated threat. It was, however, an attempt to anticipate the requirements of a situation which had never occurred.

As a result, during the accident, emergency personnel at all levels were operating in three modes simultaneously:

First and foremost, they were developing a detailed evacuation plan, virtually from scratch. Secondly, they were in a standby or pre-operational mode--conceivably, the order to execute an evacuation could have replaced further development of the plan at any stage. Finally, they were in a crisis-response mode--responding, for example, to phone calls and inquiries from people who viewed the existing situation as a crisis and the EOC as the appropriate management focus for that crisis. (Human Sciences Research, 1979.)

The second aspect of the context that is particularly relevant is the extreme complexity of the jurisdictional responsibilities in this area. Dauphin County, for

instance, includes some forty municipalities (cities, boroughs, and townships), and York County includes seventy-two. Each of the municipalities, in turn, has at least four subsystems that had responsibility for public safety during the emergency.

1. Director of Civil Defense. Each local municipality can propose the name of a resident to serve as the Civil Defense liaison. The name is approved by the governor, then forwarded to the state and relevant county directors of Civil Defense. In time of emergency, the notification procedure in Pennsylvania is a "top-down" one; therefore, in order for local areas to be notified, they must have an approved liaison on file with the governor, state director of Emergency Preparedness, and county Civil Defense. There is no explicit procedure in this system for notifying mayors, township supervisors, or presidents of councils in the event of an emergency. All such persons interviewed either heard about the accident from friends or relatives, or from television and radio. Most were upset that they had not been notified officially and in a timely manner. This was especially true for mayors, who are charged with protecting the public's safety.

2. Mayor. The main duties of the borough mayors are to serve as the ceremonial head of the borough, to preserve order, to enforce borough ordinances and regulations, and to remove nuisances. The mayor also serves as the main contact for the general public with the local government. Thus, complaints and problems are typically funneled through the mayor.

Because the mayor has responsibility for preserving order and protecting the public, he has control of the police department, if there is one. Although the mayor has direct authority for the police department, the borough council has responsibility for the police budget, for the appointment of police officers, and for the determination of the weekly hours of employment of the officers. In townships with police departments, the police chief reports to the township manager, much as he does to the mayor in a borough, and the township supervisors function as the borough council does.

3. Police and Fire Protection. Only half of the municipalities in the area have a police force. Municipalities without a police force depend on the state patrol for protection. Allocation of state resources is normally handled through either county or subcounty communications centers, which handle the disposition of all emergency personnel--police, fire, ambulance, and rescue squads.

4. Education. School superintendents of the districts have responsibility for the management of the district and its resources, in particular, its school buses. Since buses played such an important role in the emergency planning, school superintendents were potentially significant actors for planning purposes. School districts in the area were consolidated during the late 1950s. For the most part, they were consolidated along municipality lines, but Newberry township is divided between the West Shore School District and the Northeastern (Manchester) School District.

Emergency Response. Although an emergency was not formally declared by the governor, information that there had been an accident proceeded through the pre-specified Civil Defense channels: that is, from Metropolitan Edison to the Pennsylvania Emergency Preparedness Agency, from there to other state and federal agencies and to the county directors, and, finally, to the municipalities' designated coordinators.

In some municipalities, this notification procedure caused difficulties. First, some municipalities had no designated Civil Defense coordinator or had selected one, but had not submitted his name for formal approval by the Governor. Those municipalities without a coordinator on the governor's list (e.g. Royaltown) were never formally notified of the accident to the best of our knowledge. Second, because no formal emergency was declared by the governor, the normal municipal body charged with public safety remained legally in charge, rather than the Civil Defense coordinator. Generally, this was the mayor or the township supervisor. Local officials state that because no formal emergency was declared, the Civil Defense coordinator had no legal authority to make decisions; but, in fact, all the emergency preparedness measures were being coordinated through the Civil Defense coordinators of the various municipalities. Civil Defense coordinators had to prepare as if an emergency had been declared, when in fact it had not. Although they were technically in charge, most mayors and supervisors received information on the status of the plant only second hand from their Civil Defense coordinators or via the daily briefings and the news media. For officials on the West Shore, this was a particular problem since both the news briefings and the briefings for public officials were held in Middletown, some forty minutes (one way) away. Many of

these municipalities do not have a single entity responsible for public safety even under ordinary circumstances; the de facto role of the Civil Defense directors, despite the fact that no emergency was declared, further complicated a complex division of responsibility.

This ambiguity demonstrates one unique facet of the response to a radiological emergency as opposed to responses to other types of emergencies. Normally, there is a planning stage during which the implications of a proposed emergency are thought through and addressed in the plan. The plan is then held in readiness and periodically updated until it is required for a specific emergency. Given the paucity of detailed plans to cover a radiological accident, a large part of the activity that occurred during the emergency period involved developing plans which, in principle, could have been developed far in advance. When the emergency is declared by the appropriate authorities, the Civil Defense network assumes responsibility for protecting the public, and the plan is implemented.

In the case of the TMI accident, however, there was a third stage, which has variously been referred to as the alert stage, the pre-operations stage, or the stand-by stage. In this stage, local authorities were spending time mobilizing resources so that they would be better prepared to evacuate quickly. Given that radiological emergencies can develop slowly, can develop in such a way that it is not clear if or when an emergency will actually be declared, and can require very complex coordination in order to protect the public, it is prudent and appropriate to include this additional pre-operations stage explicitly into the planning process. However, in order for the appropriate actors to function efficiently during the pre-operations stage, there would need to be a clear delineation of the responsibility and authority of each person with authority to protect the public. If the authority during the pre-operations stage is to be the Civil Defense network, there must be a mechanism for transferring authority from local officials to the network in the absence of a declared emergency. At the time of the TMI accident, such a mechanism did not exist. (Human Sciences Research, 1979.)

Some municipalities responded by assembling all parties with any responsibility for public safety in one physical location, and all worked together and made decisions jointly. In one case, the police chief, the fire chief, the manager, the chief elected official, and the Civil Defense coordinator worked together almost

continuously for several days. In other municipalities, there were varying amounts of friction. These ranged from minor coordination problems to very heated arguments in which the participants were close to blows and an elected official was threatened with arrest.

Responsibilities of Public Officials. All of the municipalities formally organized their emergency operations centers (EOC's) and response teams on Friday, 30 March. In some cases, police and fire personnel were on standby earlier, but it was not until Friday that emergency personnel went on duty around the clock. Those in charge had responsibility for making several types of decisions. These included:

1. Preparing an evacuation plan for the entire municipality, should that become necessary. As one task in preparing this plan, most municipalities lined up school buses to evacuate those without their own transportation, particularly the sick and the elderly. Technically, the superintendent of each school district is responsible for the school buses owned by the district; in the event that several municipalities within one district request buses, the superintendent has to cope with an equity question. In at least one case, the friction between the school superintendent and another responsible official over the handling of the buses became quite heated and continues to be a source of conflict.

2. Once a plan was prepared, residents had to be notified. Generally, one-sheet flyers were mimeographed (about Sunday) and distributed by firefighters. In some cases, sirens were sounded and information was given over loudspeakers; in others, firefighters went door-to-door to every house in the municipality without flyers or sirens and informed people what to do.

3. At least two municipalities issued their own advisories for all elderly and disabled people to evacuate. All such people were asked to leave the area and stay with friends or relatives, if possible.

4. Detailed plans for coordinating with other agencies in the event of an evacuation, looting, or any other serious development had to be made. These plans included coordination with other municipalities, county officials, state emergency personnel, the State Police, the National Guard, and helicopter crews.

In these respects, the municipalities responded much as they would have in any emergency, except for the complexities noted. Where there were not problems concerning who was in charge, tasks appear to have been performed fairly smoothly, especially considering that no municipality had a prior evacuation plan. One difficulty that was experienced, however, points to a general problem in formulating emergency response plans for a nuclear accident. Originally, the Civil Defense directors were informed that it might become necessary to evacuate the five-mile radius. Municipal authorities within the radius planned accordingly in designating evacuation routes and destinations, and in lining up school buses. When it was later announced that a precautionary evacuation might be required for a much larger area, municipalities within the five-mile radius "lost" many of "their" buses and had to begin again on their plans. The point is that unlike other accidents, nuclear accidents may require multiple contingency plans, each of which is quite complex, depending on the seriousness of the threat at any particular time.

At the county level, an initial effort was made to expand the 5-mile evacuation plan to a 10-mile plan and then to a 20-mile plan. This strategy was abandoned, however, when the logistical difficulties of having multiple plans became evident, and thereafter effort was concentrated on developing a 20-mile plan that could be scaled down if necessary. The 20-mile radius, of course, included considerably more people than either the 2-mile low population zone (LPZ) utilized in NRC siting criteria for TMI or the 5-mile area designated in the relevant county emergency plans, and required much more coordination.

In addition to the public agencies that had direct responsibility for dealing with the emergency, Hershey Park, approximately 10 miles from TMI, became involved on Friday, 30 March (Serff, p.c., 1979). The Derry township police called shortly after 9:00 a.m. to request that the sports arena be designated an evacuation center. Although the arena had been designated a fallout shelter in the 1950s, explicit plans had never been made for it to receive evacuees, and it had not been needed during other emergencies in the area, such as floods. Therefore, plans had to be formulated very quickly; the manager was informed that as many as 14,000 persons might arrive.

Preparations were completed by 11:00 a.m. Later in the day, the army base at Indiantown Gap brought cots and blankets. A press room was set up in

conjunction with a communications center. Arrangements were made with the Hershey Motor Lodge and the local cable TV station to set up several TV's in the arena, both to entertain the children and to provide a source of information about the plant. Other entertainment for the children was arranged, including magicians, tours of the zoo and Chocolate World, coloring books, balloons, and clowns. (Serff, p.c., 1979.)

Evacuees began to arrive on Friday afternoon. For the most part, they stayed only a day or two until they could arrange for other housing with friends or relatives. After it became known the next week that the Nuclear Insurers were making cash payments to persons meeting the definition of the governor's advisory who had evacuated, there was a substantial decrease in the number of persons at the center.

An evacuation plan for the center was developed by Sunday morning. The number of persons at the center who lacked private transportation was estimated, and two school buses were obtained to transport them. The evacuation route for the center was obtained from the county Civil Defense office. It was estimated that everyone could be removed from the evacuation center within fifteen to thirty minutes. If an additional half hour were available, it would have been possible to move the entire shelter, including food and equipment, into the tractor-trailers standing by for that purpose.

Simultaneously, evacuation plans for Herco, the business, were being developed. The management of Hershey Park had not previously prepared a systematic plan for completely leaving the area. Decisions were made about which records and equipment would be removed, how they would be transported, and who would transport them. A systematic plan for securing the rest of the premises was also developed, with responsibilities assigned to particular individuals. By late Saturday, such an emergency plan for shutting down the business was complete.

2.4.2 Local Government Response

The Borough of Middletown was in a somewhat unique position during the emergency, although other municipalities had similar problems to a lesser extent. Middletown not only buys electricity at a fixed rate from Metropolitan Edison (1¢/kwh) for resale to the public, it actually runs its own electric department, with line crews, installation and inspection personnel, and so forth. Similarly, the borough provides water and sewage treatment both for the borough and for surrounding municipalities. In all, Middletown has some seventy paid employees.

During the emergency period, at least three types of evacuation were mentioned as possibilities:

1. A voluntary evacuation of individuals or households, either upon the recommendation of the governor or as a result of an individual decision;
2. A precautionary general evacuation, in which everyone would be asked to leave for a short period of time while the plant was being brought to a more stable condition; or
3. An emergency general evacuation, in which everyone would be asked to leave as quickly as possible to avoid an imminent threat.

From an organizational point of view, neither the first nor the third possibility posed a problem. If the evacuation were purely voluntary, adequate crews were available to staff the utilities. Under type three, presumably everyone would leave, and if and when they were allowed to return, any problem with the utilities would be handled at that time.

However, evacuation of the second type did pose an organizational problem. If everyone were asked to leave for a short period of time, a skeleton crew would need to stay behind to run the utilities and to deal with emergencies. Presuming that there was sufficient danger to warrant the evacuation, this crew would need protective gear. However, when contacted, the state was not able to provide suitable protective gear for such a crew. This second possibility was sufficiently real to alert borough officials to the difficulties it would present in terms of the liability of the borough, especially if a formal emergency were still not declared. However, these problems had not been explicitly addressed prior to the accident, and no provision had been made for them in emergency planning.

A second idiosyncratic institutional effect for Royalton arose out of its relationship to Middletown. For some time, Royalton has depended on Middletown for the infrastructure to support many of its public services. Royalton, for instance, is not equipped with an extensive communications center to handle emergencies; firefighters, ambulances, and so forth are coordinated through Middletown's communications center. Thus, during the accident, Royalton's Civil Defense director worked out of the Middletown communications center. For the most part, there was cooperation. However, when resources (school buses, in this case) became limited, each municipality was left to fend for itself (Samo, p.c., 1979). One effect of this experience is that some Royalton citizens are exerting pressure for Royalton to develop its own evacuation plan separate from Middletown and to obtain its own radio, siren, and radiation monitoring equipment. The feeling is that, in a crisis, Royalton may not be able to depend on Middletown to meet its emergency needs and would be better off to work directly with the county. In addition, the county emergency plan specifies a different destination point for Royalton evacuees than for Middletown evacuees. Thus, this emergency demonstrated that there are some difficulties in the existing institutional arrangements between the two boroughs.

Finally, Middletown was also especially impacted because its public facilities were used for press conferences and news briefings. The borough attempted to carry on its normal functions during this period; contrary to some press reports, conferences were not held in the Borough Hall, which is immediately adjacent to other borough offices. Rather, they were held in the Middletown Community Service Organization (MCSO) Building in the next wing. The door between the wings was locked to keep reporters from interfering with day-to-day activities.

2.4.3 Other Institutions

Other institutions in the area near TMI were affected by the accident as well. Among those that have received special attention are churches, schools, hospitals, other health facilities, homes for the elderly, and prisons.

Churches. Local churches varied in their response to the accident. Generally, they held regular services even in cases where attendance was quite low. The specific responses varied however. (WITF-TV, 1979.) Some of the churches

continued as usual without any specific acknowledgement of the problem at TMI. One minister said, "We mentioned to the congregation that we felt we were living in the last days." The Bishop of the Roman Catholic diocese gave permission for granting general absolution, which was administered in Steelton and Middletown to people at mass the first weekend. The perception of the clergy was that the people attending services were quite intense.

Schools. On Thursday, 29 March, one principal asked the central administration of the Middletown Area School System what procedure should be followed if an evacuation became necessary (Bartel, p.c., 1979). He was told that normal emergency procedures would be followed. Generally, these procedures appear to have been followed. Schools within five miles of TMI were closed following the governor's advisory on Friday, 30 March. The last to reopen were the Middletown area schools, which reopened on 11 March.

When the governor advised people to stay indoors in his press meeting at 10:30 Friday morning, each school in the Middletown district was notified by telephone to shut down ventilating systems, to shut windows, and to allow only indoor recess. Crossing guards, bus drivers, and cafeteria staff were also notified to stand by. Absentee lists were checked to ascertain which children were at school that day. When people began arriving to pick up children, they were asked in many cases to sign for them, especially if they were not the children's own parents. Thus, an ad hoc procedure was developed to account for every child. The amount of hysteria at each elementary school seems to have been a function of its size. In the smaller schools, principals were able to patrol the halls and reassure parents who were very upset before they entered the classrooms. In larger schools where this was not possible, children became much more frightened by other children being removed by their parents from school and by teachers in tears.

Official dismissal began about 12:30 p.m. Buses followed their normal routes, making three or four trips each. All the children were gone by 1:30 p.m. Parents were notified of the school closings by local radio stations, as would be the normal procedure during a snowstorm or similar emergency. The school assumes that children know how to obtain shelter if school is dismissed early and parents are working. Although nearly all the schools have fallout shelters, there is no

indication that officials seriously considered leaving the children at school until the normal dismissal time. Consequently, some children were dropped off at locked homes and were outdoors Friday afternoon.

A different approach was followed on the West Shore. Newberry and Fishing Creek elementary schools were evacuated to a school more than ten miles from TMI. This strategy had the advantage of insuring the safety of the children. However, a few parents had difficulty in locating their children, which caused temporary panic (Lesniak, p.c., 1979).

As with other institutions, the schools in the area faced problems they were not prepared for (Bartel, p.c., 1979). Although the preference of many administrators would be to dismiss children in the event of an emergency, the accident at TMI illustrated the necessity for developing a plan whereby the schools could assume responsibility for evacuating the children themselves, including some mechanism for alerting parents of their destination. Second, the schools needed a policy for dealing with the news media and a mechanism for enforcing the policy. Some reporters were going directly to classrooms without checking with the principal or were interviewing children on the playground. Third, it was difficult to obtain accurate information for planning purposes and hard to know which informant to believe, especially since the Emergency Broadcast System was not activated. Some schools shared the frustration of many other institutions in that they did not feel they received adequate, timely information for making decisions to protect the children.

Hospitals. The only hospital in the area that could remain in operation in the event of a serious emergency was Hershey Medical Center. It has the capability of being sealed and pressurized and has extensive radiological emergency treatment facilities. Other hospitals would have needed to evacuate completely. Since hospitals are normally the destinations for victims of a disaster, they were not prepared for a full-scale evacuation of their entire facilities.

Beginning on Friday morning, 30 March, hospitals in the area began to reduce their patient population. None but emergency cases were admitted, elective surgery was cancelled, recuperating patients were sent home as soon as possible,

and kidney dialysis patients were moved to State College. An adequate staff was available to treat the reduced number of patients since many of the staff members evacuated their families and then returned. For instance, Holy Spirit Hospital's staff absentee rate never exceeded 20 percent, but its patient load was reduced to as low as 38 percent of full occupancy. The remaining patients were consolidated into a few wings, and other wings were closed (Frei, 1979).

The evacuation plans developed by hospitals in the area included several unique features. First, arranging for host facilities for patients was more complex than for the general population, since facilities for treating patients needing specialized care are not available in every hospital. For instance, neonatal (incubator) babies would have needed to be transported to Philadelphia. Second, a system for identifying and transporting key medical records had to be devised. Third, staff members, including ambulance drivers, willing to go with the patients and be separated from their own families had to be identified. Fourth, special provisions were required for psychiatric inpatients. For instance, a system of early release was devised, including provisions for supplying medications for about half the patients at Holy Spirit. Name bands were double-checked, since many of those not released would be sedated during the evacuation. First aid supplies, equipment, extra doses of medication, and restraints were assembled in a single location so that they would be available for an emergency evacuation. It does not appear that any attempt was made to plan for transporting expensive equipment from the hospitals.

During the emergency period, morale was reported to be good at the hospitals. Patients felt confident that provisions had been made for them. Psychiatric patients even joked that they would be willing to split their tranquilizers with staff. Hospitals in the area began to resume normal operations about Wednesday of the following week. By Friday, 6 April, most hospitals were back to normal.

Other Health Facilities. Other facilities in the area also lacked emergency plans. At outpatient mental health service units, the response to the accident varied considerably. Those associated with hospitals fell under the emergency plans of the hospitals. Most others continued to operate with available staff.

However, the staff of at least one unit decided to close completely from Friday afternoon until Monday morning. The state had provided no guidelines as to the conditions under which this would be considered appropriate. Units that remained open reported receiving an increase in the number of calls for information, primarily from clients without families who were unsure of what they should do.

Most of the group homes for the mentally retarded were evacuated. Houseparents wanted to both evacuate their own families and insure the safety of the clients. They made their own arrangements for lodging at the destination, staying with relatives or at institutions such as Pennsylvania State University at State College.

Homes for the Elderly. Similarly, nursing homes in the area made ad hoc arrangements. Frye Village and the Odd Fellows Home in Lower Swatara Township were both evacuated, partly because administrators wanted to avoid the confusion of a forced evacuation and partly because they were short of staff. The elderly were dispersed to hospitals and nursing home facilities outside the area. Other nursing homes prepared similar plans for evacuation, but did not implement them.

Prisons. Expanding the evacuation zone to twenty miles placed several prisons in the evacuation zone. The Dauphin County Prison in Harrisburg faced problems typical of correction institutions in the area (Human Sciences Research, 1979). First, a way had to be arranged to transport the prisoners, but the Pennsylvania Bureau of Corrections buses had been allocated elsewhere. The needed buses were promised by the National Guard but were not available at the prison. They would not be dispatched until after the emergency was declared. Second, prison officials had to arrange for a host facility. This was handled by the Bureau of Corrections without any difficulty. Third, the warden lacked authority to release prisoners being held on minor offenses in the event of an emergency. His intent, however, was to release about a third of the inmate population if necessary. Fourth, the logistics of actually transporting the prisoners had to be developed. Prisoners would have been released from their cells in small groups and moved to the front of the prison to be counted, handcuffed (although sufficient cuffs were not available), and boarded onto the buses.

Prisoners were "uptight" during the emergency period. Special efforts were made to keep them fully informed, both as to the plant's status and as to the details of the evacuation plan. None of the inmates panicked. Perhaps the most difficult response to deal with was concern on the part of families of the inmates. The warden was besieged with calls from persons worried that the prisoners would be left behind. This problem was ameliorated by giving inmates special telephone privileges so that they could contact their families.

III. EFFECTS OF THE ACCIDENT DURING THE EMERGENCY PERIOD

3.1 Introduction

The previous section of this report described the behavioral response of individuals, businesses, and institutional groups to the emergency at Three Mile Island. The purpose of that section was to establish a foundation for understanding the consequences of the accident. The next step is to begin to explore the consequences or effects of the events that took place during the emergency period on the individuals and groups that reside in the vicinity of the plant. This serves three purposes. First, the discussion documents the extent or magnitude of the consequences of the accident so that statements can be made about the order of magnitude of the effects. Second, this section provides the information necessary to come to conclusions about the significance of the effects to the individuals and groups experiencing them. Third, determination of the magnitude and significance of the emergency period effects provides the basis for beginning to understand why individuals and groups responded as they did.

3.2 Emergency Period Effects on Individuals

3.2.1 Economic

Emergency period economic effects on area residents consisted of income losses (or gains) plus extraordinary expenses uncompensated by insurance.¹ These economic costs fell particularly heavily on evacuating households, but losses were also incurred by those who remained.

Loss of income among evacuating members of the labor force was not as pervasive as might have been expected. The NRC survey shows that slightly more than one-third of evacuating labor force members lost work and that just over half of these lost pay. Thus, of the evacuees in the labor force at the time of the accident, only about one in five experienced a loss in pay. Based on the NRC survey, the median pay loss was \$110, although the mean was \$271, indicating that there were a few large losses reported. (Flynn, 1979.) In addition to asking the

¹It should be noted that the perspective of loss taken here is that of the local resident. Thus, if the resident is compensated by insurance, his loss disappears (assuming his share of the insurance payment is negligible). From society's point of view, however, compensation by insurance does not eliminate the costs of the accident.

respondent in households that had evacuees about employment or pay loss for each family member, there was a summary question asking whether there were any other effects on family income, either positive or negative. Very few were reported. One percent reported other gains, and about six percent indicated that they had suffered other losses--principally loss of business income.

Nearly all evacuating households experienced extra expenses associated with the evacuation. Median household expenses for evacuees were reported in the NRC survey to be \$100, but, again, the mean was substantially higher at \$198. A small additional percentage of these households (nine percent) reported additional extra expenditures for which the median was \$60.²

Economic effects during the emergency period were experienced infrequently by individuals that did not evacuate. Only seven percent of nonevacuating households reported extraordinary expenses during the emergency period, and about eight percent reported a loss of family income. Median extra expenses were reported to be \$51 and median income loss, \$142.

Table III-1 summarizes the data collected in the NRC survey. The table shows that income loss, which was particularly heavy for evacuees, contributed to about half of the short-term economic costs suffered by households. The other half was due to evacuation costs and other accident-related expenses.

The survey results also imply that households within the fifteen-mile ring had received a total of \$1,215,000 in insurance compensation at the time of the survey (23 July through 6 August 1979). Independent data collected by the Pennsylvania Department of Insurance support the reliability of the survey findings. As of 10 August 1979, the Department of Insurance reported that private (nongovernment) claims within a twenty-mile radius of TMI had been paid as follows (Pennsylvania Insurance Department, 1979):

²There may be some upward bias in these estimates because some expenditures, food for example, would have been incurred in the absence of the accident. Even though the survey question asked for "extra" expenditures due to the accident, it is likely that some expenditures that otherwise would have taken place were not subtracted.

TABLE III-1

ECONOMIC COSTS OF THE ACCIDENT AT TMI FOR
HOUSEHOLDS IN THE 15 MILE RING

| | 0-5 Mile Ring | 5-10 Mile Ring | 10-15 Mile Ring | Total for 15 Mile Ring |
|-----------------------------------------------------------------------------|-----------------|-------------------|-------------------|------------------------|
| Costs for Evacuees | | | | |
| Pay loss (or gain) | \$ 726,000. | \$1,861,000. | \$1,270,000. | \$ 3,857,000. |
| Evacuation costs | 1,719,000. | 2,990,000. | 4,119,000. | 8,828,000. |
| Other expenses | 108,000. | 75,000. | 763,000. | 946,000. |
| Other income loss (or gain) | 34,000. | 600,000. | 2,162,000. | 2,796,000. |
| Insurance Payments to Evacuees | <u>643,000.</u> | <u>424,000.</u> | <u>148,000.</u> | <u>1,215,000.</u> |
| Total Costs Net of Insurance | \$1,944,000. | \$5,102,000. | \$8,166,000. | \$15,212,000. |
| Costs for Non-Evacuees | | | | |
| Income loss (or gain) | 140,000. | 1,043,000. | 1,412,000. | 2,595,000. |
| Other expenses | <u>29,000.</u> | <u>122,000.</u> | <u>255,000.</u> | <u>406,000.</u> |
| Total Costs for Non-Evacuees | <u>169,000.</u> | <u>1,165,000.</u> | <u>1,667,000.</u> | <u>3,001,000.</u> |
| Total Costs Net of Insurance Compensation (Evacuees and Non-Evacuees) | \$2,113,000. | \$6,267,000. | \$9,833,000. | \$18,213,000. |

Source: Flynn, C.B., "Three Mile Island Telephone Survey: Preliminary Report on Procedures and Findings," U.S. Nuclear Regulatory Commission, 1979.

| | |
|---------------------|-------------------------|
| \$1,212,388. | For relocation expenses |
| 85,937. | For wage loss |
| <u>\$1,298,325.</u> | Total Paid |

Thus, once the approximately \$1.2 million of insurance payments is subtracted from income loss and accident-related expenses, short-term economic costs borne by area households within fifteen miles of TMI appear to be about \$18 million.

Additional perspective on the magnitude of these costs is attained by considering them relative to the number of affected households. Table III-2 shows that for the fifteen-mile ring as a whole, costs per household averaged \$146. Relative to mean family income of about \$17,000, as estimated in the NRC survey, this amounts to a little less than 1 percent of annual family income. As would be expected, the burden on households that evacuated was relatively greater. The average cost per household for all households in the 0-15 mile ring with one or more evacuees was \$296, or about 1.75 percent of mean family income.

Table III-2 also shows that costs per evacuating household were positively correlated with distance from the site; that is, average costs per evacuating household were significantly greater in the 10-15 mile ring than in the 0-5 mile ring. This corresponds with other information from the NRC survey that indicates that evacuees farther from the plant site traveled farther than persons living closer to the site. Due to the fact that the 0-5 mile ring had the largest proportion (66 percent) of evacuating households, average costs for all households in the 0-5 mile ring were higher (\$177) than for the 5-10 mile ring (\$156) or the 10-15 mile ring (\$136).

Interpretation of these data should be conditioned by two additional considerations. First, it must be remembered that all of the data described above pertain only to the 0-15 mile ring, and that the NRC survey clearly indicated that the effects of the accident extended well beyond the 15-mile ring. Unfortunately, the sampling fraction decreases rapidly beyond 15 miles, so data of comparable reliability to that for the 0-15 mile ring cannot be obtained. For purposes of evaluating overall costs of the accident, the NRC survey indicates that the incidence of evacuation in the 15-25 mile ring was about 11 percent. Beyond 25 miles, only 5 households were surveyed from a total of 270 in which one or more

TABLE III-2

NUMBER OF HOUSEHOLDS AND COSTS PER HOUSEHOLD

| | 0-5 Mile Ring | | 5-10 Mile Ring | | 10-15 Mile Ring | | Total for 15 Mile Ring | |
|--------------------------------------------|---------------|-------|----------------|-------|-----------------|-------|---------------------------|-------|
| Households that Had One or More Evacuee | 7,872 | (66%) | 19,679 | (49%) | 23,846 | (33%) | 51,397 | (41%) |
| Average Cost per Evacuating Household | \$ 247 | | \$ 259 | | \$ 342 | | \$ 296 | |
| Households with No Evacuees | 4,055 | (34%) | 20,482 | (51%) | 48,416 | (67%) | 72,953 | (59%) |
| Average Per Non-Evacuating Household | \$ 42 | | \$ 57 | | \$ 34 | | \$ 41 | |
| ALL HOUSEHOLDS | 11,927 | | 40,161 | | 72,262 | | 124,350 | |
| Average Cost per Household | \$ 177 | | \$ 156 | | \$ 136 | | \$ 146 | |

Source: Flynn, C. B., "Three Mile Island Telephone Survey: Preliminary Report on Procedures and Findings," U. S. Nuclear Regulatory Commission.

members evacuated. Thus, beyond 25 miles, costs appear to be sufficiently small to be ignored. For the 15-25 mile ring, however, an order-of-magnitude estimate can be made. Assuming that average costs per evacuating household and non-evacuating household in the 15-25 mile ring are the same as for the total of the 0-15 mile ring and that 11 percent of the households evacuated, a rough estimate is that total costs in the 15-25 mile ring may have been about \$9.4 million.

The second qualification to the summary numbers in Tables III-1 and III-2 is that they may be affected by future insurance payments. Insurance claims paid to date were primarily to persons that fell within the scope of the governor's advisory, namely, families with pre-school children or pregnant women in households within five miles of TMI. Relocation and wage loss claims were paid to a larger group for the first few days, but the more restrictive definition was increasingly applied as time from the accident increased. The point is that the legal liability of Nuclear Insurers is not known at present, and, given the large balance of outstanding claims, it is possible that the ultimate losses suffered by area residents may be smaller than presently estimated. The magnitudes of the claims presently outstanding are shown in Table III-3.

TABLE III-3
SUMMARY OF UNPAID INSURANCE CLAIMS OR
PENDING ACTIONS: 10 AUGUST 1979

| | Number | Dollars |
|-----------------------------------------------|--------|-------------------------|
| Individual Claims for Wage Loss or Relocation | | |
| Rejected or Pending | 962 | \$ 323,000 ^a |
| Government Claims | 27 | 64,000 |
| Business Claims | 113 | 1,196,000 |
| Individual Actions | 15 | 81,500 |
| Class Actions | 9 | 3,740,000,000 |

^aEstimate based on average payment per claim made to date.

Source: Pennsylvania Insurance Department, "Socioeconomic Impact Study Work Project," 24 August 1979.

Not all of these claims would eventually accrue to households in the area, even if Nuclear Insurers were found liable. Some would accrue to area households, however, and to the extent that they did, the estimate of net economic impact on area households would have to be adjusted downward.

3.2.2 Health Effects

The primary document used to estimate the amount of radiation received by the general public is "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station," prepared by the Ad Hoc Population Dose Assessment Group. The Dose Assessment report estimates the maximum additional radiation received by any individual off-site to have been less than 100 millirems through 7 April 1979. The natural background radiation in the Harrisburg area is estimated to be 116 millirems per year. These figures can be put into context by noting that the background radiation in Denver, Colorado is estimated to be 193 millirems per year, and the Environmental Protection Agency guidelines for the level at which protective action (evacuation) should be considered is 1200 millirems per hour. Thus, it appears from the best estimates to date that the amount of radiation received off-site was far below the level that would be considered a serious risk to health. Nevertheless, estimates of additional health effects (fatal and nonfatal cancers, genetic disorders) which might be produced by the accident range from 0 to 100, with the best estimate being 2. Since the number that would normally experience such health effects in the area affected is estimated to be 619,000, even the highest estimate of 100 additional health effects will be virtually undetectable statistically (Ad Hoc Population Dose Assessment Group, 1979).

3.2.3 Stress and Psychological Effects

The amount of stress experienced by people near TMI was both a function of the perceived amount of threat to physical safety and of the reliability of the information being used to ascertain the amount of threat. The perceived amount of threat varied considerably among individuals. For instance, respondents in the NRC study were asked about their perception of the seriousness of the threat at the time of the accident. Most respondents thought the threat was very serious (48 percent) or serious (19 percent), but more than a fifth (21 percent) thought it was only somewhat serious, and 12 percent thought it was no threat at all. Generally, those closer to the plant were more likely to perceive a serious threat than those farther away. Conversely, those who thought it was no threat at all were located

farther from TMI. Those who thought TMI was a very serious threat at the time of the accident were younger, female, more highly educated, and of high income. Pregnant women were much more likely (64 percent) than average to view it as a very serious threat and much less likely to think it was no threat at all.

Kraybill's study indicated that 76 percent felt that the threat was very serious, and an additional 20 percent felt it was a little serious. Those more likely to perceive the situation as serious included females, persons aged 25-34, the better educated, and those who evacuated (of those who had returned by 8 April). Similar results were found when respondents were asked about their concern over emissions from the plant. Sixty-one percent were very concerned with emissions at the time of the accident, and 26 percent were somewhat concerned, but 13 percent were not at all concerned. Those who did not evacuate were three times as likely (19 percent vs. 6 percent) to be unconcerned as those who evacuated.

Considering that pre-accident perceptions of TMI were either neutral or positive, these indicators of concern during the accident represent a substantial change. Kraybill's study indicated that nearly half (48 percent) did not feel they received sufficient information about emergency procedures during this time. People aged 25-32, the better educated, and those who evacuated were most likely to respond that they had not. Respondents in the NRC study found media such as local TV and radio most useful. National sources such as national network TV were less useful, and the print media ranked behind all radio and TV. Poor ratings for friends and relatives as information sources apparently resulted because they were perceived as having rumors rather than factual information.

The NRC study also included questions about the various sources of official information. The Governor of Pennsylvania and the NRC were cited as the most helpful during the two-week period of the accident. Respondents perceived Metropolitan Edison as least helpful. The Rutgers study had similar results: 57 percent said the NRC was the most reliable source, followed by 19 percent who cited Governor Thornburgh. Smith's study showed that Harold Denton of the NRC was viewed as the most legitimate source by 45 percent, followed by no one (30 percent), the governor (11 percent), and the media (11 percent). Seventeen percent volunteered that Metropolitan Edison was not viewed as a legitimate source.

When asked "Overall, how satisfied were you with the way you were given information during the emergency?", the median response for NRC respondents was in the middle of the four-point scale: half were very satisfied (12 percent) or mostly satisfied (37 percent), and half were very dissatisfied (22 percent) or mostly dissatisfied (29 percent). Generally, those farther from TMI were more likely to be satisfied with the information they received than were those closest to TMI. Those who were least likely to be satisfied were pregnant women (71 percent) and students (75 percent). There was a marked difference in overall satisfaction with information by evacuation status. Evacuees were much more likely to be dissatisfied (64 percent) than were nonevacuees (47 percent). (Flynn, 1979).

The perceived lack of information was especially frustrating for those who had already evacuated. These persons were dependent on national media for information, and in some cases heard information which later proved to be inaccurate. Evacuees were unsure of whether they would ever be able to return to their homes and friends and were concerned because they had not thought to bring family photographs and important papers with them (Sides, Kinney, p.c., 1979). They were also concerned about the safety of their friends who were left behind.

Given the high degree of stress, it is not surprising that some of the people in the area reported experiencing psychosomatic symptoms because of the accident. Goldsteen's research indicated that persons in the area felt demoralized shortly after the accident and that students experienced an average of one physical symptom such as stomachache, headache, or sleeping problems. The NRC survey showed a higher level of stress symptoms for those persons living closer to TMI at the time of the accident for all fifteen indicators: stomach trouble, headache, diarrhea, constipation, frequent urination, rash, abdominal pain, loss of appetite, overeating, trouble sleeping, sweating spells, feeling trembly and shaky, trouble thinking clearly, irritability, and extreme anger. Other indicators of stress among local residents included resumption of smoking during the emergency period (Trinity Parish newsletter, September 1979) and insomnia, short temper and long-lasting indigestion (TMI Alert, July 1979). Thus, the perceived threat, the lack of good information, the evacuation experience itself, and the psychosomatic symptoms indicate that part of the population experienced considerable stress at the time of the accident. At the same time, a significant minority of the residents were not at all worried about emissions from TMI and did not feel at all threatened.

3.3 Emergency Period Effects on Business and Industry

3.3.1 Direct Effects

Employment and Unemployment. Studies regarding the employment losses due to TMI during the week immediately following the accident (30 March through 6 April) were carried out by the Pennsylvania Department of Commerce. Firms containing approximately 70 percent of manufacturing employment were studied as were firms containing approximately 31 percent of nonmanufacturing employment (Pennsylvania Department of Commerce, 1979). The manufacturing study was based on industrial directory listings, and so the geographic area studied corresponds closely to a twenty-mile ring. For nonmanufacturing firms, however, the study area included all firms in a six-county area.³ Total employment in the manufacturing study was about 100,000, while total employment in the six-county nonmanufacturing study was about 267,000 (Pennsylvania Department of Commerce, 1979).

In manufacturing firms, approximately 188,000 person-hours of work, or about 1.9 hours per employee on the average, were lost during the week following the accident. Among nonmanufacturing firms, total losses amounted to just over 1 million person-hours, as shown in Table III-4. If the manufacturing and nonmanufacturing estimates are summed, the total loss in employment is on the order of 1.25 million person-hours. Based on a 40 hour work week, this amounts to approximately an 8.5 percent loss in employment during the week following the accident in the areas surveyed. Thus, the employment loss was significant in the context of the short period of time following the accident. In the context of average annual employment, however, the loss represents 600 person-years, or only a little more than one-tenth of one percent of average annual employment; so the absolute magnitude of the short-term effects appears small.

In contrast to the study by the Pennsylvania Department of Commerce, which examined data on establishments, the NRC study was a survey of households. Within fifteen miles of TMI, the NRC survey estimates that 34,000 persons lost work due to evacuation. The mean work loss was 4.15 days, which gives an aggregate estimate of 1.13 million lost person-hours. This is of the same order of

³Specifically, this area includes Dauphin, Cumberland, York, Lancaster, Lebanon, and Perry counties.

magnitude as the Department of Commerce estimates, although there are important definitional differences in the estimates. First, the NRC estimates cover the entire period of a household's evacuation, while the Department of Commerce estimates are only for one week after the accident. Second, the NRC study area (fifteen-mile ring) is smaller than the Department of Commerce areas (six-county area or twenty-mile ring). Finally, the NRC survey estimates hours of work lost for evacuees only. The Department of Commerce study deals with employment lost by evacuees and nonevacuees alike.

TABLE III-4

PERSON-HOURS LOST IN NONMANUFACTURING INDUSTRIES

| | Total | Average Per Employee |
|-----------------|-----------|----------------------|
| Agriculture | 1,935 | .7 |
| Mining | -- | -- |
| Construction | 132,438 | 5.6 |
| Transportation | 84,479 | 3.1 |
| Wholesale Trade | 70,069 | 2.8 |
| Retail Trade | 345,060 | 3.8 |
| Finance | 71,438 | 3.3 |
| Services | 359,422 | 4.9 |
| TOTAL | 1,064,841 | 4.0 |

Source: Pennsylvania Department of Commerce, Bureau of Statistics, Research and Planning, 1979.

The employment loss estimate is important as an indication of the order of magnitude of the short-term economic disruption associated with the accident. The estimates indicate that the total employment effect was on the order of between one and one-half and three tenths of one percent of average annual employment. Two additional qualifications must be kept in mind in interpreting the employment numbers. First, the employment loss does not necessarily mean income loss because many employees continued to be paid despite absence from work. Second, the employment loss does not necessarily mean production loss. In

many cases, production can be sustained in the short-run despite a reduction in work force. In other cases, compensatory increases in output may have occurred after the emergency period.

Additional perspective on the seriousness of the employment effects of the accident can be gained from the records of the Pennsylvania Office of Employment Security. They report that a total of 704 initial claims and 1,203 continued claims have been filed in the Harrisburg, Lancaster, Lebanon, and York offices for TMI-related reasons.⁴ The department reports that almost all of the claims (95 percent) were made during the first week of April and that very few continued beyond the end of the month. Relative to the size of the labor force in the area, the number of persons involved was only a very small fraction of one percent, despite the fact that a significant proportion of the population was directly affected by evacuation. The reason for this is that in order to qualify for unemployment compensation associated with the accident, an individual must have been prevented from working by his or her employer, and the individual must have remained in the area and have been willing to work had work been available. Thus, persons who evacuated or who could have continued working were not eligible for unemployment compensation.

Income. Both the study of establishments by the Department of Commerce and the survey of households by the NRC inquired about wage losses incurred during the emergency period. In the manufacturing sector, the Department of Commerce estimated that wage losses were approximately \$1.5 million. In the non-manufacturing sectors, the estimated loss was \$5.5 million.

The NRC survey asked two basic questions about income change. First, all persons who evacuated were asked directly about income loss due to the evacuation. Within the fifteen-mile ring, this amounted to about \$3.9 million. Evacuees were then asked whether, in addition to direct pay loss associated with evacuation, there was any other gain or loss in family income due to the accident. The response to this question resulted in an additional estimate of a net loss of \$2.8

⁴Once an initial claim has been filed, it must be renewed weekly if the unemployment continues. Each of these renewals is counted as a continued claim.

million. Nonevacuees were asked a similar question about change in family income due to the accident, and they estimated a net loss of \$2.6 million. Thus, the NRC survey indicates a net income loss of \$9.3 million (see Table III-1).

In comparing this to the estimated loss of about \$7.0 million derived by the Department of Commerce, all of the definitional differences discussed with respect to the employment estimates must be kept in mind. In addition, the NRC question with respect to income change was more inclusive than the wage loss question asked by the Department of Commerce. In particular, the income question included changes in proprietors' income and other forms of nonwage income that were not included in the Department of Commerce estimates.

The order of magnitude of the income effects can be seen by multiplying a rough estimate of personal income per capita (\$8,000) by the estimated population of the fifteen-mile ring (about 370,000 persons). This gives a total personal income estimate of close to \$3 billion. The \$9 million income loss estimated in the NRC survey represents, therefore, about three-tenths of one percent of annual income in the area. These aggregate income estimates probably give the best estimate of the overall emergency-period economic impact of the accident because the NRC question included gains in income due to the accident as well as losses. Thus, the income estimates include increases due to overtime pay or to additional business sales due to the accident. The estimates do not include income changes experienced by anyone other than area residents, however.

Production. The only estimate of lost production comes from the manufacturing and nonmanufacturing studies by the Department of Commerce. In the manufacturing study, each firm was asked: "What was the approximate value of production lost during the first week after TMI?". The estimated total is \$7.7 million. This estimate has some serious problems associated with it. First, it is very likely that it was interpreted by area firms as a question about gross output, not about value added. Yet it is only value added that was lost during the emergency period. The emergency should not have caused any of their purchased inputs to disappear. The magnitude of this problem can be seen by dividing estimated production lost by estimated person-hours lost. This suggests that \$41 of production was lost per person-hour. Yet in 1977, Gross State Product (GSP) per

person-hour in manufacturing for the state as a whole was only \$11 per hour. Thus, it appears that production loss may be overestimated (as opposed to gross output) by a factor of four. The second source of overestimate in this number occurs because it is likely that at least some of the lost production will be made up with little or no additional expenditure of resources relative to what would have happened in the absence of the accident. Nothing is known (to our knowledge) about the possible magnitude of this compensating effect, but compensating adjustments certainly did occur.

The situation with respect to nonmanufacturing is much more difficult, because there are many sectors where the source of the interruption was from the product or service demand side, not from an interruption in the supply of factors of production (principally labor). The question asked was: "What was the approximate value of business lost during the first week after TMI?". Table III-5 shows the estimates by sector. The relatively high level of business losses in wholesale and retail trade makes sense, given the large number of persons who evacuated the area, but it is less clear why losses in the finance sector were so high relative to the size of the sector.

TABLE III-5
VALUE OF BUSINESS LOST DURING
FIRST WEEK AFTER ACCIDENT

| | Business Lost (Millions) | Average Per Employee |
|-----------------|-----------------------------|-------------------------|
| Agriculture | \$ 0.0 | \$ 0.0 |
| Mining | 0.0 | 0.0 |
| Construction | 2.8 | 118.3 |
| Transportation | 1.2 | 45.2 |
| Wholesale Trade | 11.0 | 433.9 |
| Retail Trade | 39.1 | 426.1 |
| Finance | 45.0 | 2081.1 |
| Services | 6.8 | 93.5 |
| TOTAL | 106.1 | 397 2 |

Source: Pennsylvania Department of Commerce, Bureau of Statistics, Research and Planning, 1979.

As was the case with the manufacturing estimates, care must be taken not to misinterpret the numbers in Table III-5. They do not refer to lost production, but rather they deal exclusively with lost business (that is, with lost sales), and only a small percentage of the sales represent real economic losses. The wholesalers' merchandise remains after the accident; all that is lost is the trade margin by which the merchandise is marked up. Even this would probably be an overestimate since part of the business will only have been delayed, not permanently postponed.

The implication of the above discussion is that the production and sales loss data are easily misinterpreted. A more accurate approach is to work from the income loss data. The retailer who loses \$1.00 in sales will report that his income is down by 5 to 10 cents, not by \$1.00. Thus, based on the fact that personal income in Pennsylvania is on the order of two-thirds of GSP and that the income loss estimates derived above were between \$7 and 9 million, real production losses during the week immediately following the accident probably ranged from \$10 million to \$14 million. As mentioned above, the amount of this figure that may have subsequently been made up is unknown.

3.3.2 Indirect Effects

The effects of an exogenous change in demand or production can usefully be categorized as direct, indirect, and induced. For example, if the demand for automobiles falls due to some exogenous cause, the reduction in automobile production is the direct effect, the reduction in production due to a decline in inter-industry purchases by the automobile industry is the indirect effect, and the reduction in production due to reduced consumption spending by automobile workers or workers in industries supplying the auto industry is the induced effect. For the U.S. economy as a whole, the short-term (one year) income and production multipliers (inclusive of the direct, indirect, and induced effects) would be estimated by most models to be about 2, and the long-term multipliers, between 3 and 4. For a subarea of the U.S., however, the multipliers would be considerably smaller because of the larger import leakages. In general, the smaller the economy in question, the smaller the multiplier.

With respect to the short-term economic effects of the accident at TMI, the question arises as to whether there were additional indirect or induced consequences of the direct effects. The question is complicated because there is no way for most businesses to identify whether a change in sales may be an induced or indirect effect stemming from TMI. This would be particularly true of large businesses located in areas where the relative size of the TMI effects were small. It is true, however, that both the Department of Commerce study and the NRC survey will contain some indirect or induced effects or both because the effects of the accident on sales were conspicuous in many cases. Thus, induced effects on the income of a Middletown grocer are already included in the income estimates reported above, but those of a York or Lancaster grocer probably are not.

Attempts to refine the economic loss estimates to account for indirect and induced effects run into two problems. First, the size of the multipliers depends importantly on the extent to which a change in income leads to a corresponding change in local consumption. The issue, then, is the extent to which the relatively small change in net income of area households was accommodated by reduced consumption as opposed to reduced saving. The loss was small enough that it is plausible that there may have been little change in normal consumption patterns, with most of the income loss (and increased expenditures) being accommodated by a reduction in saving. If this is the case, induced effects of the income loss will be very small.

The second problem has been raised above. Indirect production effects will not occur if production levels are subsequently adjusted upwards to compensate for the disruption during the period immediately following the accident. Thus, if direct income effects are on the order of one-quarter of one percent of aggregate area income, and if it is assumed that the long-term income multiplier for the Harrisburg area is around two, the total effect of the accident on the area's economy is certainly less than one-half of one percent. This percentage is an upper bound estimate because 1) some of the indirect and induced effects are already counted in the one-quarter of one percent direct income estimate, 2) a large saving adjustment to a small transitory change in income could cause the multiplier to be very much smaller than two, and 3) compensating production adjustments will cause the actual effect to be diminished relative to the estimates above.

3.3.3 Sectoral Effects

The estimates discussed in the preceding sections give an indication of the aggregate effects on economic activity in the area surrounding Three Mile Island. There were, however, certain sectors of the local economy that were particularly vulnerable to the effects of the accident, and these have been subjected to additional study.

Agriculture

The accident understandably raised questions about potential contamination of agricultural products grown or processed in the vicinity of the plant. Concerns were felt by farmers, processors, consumers, and industrial users of the area's products. The Pennsylvania Department of Agriculture responded quickly to the emergency, and extensive testing was underway by Thursday, 29 March. The testing programs (principally of milk) uniformly failed to show levels of radiation that would be cause for concern. (Pennsylvania Department of Agriculture, 1979.)

Between 29 March and 21 April, the Department of Agriculture took two hundred samples of milk to test for the presence of Iodine-131. The highest reading found in any of these samples was 29 picocuries per liter. The state's health standard for milk is 1,000 picocuries per liter, much more stringent than the 12,000 picocuries per liter level at which the Federal Food and Drug Administration begins to initiate regulatory action to protect the health of the public. Since 4 May 1979, milk sampling has been continued, but all tests have shown less than 10 picocuries, the threshold at which Iodine-131 can be measured using the testing equipment. Additional tests of other food items and animal health studies have also been carried out, but all have reported an absence of contamination. (Pennsylvania Department of Agriculture, 1979.)

Consumers and industrial purchasers of the area's agricultural products reacted immediately to the accident. Because of the potential concentration of Iodine-131, milk was the commodity on which most attention focused. Local industrial concerns were careful to segregate, test, and monitor the use of locally produced milk, and there were several cases of cancelled orders by out-of-state dairies for Pennsylvania milk. One large dairy serving Harrisburg reported that sales dropped 18 percent during the first week and 15 percent during the second week after the accident. The dairy found it necessary during this time to advertise

in the local papers that they did not utilize milk from farmers within a ten-mile radius of Three Mile Island and that they had, in fact, disposed of milk produced within this area. (Governor's Office of Policy and Planning, 1979).

Similar effects were noticed in the sales of other fresh agricultural products produced in the area, but it is difficult to know the extent to which the decline in sales was due to customer resistance or the extent to which it was due to the number of persons that had evacuated the area. In any event, the conspicuous effect on sales was limited to the week immediately following the accident. The effect of the renewed demand from the returning evacuees plus the reassuring news from the Department of Agriculture apparently combined so that, with only a few exceptions, sales and consumption of locally produced products appeared near normal by the latter part of the week following the accident (Pennsylvania Department of Agriculture, 1979).

Further documentation of effects on the agricultural sector was obtained by the Department of Agriculture in a study of full-time farmers living and farming within a 25-mile radius of Three Mile Island. By mid-August, 304 farmers had been contacted. The study confirmed the fact that emergency period economic impacts on the area's farmers were not serious. In fact, only 4 percent reported having suffered economic losses due to the accident, although, within 10 miles of the plant, the incidence of loss was somewhat higher (9 percent).

More significant than these emergency period losses, however, is a clearly articulated apprehensiveness toward the Three Mile Island facility as it relates to the health of the farm family, the farmer's livelihood, and the value of farm real estate. Table III-6 gives an indication of the extent of this anxiety. The concern of the farmer is easy to understand. Both his income and his wealth are tied to his land, and if a force beyond his control threatens the productivity of his land, the farmer is likely to feel very vulnerable. This vulnerability is further aggravated by his lack of mobility. Livestock presented particular problems in terms of the potential need for evacuation and contributed to a sense of being locationally tied, when exactly the opposite was required by the threat.

TABLE III-6

ATTITUDE RESPONSES BY FARMERS
STUDIED BY DEPARTMENT OF AGRICULTURE

| | <u>Location of Farmer with Respect to Three Mile Island</u> | | |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------|----------------|-----|
| | Within 10 Miles | 11-25 Miles | ALL |
| Percent of Farmers Responding that TMI Poses a Serious Threat to Their General Health. | 36 | 27 | 28 |
| Percent of Farmers Responding that TMI Poses a Serious Threat to Their Livelihood. | 26 | 25 | 25 |
| Percent of Farmers Responding that TMI Has Adversely Affected the Value of Their Farm. | 23 | 6 | 7 |

Source: Pennsylvania Department of Agriculture, 1979.

Tourism

There was an immediate and perceptible impact on the tourist industry in the study area during April due to the accident. Telephone contacts with the ten major lodging and convention site centers in the area reported initial losses of nearly \$2 million in gross sales directly attributable to TMI. Such losses included the cancellation of a major trade show scheduled for the Pennsylvania Farm Show Building in Harrisburg, as well as other conference and reservation cancellations. An attempt was made to extrapolate these findings to the tourist industry, and it was estimated that the total loss may have been two to two and one-half times more than the initial estimate. This, however, fails to account for the fact that there was a very substantial influx of transients (such as media and technical personnel) into the area during the emergency period. Thus, while there was clearly a major interruption in the convention business, there was undoubtedly some compensation for the lodging and restaurant trades, especially in the Harrisburg, Steelton, and Middletown areas. (Pennsylvania Department of Commerce, Bureau of Travel Development, 1979.)

3.4 Institutional Effects

3.4.1 State Government Impacts

A partial measure of the cost of the TMI accident to state government can be gained from data concerning salaries paid to personnel who were granted administrative leave for the period following the accident. For the period from 30 March 1979 through 9 April 1979, a total of 21,938 hours was granted in administrative leave. The cost of these hours was \$161,257 (Pennsylvania Office of Budget and Administration, 1979).

Additional extraordinary costs were incurred by the state in emergency management efforts. Work performed for the President's Commission on TMI made additional estimates of costs incurred by the state. It was estimated that costs for administration and planning of evacuation ranged from \$87,000 to \$152,880 with a medium estimate being \$121,440. Most of these costs were incurred by the Pennsylvania Emergency Management Agency. Additional costs were incurred for evacuation and relocation assistance. These were estimated to have ranged from \$170,000 to \$372,000 with a medium estimate of \$256,000. This estimate of \$256,000 was estimated to have been incurred approximately as follows: Department of Welfare--\$71,000, Governor's Action Center--\$104,000, Department of Transportation--\$21,000, National Guard--\$18,000, and State Police--\$43,000. (SRI, International, 1979).

3.4.2 Local Government Impacts

The Department of Community Affairs has conducted a survey of TMI related expenses incurred by county and local governments. Unfortunately, only about half of the sixty-eight units have responded, so it is difficult to generalize without knowing more about the representativeness of the units that did respond. Of the units that responded to the survey, it was reported that total dollar expenditures of \$113,000 had been incurred. In the six municipalities nearest TMI, out-of-pocket expenditures were less than \$10,000 each. In interpreting these data, it should be kept in mind that many local governments depend on volunteer labor or labor for which compensation is not tied to hours worked. For instance, the Londonderry Township Emergency Operations Center was staffed by eighteen volunteers who put in a total of 510 hours of labor without pay. Therefore, the estimated dollar costs certainly underestimate the actual efforts made by many local governments to cope with the consequences of the accident.

3.4.3 Other Institutions

Institutions near TMI were unprepared for a complete evacuation prior to the accident. One effect of the accident was to illustrate to them in the most graphic terms the difficulties of actually implementing any massive evacuation. Institutions responsible for evacuating people, especially dependent people, had not thought through the mechanics of how this could be done. Neither had they considered which records and equipment would need to be removed from the area in the event that it would be impossible to return to it. Planning was further complicated by the fact that no one knew how long an evacuation might last.

By Sunday, institutions in the area had devised their own evacuation plans, usually in coordination with the county Civil Defense director. They recognized the ad hoc character of these plans, given the conditions and time pressure under which they were developed. But, even six months after the accident, few of these institutions felt confident that their evacuation plans were adequate for insuring an orderly departure in the event of another accident.

IV. POST-ACCIDENT PERIOD EFFECTS

4.1 Introduction

The period of the emergency at Three Mile Island was disruptive for the residents of the region surrounding the plant. Stress was interjected into the daily lives of many people, economic activities were interrupted, and local political and institutional structures came under pressure. Most of the conspicuous signs of the emergency disappeared as suddenly as the emergency appeared. There was no damage to public and private facilities (other than the nuclear generating plant itself), and by the second week in April, most evacuees had returned to their homes, businesses were open, schools and other institutional facilities had reopened, and daily activity appeared much as it had before the accident.

The presumption was made frequently by those at a distance from the plant site that real estate values would plummet, that tourism and agriculture would be adversely affected, and that the entire economic future of the area would be in question. Yet in the vicinity of the plant, real estate transactions continued to take place, dairy products were produced and sold, visitors came to have their pictures taken against the background of the Three Mile Island cooling towers, and industrial developments continued to move forward. A conspicuous characteristic of the post-accident environment was the discrepancy between the presumed severity of impact suggested by persons with little direct familiarity with conditions in the area, and the absence of continuing effects alleged by many living in the area.

This section examines the period from mid-April through the end of September 1979. The purpose is to identify the extent to which there appear to have been continuing effects of the accident on the individuals, businesses, and institutions of southcentral Pennsylvania. Not surprisingly, neither of the extreme generalizations caricatured above are very accurate in describing conditions as they have developed during the months following the accident.

4.2 Effects on Individuals

4.2.1 Economic

An important conclusion of this section is that there do not appear to be widespread continuing economic effects attributable to the accident. The NRC

survey identified only a small population of households that reported continuing effects. Among households that evacuated, 12 percent reported continuing effects. Among households that did not evacuate, only 4 percent reported continuing effects. The most frequently mentioned effects were higher electric bills, reduced real estate values, and declines in business. Each of these effects are examined in more detail below. It is sufficient to note here, however, that these effects were reported by a small group to begin with and that there is no evidence to suggest that any of these effects have yet imposed large economic costs on individuals.

The individuals who have suffered the most direct adverse economic impact are very likely the GPU common stockholders. The total value of their investment has dropped by about \$550 million since the accident. On the day before the accident, GPU common stock reached a high of 17 7/8. By October, the stock was being traded at 8 or less. The residential distribution of these stockowners is not known, but it is likely that some area residents have suffered large capital losses.

4.2.2 Continuing Stress and Psychological Effects

There is some evidence that stress has persisted since the emergency period. Nearly a quarter of the respondents in the NRC study still perceived TMI as a very serious threat to their safety. Only 28 percent felt it was no threat at all. Even more respondents were still very concerned about emissions from TMI (41 percent), and somewhat fewer (25 percent) were not at all concerned. Of course, both perception of threat and concern with emissions had decreased by late July relative to their levels during the accident (61 percent very concerned). However, the fact that concern with emissions was considerably higher in July than it was before the accident (41 percent vs. 12 percent very concerned) shows that TMI has clearly become a substantially greater source of stress.

It appears that many of the psychosomatic indicators of stress have been reduced to their pre-accident levels over time. Goldsteen's data indicate that feelings of demoralization increased sharply during the emergency period, but these indicators of stress were short-lived. Data from the NRC survey show a similar pattern for similarly measured indicators: overeating, loss of appetite, difficulty in sleeping, feeling trembly or shaky, trouble thinking clearly, irritability, and

extreme anger. However, the more somatic symptoms, such as rash, headache, stomach trouble, diarrhea, constipation, frequent urination, cramps, and sweating spells continue to affect a small percentage of the population.

Attitudes toward TMI are another indicator of continuing psychological effects of the accident. The percentage who feel the disadvantages of TMI outweigh its advantages has changed from 27 percent before the accident to 50 percent since the accident. This is consistent with local estimates that at least a third of the people in the area are pro-nuclear and a third are anti-nuclear and that communities are probably split about 50-50.

There is continuing concern by local residents over the quality of existing evacuation plans. It is generally known that most areas did not have well-developed plans prior to the accident but that they had developed plans by Saturday afternoon or Sunday morning. Since the accident, there has been additional work done on the plans either by the county and municipal officials, with, in some cases, citizen participation. Some municipalities have already spent dozens of person-hours on revising their plans since the accident. However, it appears to some that there are still problems with the plans. Examples of deficiencies mentioned by residents include: failure to take into account wind direction, designation of an evacuation destination only about ten miles from Three Mile Island, failure to include an element for evacuating the elderly, and forced separation of parents and children if school is in session.

Another short-term psychological effect is the persistence of rumors. This is perhaps more of a problem among the anti-nuclear people, who make a greater effort to keep continuously informed about developments. For instance, there has, in fact, been a fire on the island since the accident. A Londonderry firefighter on the scene said it was in a storage dump of contaminated suits and chemicals. This fire is apparently the referent for the rumor that there has been a fire in the control room since the accident. There are rumors that Metropolitan Edison is burning off the fuel remaining in TMI-1 at night so as not to alarm the populace. Interviews with local residents were commonly interspersed with requests for

technical information about the plant and the accident. The ongoing discussion regarding Three Mile Island is still quite technical, and it is clear that in trying to understand what is currently occurring, many laypeople are still confused.

This problem is not mitigated by what appear to be continuing contradictory statements in the local press, such as differences of opinion about how much radiation was received by the local population, whether it is even possible to estimate the amount of radiation with any degree of certainty, and whether an evacuation or advisory was warranted by the facts. Metropolitan Edison's constant reference to the Dose Assessment Group's report has served to decrease the local confidence in that report, especially among the anti-nuclear people. At present, there is no trustworthy source of information for laypersons about what happened in the past nor what is happening currently at TMI. For some, this continuing lack of clear, unambiguous information contributes to continuing stress.

4.2.3 Daily Activities

In many ways, day-to-day life has returned to normal in the area near TMI. People are back at their jobs or in school, and community meetings and activities are proceeding as scheduled. The NRC survey showed that although about a quarter of the respondents experienced disruptions of activity (over and above evacuation) during the emergency period, 90 percent of the respondents said their normal activities in July were completely unchanged by the accident.

As in any area of the county, there are many local issues on which there are divided opinions. In this area, they include zoning, busing of parochial children, a new sports complex, a new swimming pool, and the upcoming political elections. However, there is consensus on the part of local officials that no other issue has elicited such strong feelings in the communities as has Three Mile Island. There is general agreement that both the pro-nuclear and anti-nuclear opinions represent substantial portions of the population.

In discussing their feelings about TMI, local informants frequently compare the accident experience to their experience with Hurricane Agnes. Individuals evaluate the two events quite differently, depending on whether they are more pro- or anti-nuclear. Some have the attitude that they lived through the flood and that they will surely live through Three Mile Island. In fact, many see the flood as being

a much greater disaster. Those who are more concerned feel that the accident at Three Mile Island was not in the same category as Agnes because it resulted from manmade, as opposed to natural, forces. They resent having had to live through the accident and having to worry about the possibility of another accident when both are preventable by human means--that is, by not having a nuclear station at Three Mile Island. These feelings are exacerbated by the fact that radiation is invisible, which means that when an accident does happen, it is not clear to the layperson what the extent of the accident is. A continuing concern in the area is that no one is perceived as being sure about how serious the accident was. On the other hand, it was clear to everyone that Agnes was quite serious.

Unlike other issues on which there are split opinions, the intensity of feeling on TMI is perceived to make a qualitative difference. Both sides are apprehensive about the approaching anniversary of the accident and the possibility of restarting Unit 1; both sides assume that these events will lead to demonstrations. Theoretically, there are only three ways for members of a formerly unified group to cope with serious differences of opinion. Either they can 1) argue about it, 2) avoid the topic, or 3) avoid each other. There is evidence that all three coping strategies are being used. Initially, it appears that there was quite a lot of discussion about Three Mile Island, as would be expected of any such event so heavily reported in the news. However, as it became clear how individuals felt, and particularly the depth of feeling, there was an implicit, and in some cases explicit, agreement to avoid the topic in order to avoid upsetting everyone. At present, this second approach is the most common pattern.

The third pattern, avoiding each other, seems to be in its early stages of development and was mentioned only by anti-nuclear groups. The avoidance is partly coincidental; there are so many meetings for members of anti-nuclear groups to attend and so much additional work that most of these informants' contacts are with other people who share their sentiments. However, there is an additional avoidance pattern which is more conscious. Many people in the area were able to sympathize with their anti-nuclear friends immediately after the accident, but are tired of "continual harping" on the subject and resent the efforts of the nuclear opponents to keep issues in the forefront. Conversely, the opponents cannot

understand how their friends could want to forget about Three Mile Island. Thus, although no informant mentioned consciously avoiding anyone because of Three Mile Island, there are indications that this pattern may be slowly evolving.

4.2.4 Movement from the Area

Even though there is little evidence of continuing direct economic effects on individuals living near Three Mile Island, the previous sections indicated that there continues to be a high level of sensitivity to living near the nuclear plant. It is difficult to know the magnitude or extent of these concerns without extensive interviewing that has not, and probably will not, be done. Heavy reliance will have to be placed, therefore, on the behavior of individuals as an indication of the extent of their continuing stress and anxiety.

The most extreme behavioral response is to pack up and leave the area. Given the economic and psychological costs associated with a sudden move, this would certainly be an indication of extreme distress. The respondents in the NRC survey were asked whether anyone in the household had considered moving because of the accident. As shown in Table IV-1, 19 percent indicated they had, and this

TABLE IV-1
HOUSEHOLDS WHO CONSIDERED MOVING BECAUSE OF TMI

| Distance | Percent Of Respondents |
|-------------------------|------------------------|
| 0-5 Mile Ring | 30 |
| 5-10 Mile Ring | 19 |
| 10-15 Mile Ring | 17 |
| 15-25 Mile Ring | 7 |
| 25-40 Mile Ring | 5 |
| 40 Miles or More | 3 |
| TOTAL FOR ALL DISTANCES | 19 |

Source: NRC Telephone Survey

response was given much more frequently by persons living nearest the station. Those who considered moving were younger and more highly educated than respondents who reported that they had not considered moving. Evacuees were more than three times as likely to say that they had considered moving as compared to nonevacuees (33 percent versus 9 percent). The Pennsylvania Department of Health survey reported similar results, with 25 percent of the evacuees and 5 percent of the nonevacuees within five miles of TMI having considered moving.

Among the households that reported they had considered moving, 22 percent (25 percent in the Pennsylvania Department of Health Survey) reported that they had definitely decided to move. This implies that as many as 5,100 households within fifteen miles of the plant (approximately 4 percent) report that they intend to move. The number that will actually move remains to be determined, but it is significant that these responses (in the NRC survey) were recorded in late July and early August.

The census conducted by the State Department of Health of the population within five miles of the plant gives a preliminary indication of movement from the area. As of 21 August, preliminary hand tabulations of data collected by the Department of Health indicate that 147 households within five miles of TMI were identified as having moved between 1 April 1979 and the end of July (about one percent of the estimated total number of households). Of the movers that had been contacted, 29 percent indicated that their move was motivated by the accident at TMI. If this percent is applied to the total number of households who moved (147), an estimated forty-three households may have moved due to the accident--less than three-tenths of one percent of households within the five mile ring. Additional tabulations on movement from the area will be available in the future, but, to date, out-migration due to the accident appears modest. (Pennsylvania Department of Health, 1979.)

As an additional check on possible out-migration from the area immediately around the plant, elementary school enrollments since the 1974-75 school year were

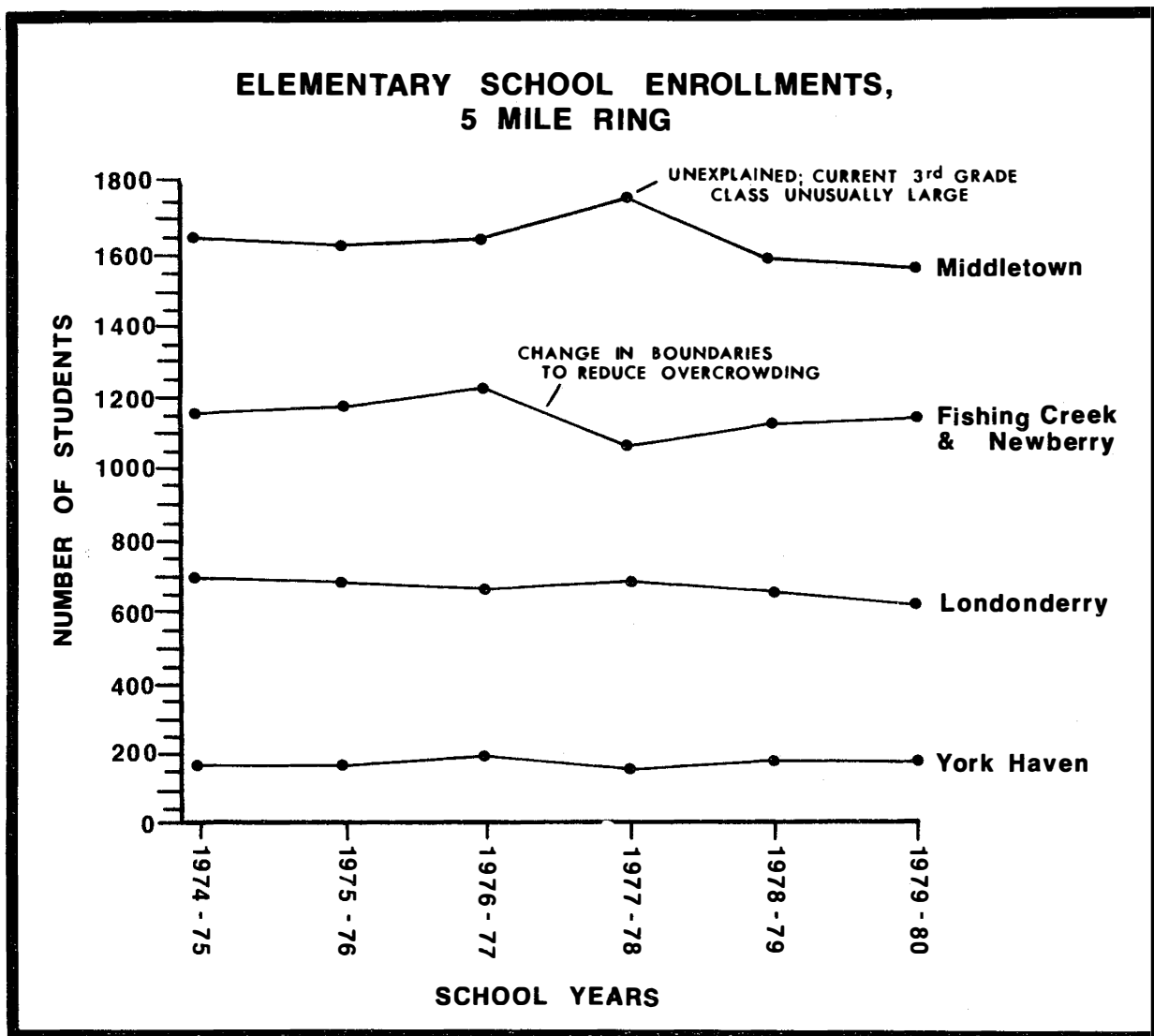


FIGURE IV - 1

SOURCE: MOUNTAIN WEST RESEARCH, INC. 1979

obtained from local officials. Figure IV-1 fails to show any noticeable trend. The only odd points in otherwise smooth trend lines are: 1) the large increase in 1977-78 enrollment in the Middletown Area School District (the current third grade is much larger than classes ahead or behind it, but the reason for this is not yet known) and 2) the dip in enrollment from 1976-77 to 1977-78 for Fishing Creek and Newberry elementaries. Population growth in the early '70s was so great in this area that additional facilities were added to Newberry Elementary School. The school boundaries were redrawn when the school opened to relieve crowding at Fishing Creek and other nearby elementary schools. Since the bulk of the transfer was from Fishing Creek to Newberry, the enrollments for these two have been

aggregated. The dip, therefore, represents children reassigned to other schools. However, the slope of the upward trend since the new boundaries were drawn is quite similar to the slope prior to the redistricting. In no case is there clear evidence of an effect of the accident, and our conclusion remains that even though many families living near the facility report stress and continuing threat due to the proximity of Three Mile Island, relatively few have been sufficiently concerned to relocate their homes because of the accident.

4.3 Post-Accident Period Effects on the Local Economy

4.3.1 Evidence of Continuing Direct Effects on the Economic Base of the Area

By September 1979, six months after the accident, there was no evidence of continuing direct negative effects on the economic base of the area surrounding TMI. A small proportion of manufacturing firms (9.8 percent), and of nonmanufacturing firms (4.1 percent), did report in the Department of Commerce study that they perceived a short-term image effect on their product. In the nonmanufacturing survey, questions were asked about long-term effects, but they have not yet been analyzed (Pennsylvania Department of Commerce, 1979). The manufacturing study was carried out so soon after the accident that it was premature to identify a longer-term effect. Whether these perceived effects have persisted in the long-run, and whether they actually affect sales even if they do exist, is, therefore, an open question. Even in the short-run, these effects were so small that it is unlikely that they are of any long-term importance.

The most vulnerable sectors--agriculture and tourism--have been subjected to studies to try to determine the presence of long-term effects. Within ten miles of TMI, 7 percent of the farmers indicated that they were continuing to experience losses due to the accident. Beyond ten miles, 3 percent reported experiencing losses (Pennsylvania Department of Agriculture, 1979). The Department of Agriculture reported, however, that the loss of sales may be more closely related to the gasoline shortage than to the accident at TMI. The Department of Agriculture concludes in its 24 August report that: "At this point in time, it does not appear that there has been a permanent decrease in sales or a resistance to the buying of agricultural commodities produced or processed in the TMI vicinity" (Pennsylvania Department of Agriculture, 1979).

Concern with possible long-term effects on tourism led to a travel industry-sponsored survey of potential travelers to Pennsylvania. A total of 608 persons were interviewed over the period 26 April-30 April. The results indicated that only 2 percent of the respondents would avoid traveling to Pennsylvania because of concerns regarding TMI and nuclear power. Given the proximity of the date of the survey to the emergency period, it seems unlikely that there are any continuing effects on tourism at this time (Pennsylvania Department of Commerce, Bureau of Travel Development, 1979). It would in fact be almost impossible to determine the actual extent of continuing effects on tourism because the industry was severely affected by several other factors this summer: a polio outbreak in Lancaster County, gasoline shortages, and bad weekend weather. Each of these factors contributed to making the 1979 summer season less successful than usual, and it would not be possible to isolate any independent effects due to TMI, even if they existed.

Interviews with the Small Business Administration (SBA) and with the Bureau of Employment Security (BES) support the conclusion that there has been no continuing direct disruption of the area's economy. The SBA reported that a total of \$423,000 in loans had been approved to assist fifteen firms seriously impacted by the accident. Most of these were general retailers or service-related businesses that suffered adverse financial impacts immediately after the accident. By late summer, very few additional applications were being filed, and they continued to deal only with short-term losses. The loan officer interviewed was unaware of any continuing disruption due to the accident. For purposes of comparison, the SBA officer pointed out that as a result of Hurricane Agnes in 1972, 35,000 loans were made, and that as a result of Eloise in 1975, 1,500 loans were made (Japak, 1979).

Information from the Bureau of Employment Security reinforced these conclusions. There were unemployment insurance claims in April and a few continuations since that time; but, at present, there is no evidence of any continuing economic dislocation due to the accident (Pennsylvania Department of Commerce, 1979).

4.3.2 Indirect Effects on the Economy of the Area

Cost of Power. Although there is no evidence of continuing direct interference with economic activity due to the accident, many people mention

increases in the price of electricity as a possible indirect effect of the accident. Metropolitan Edison Company (Met Ed) and the Pennsylvania Electric Company (Penelec) had been granted rate increases by the Pennsylvania Public Utilities Commission (PUC) in late March 1979 to reflect the inclusion of TMI Unit 2 in their rate base¹. This increase was rescinded after the accident, and, in an order entered 19 June, Met Ed and Penelec were prohibited from including any part of the capital assets of TMI Unit 2 in their rate base. Further, if Unit 1 is not back in service by 1 January 1980, the utilities will be asked to show cause why Unit 1 should not be removed from the rate base. The implication of these decisions is to prohibit the utility from earning any return on a substantial share of its assets. This imposes costs on the investor-owners of GPU, whose common stock has fallen by more than half since the accident.

It remains, however, that Met Ed must purchase replacement power to supply customers that would have been supplied by TMI. At present, monthly replacement power costs are about \$24 million. This is estimated to be reduced to about \$10 million if Unit 1 is restarted. The PUC has been conservative in the amount of these increased costs that the utility has been allowed to pass on. Eventually, it appears that all of these costs will be recoverable by the utility, provided that it can demonstrate that all reasonable steps were taken to minimize these costs.

The PUC maintains that the result of all this is that "the ratepayers of Metropolitan Edison Company and Pennsylvania Electric Company should be no worse off and no better off because of the incident" (Pennsylvania Public Utility Commission, 1979). This statement is confusing because it is not related to any of the principles laid down in the order of 19 June and because its truth clearly depends on the future (unknown) price of replacement power and on what happens to Unit 1. In any event, customers in the Met Ed and the Penelec service areas (see Figure IV-2) are paying more for electricity now than they were before the accident because of the rate increases due to the costs of replacement power. It is the presumption created by the PUC that these rates do not differ substantially from the rates that would have prevailed had the accident not occurred and had

¹The TMI station was constructed by GPU Service Corporation and is operated by Met Ed. The station is owned jointly by GPU's three operating companies: Jersey Central Power and Light (25 percent), Metropolitan Edison (50 percent), and Pennsylvania Electric Company (25 percent).

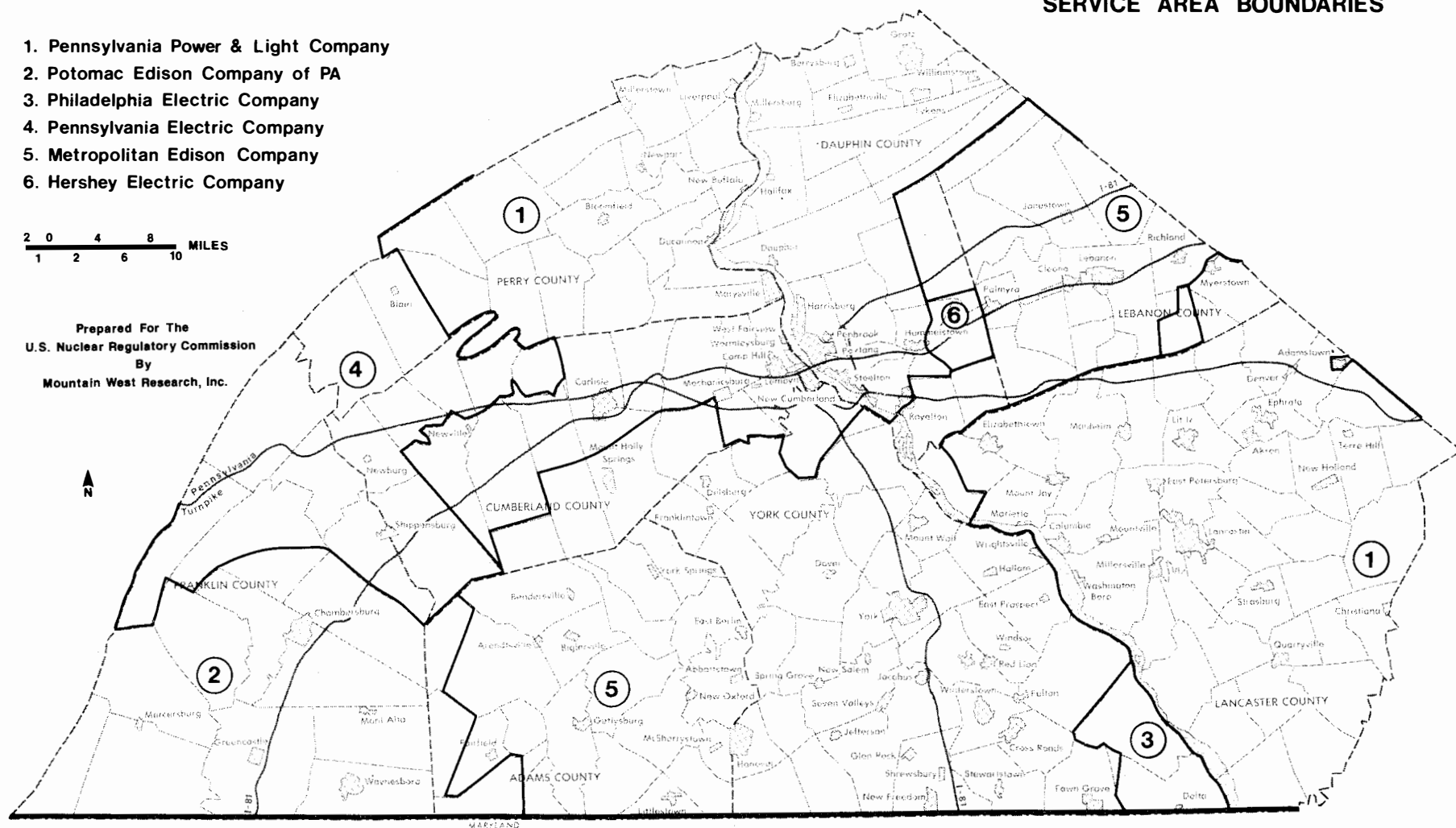
FIGURE IV-2

ELECTRIC UTILITY SERVICE AREA BOUNDARIES

1. Pennsylvania Power & Light Company
2. Potomac Edison Company of PA
3. Philadelphia Electric Company
4. Pennsylvania Electric Company
5. Metropolitan Edison Company
6. Hershey Electric Company

2 0 4 8 10 MILES
1 2 6

Prepared For The
U.S. Nuclear Regulatory Commission
By
Mountain West Research, Inc.



Unit 2 been included in the rate base. Discussions with area businessmen made it clear, however, that all of the rate increases were perceived by the public as being due to the accident. It is also true that rates will have to be raised further to cover the full costs of replacement power. If the Unit 1 restart is substantially delayed, the total price increases could be large. We shall return to the potential significance of these changes in the cost of power on the local economy in Section V. It is sufficient to conclude here that electricity prices in the six months following the accident have probably not been substantially different in the Met Ed and Penelec service areas than they would have been in the absence of the accident although this is clearly not the public perception. The perception may itself be responsible for future measurable economic effects, but through the first six months following the accident, the local economy does not appear to have been adversely affected to any measurable degree by increases in the cost of power.

Personnel Costs. A second possible source of indirect effect on the local economy is associated with increased employee recruiting expense due to difficulties in attracting individuals to the area or to turnover of existing employees. It was assumed that personnel directors of the largest employers in the area would be aware of these kinds of problems if they were in fact occurring. Eleven large firms were contacted. In only one case was any turnover attributed to the accident. In that case, it was thought that 4 or 5 employees (out of 1200) may have left the area due to the accident (Miller, 1979). Even more important because of its potential to be a continuing problem, the personnel directors responded uniformly that they could not identify a single instance in which resistance to the area affected a potential job recruit. Proximity to TMI was often reported to be a subject of jokes and small talk, but their opinion was that recruiting had not been affected by the accident.

In general, the impression given by these personnel directors was that the greater Harrisburg area was large enough that there were ample residential alternatives relatively far from TMI to satisfy persons who did not want to live close to the plant. Thus, although there might be some redistribution within the area, they felt it very unlikely that individuals would resist the area in general. The resulting conclusion is that indirect effects on the local economy through increased costs of holding or recruiting personnel do not appear to have occurred.

Clean-up and Rehabilitation Expenditures. A third potential source of indirect effect on the local economy is the expenditure being made by GPU for plant stabilization, monitoring, clean-up, and special investigations. Through 31 July 1979, this expenditure amounted to \$57 million, and it appears reasonable to expect that funds are continuing to be spent at the rate of approximately \$10 million per month (SRI International, 1979). Thus, through the end of September 1979, approximately \$80 million has been expended, some portion of which will have been spent in the local area. The largest part of the stimulus to the local area will likely be associated with the substantial influx of maintenance, repair, and technical workers necessitated by the accident. GPU is presently preparing data on the total work force employed at the site since the accident, but the data have not yet been received. Local estimates are that the work force has increased from 500 (prior to the accident) to 1500. Once these data are available, it will be possible to get an order of magnitude estimate of this stimulus to the local economy.

Effects on the Value of Real Estate. One of the most common presumptions held by persons living outside the immediate vicinity of Three Mile Island is that the value of real estate must have been seriously affected. Even the surveys of area residents frequently produced responses that indicated concerns with potential effects on the value of real estate. Countering these presumptions has been a consistent and highly visible claim by local realtors that there have been no effects. For example, the 20 August issue of The Harrisburg Evening News ran a feature titled "Nuclear Clouds Cast No Shadows on Real Estate Values." The conclusion of the article was that real estate had not lost value. No evidence was presented except for specific instances of sales substantially in excess of purchase price which, of course, does not control for all the other relevant factors affecting market price. It is significant, however, that the public posture of the local real estate community is that there has been no effect. In the same article, the president of the Greater Harrisburg Board of Realtors was quoted as follows: "I don't see any change in property values due to Three Mile Island. Prices are still going up. It's business as usual."

A realtor who deals almost exclusively in the five-mile area provided additional insight on residential transactions since the accident. To date, he does

not feel that the market has suffered because of the accident. His conclusions are based on monthly data on listings, sales, and settlements over the period 1977-1979. Both listings and sales took a very noticeable dip in April but appear to have been normal since that time. Further, there is no evidence from the settlement trend that buyers were less prone to complete sales they had begun prior to the accident (Bitner, 1979).

Two factors said to have helped to sustain sales is GPU's liberal transfer policy combined with the expansion of the work force at TMI. Although many of the additional workers are construction workers or other temporary workers, some are GPU employees who have been transferred to the site. GPU regularly pays closing costs and other similar costs for those who sell their former residence and buy another when they are transferred. If their previous house does not sell, GPU buys it. Thus, these workers are not concerned about reselling their residence near TMI when they are transferred out again because GPU will buy their house if necessary. (Bitner, 1979.)

A study soon to be undertaken by Pennsylvania State University will determine whether proximity to TMI is having any systematic effect on property values. Short of this approach, which will not produce any answers until mid-1980, the Pennsylvania Department of Community Affairs has done a useful compilation of data comparing certain characteristics of property sales within five miles of TMI relative to the same characteristics for the entire Central Penn Multi-List Area. Figure IV-3 summarizes these comparisons. Units sold in the five mile radius have averaged about 6 percent of the area total over the past two and one-half years. Second quarter sales this year were only 5 percent of the area total, but the figures show that this ratio has been subject to considerable quarter-to-quarter variability. There do not appear to be any unusual developments during the second quarter in either the sales price or the sales-price-to-listing-price ratio. However, the "average days on the market" does look suspicious. Real estate in the five-mile radius has traditionally been on the market a shorter period of time than for the area as a whole. This relationship changed significantly in the second quarter of 1979 and, if it continues, may be indicative of buyer resistance.

RESIDENTIAL PROPERTY SALES COMPARISONS FOR TMI 5-MILE RADIUS RELATIVE TO CENTRAL PENN MULTI-LIST AREA

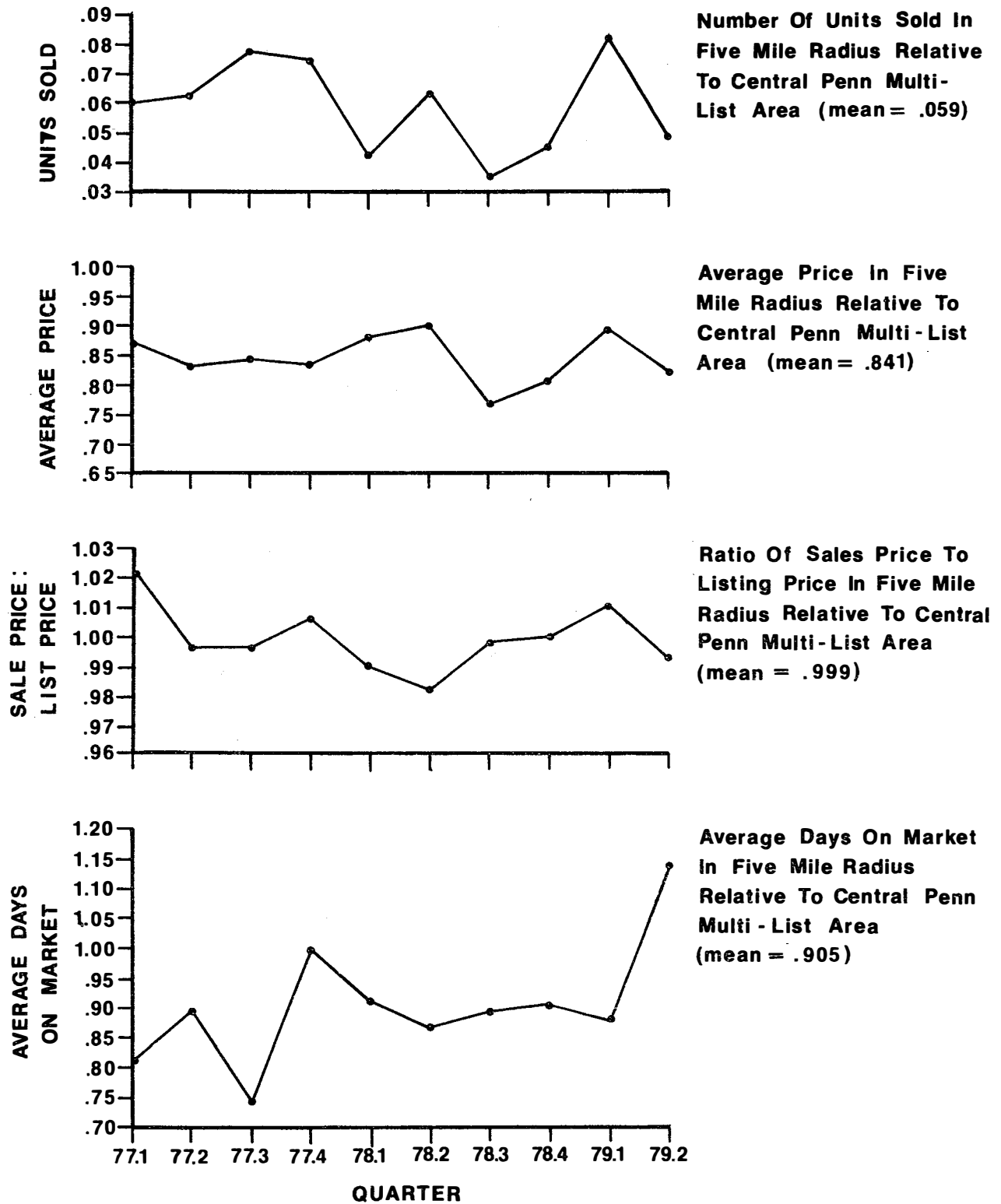


FIGURE IV - 3

**SOURCE: PENNSYLVANIA DEPARTMENT
OF COMMUNITY AFFAIRS**

4.4 Institutional and Political Effects

Very few of the health and social service institutions discussed in the context of the emergency period have experienced any effects from the accident beyond the emergency period. Most have spent little or no time since the accident on refining their evacuation plans. Hospital occupancy is back to normal, and schools are in session. Clergy do not report any increase in counseling needs because of the accident. There is no evidence of increased patient loads at mental health facilities.

However, the accident has affected the organization of Civil Defense (CD) groups in some areas. In one case, the number of CD deputies has increased from two to seven; the additional men are receiving specialized training at this time. In some areas, it is also expected that emergency personnel will request additional equipment from the municipal authorities, so there may be a resulting fiscal effect of the accident. The activities of the CD groups have generally increased markedly since the accident. Most municipalities have put in many person-hours of effort on a revised evacuation plan since the accident and are continuing to do so. In some cases, these efforts have involved members of the public and of anti-nuclear groups.

Other institutional effects vary considerably by municipality. Perhaps the most dramatic change is the resignation of the chief elected official of one municipality, directly because of the accident. Decisions he made during the emergency have continued to be questioned in public meetings, in private, and in the press. As a consequence, his effectiveness as an elected official has been impaired, although he had been elected by a landslide for a six-year term about two and one-half years prior to the accident. On the other hand, a second local official is perceived by many to have done an especially good job. He has already been approached about running for the U.S. Senate because of his performance and visibility.

Since the accident, local officials have had an added pressure group to deal with. Half of the six municipalities in the local area have their own anti-nuclear groups. Members of these groups are committed to keeping TMI closed and have

exerted pressure on their local elected officials to pass resolutions opposing the reopening of TMI. Those legislative bodies that have been requested to do so have passed such resolutions. In one case, mailed postcards were sent to everyone over age eighteen soliciting their opinions before the resolution was passed. The provisions vary among the municipalities but include such concerns as: opposition to the restarting of both units, support of restarting if proper safeguards are established, abolition of the Price-Anderson Act, and an end of the nuclear exclusion provisions in homeowners' insurance policies. These groups also observe the efforts of local officials to obtain monitors and other safety equipment, to develop emergency plans, and generally to deal with the utility. Given the intensity of their feelings, the pressure they exert is not insignificant.

The accident at TMI has sensitized the population and has led to an increase in citizen participation. Many persons in anti-nuclear groups attended council/supervisor's meetings for the first time. Local bodies had at least one or two meetings with much higher-than-usual participation. Reports of the meetings indicate that they were generally orderly, with the exception of the 20 June meeting held in Middletown. The stated purpose of that meeting was to solicit the opinions of local residents about TMI so that the council could later frame a resolution. However, participants wanted the council to state their opinions that night and cornered councilmen after the meeting was adjourned. Police escorts were required for the council to leave the building. The original intent of the Middletown Borough Council was to defer passing a resolution until research findings from the State of Pennsylvania and the President's Commission were available. However, when consideration was being given to restarting TMI-1 in August 1979, the council passed a resolution opposing the restart. Since the resolutions have been passed, participation at council/supervisor's meetings has dropped to more typical levels. However, a few individuals continue to participate at higher levels than they did in the past and to express their opinions on other topics as well.

The anti-nuclear groups themselves represent an institutional change in this area. Prior to the accident, opposition to TMI included the Three Mile Island Alert (TMIA), a Harrisburg-based group, and the Environmental Coalition on Nuclear Power (ECNP), a state-wide organization. Both of these groups have increased

their membership and operating funds substantially since the accident. In addition, three groups in the immediate area have formed (Persons Against Nuclear Energy, Middletown; Concerned Citizens of Londonderry; and The Newberry Township Steering Committee). There are additional groups farther south (Anti-Nuclear Group Representing York and the Susquehanna Valley Alliance) which are concerned about Peach Bottom as well.

This proliferation of groups has led to predictable disagreements regarding turf, methods of proceeding, and intergroup structure, although recent efforts to resolve these issues have been initiated. Although no systematic study of group membership size or characteristics is available, the anti-nuclear groups seem to include a cross-section of the population residing in the TMI region. Those who have become most active in the groups are devoting a large portion of nearly every day to meeting their goals. For those who had never been politically active in the past, this represents a substantial change in their life-style. People who did not know each other prior to the accident have become friends, and other social activities have taken second place to anti-nuclear activities. Locally, pro-nuclear people perceive the anti-nukes as sincere and honest. Unlike the anti-nukes, the pro-nuclear people have not organized to have TMI reopened.

V. POTENTIAL LONGER-TERM EFFECTS OF THE ACCIDENT

5.1 Introduction

The purpose of this report has been to present what is presently known with respect to the social and economic consequences of the accident at Three Mile Island on the residents of the area surrounding the plant. Given that our research into the consequences of the accident is on-going, we have thought of this report as an interim statement on findings to date. However, much of current behavior in the area is shaped by speculation about the future. People are concerned about the implications of various proposed alternatives for the TMI facility. Since some of the concerns have serious implications, it seems appropriate to delineate them. Furthermore, it needs to be made explicit that the effects of the accident are not over even though many of the effects of the accident appear to have dissipated in the post-accident period.

Uncertainty is a dominant characteristic of the situation presently surrounding the future of the generating facilities at Three Mile Island. There are three major areas of uncertainty. The first concerns regulatory treatment of both Unit 1 and Unit 2. Important decisions will continue to be made both by the U.S. Nuclear Regulatory Commission, by the Pennsylvania Public Utility Commission, and by the Pennsylvania Department of Environmental Resources. These decisions will affect the timing of restart/rehabilitation alternatives, the technical characteristics of feasible options, and the financial condition of GPU. The second area of uncertainty concerns the technical characteristics of the rehabilitation plan GPU will propose to pursue. Questions of fuel source, timing, safety, and environmental characteristics of the plan proposed will depend both on regulatory decisions and on the extent of the damage to the reactor core, which will not be known for some time. Finally, there will continue to be uncertainty with respect to the financial capability of GPU to operate under the options that are presented to it by the regulatory authorities. Less easy to characterize, but equally important, will be the ability of GPU to gain the confidence of the regulatory authorities and the residents of the area.

The cumulative uncertainty that arises from the interaction of these contingencies is substantial and may itself be a source of adverse impact on the

area. The purpose of the remainder of this section is to try to trace out these possible longer-term effects under the range of conditions that may ensue. Since the effects on individuals will be shaped in part by economic and institutional considerations, they will be covered last in this section.

5.2 Potential Longer-Term Economic Effects

5.2.1 Cost of Power

At the present time, there is substantial confusion about the effect of the accident on the price of electricity. There is no definitive work that establishes baseline electricity price projections in the absence of the accident, electricity price projections under different restart/rehabilitation scenarios, direct effects of any changes in price on area firms under each of the scenarios as compared to the nonaccident case, and indirect effects on the level of economic activity and on its spatial distribution among utility service areas. The State of Pennsylvania is beginning work on these issues.

An indication of the potential order of magnitude of the replacement power costs (which will likely have to be borne by the ratepayer) and of the capacity replacement costs (likely borne by GPU) can be gained from the work on economic impact prepared for the President's Commission (SRI International, 1979). Table V-1 shows that three scenarios were examined assuming the rehabilitation of Unit 2, and four scenarios, assuming the replacement of Unit 2. Use of these numbers beyond indicating approximate orders of magnitudes of costs should not be attempted without an understanding of the assumptions on which they are based. The table does show clearly, however, the large absolute magnitude of the totals, the relative importance of replacement power costs, and the sensitivity of the cost of replacement power to timing assumptions.

It appears, therefore, that the price effects could be substantial and that, given the energy intensity of industry in the local area, the long-term economic implications of these increases could be large. The effects might be of several types: reductions in the levels of production, employment, and income in the local area; the spatial redistribution of growth in favor of utility service areas other than Met Ed and Penelec; and the redistribution of income from the customers of Met Ed and Penelec to the sellers of surplus power, many of whom also live in Pennsylvania.

TABLE V-1
REPLACEMENT POWER COSTS AND PLANT
REHABILITATION/REPLACEMENT COSTS
(Constant 1979 Dollars)

| | Replacement Power Costs (Millions) | Plant Rehabilitation or Replacement (Millions) | | |
|-----------------------------------------------------|------------------------------------------|------------------------------------------------------|--------|--------|
| | | Low | Medium | High |
| <u>Rehabilitation of TMI-Unit #2</u> | | | | |
| Scenario 1: TMI #1 Jan. 1980 TMI #2 Jan. 1983 | \$ 576 | \$249 | \$306 | \$ 503 |
| Scenario 2: TMI #1 Jan. 1981 TMI #2 Jan. 1984 | 864 | 249 | 306 | 503 |
| Scenario 3: TMI #1 Apr. 1981 TMI #2 Jan. 1985 | 1,026 | 249 | 306 | 503 |
| <u>Replacement of TMI-Unit #2</u> | | | | |
| Scenario 4: Nuclear - TMI Site | 1,644 | 538 | 593 | 719 |
| Scenario 5: Nuclear - New Site | 1,644 | 780 | 974 | 1,176 |
| Scenario 6: Coal - TMI Site | 1,404 | 468 | 503 | 614 |
| Scenario 7: Coal - New Site | 1,164 | 587 | 670 | 815 |

Source: SRI International, Economic Impact of the Accident at Three Mile Island,
September 1979.

Interviews with representatives of Chambers of Commerce and of industrial development corporations indicated a high sensitivity to the implications of the accident to the "image" of the area. They emphasized, however, that the seriousness of the problem depended almost entirely on the extent to which there

were real differences in the costs of doing business in the area as a result of the accident. In this connection, present electricity prices and, even more importantly, uncertainty with respect to future prices, were seen as very serious problems in industrial recruitment efforts.

In the Department of Commerce's study of manufacturing firms, a ten percent increase in the price of electricity caused 22 percent of firms to indicate that they would not expand in the area (if they were considering expanding), and caused 30 percent to report that their plans to remain in the area would be affected. Among the nonmanufacturing firms, 13 percent reported they would not expand in the area, and 33 percent reported that their plans to remain in the area would be affected by a ten percent increase in the price of electricity. Even more significant, 62 percent of the nonmanufacturing firms reported that their plans to remain in the area would be affected by a twenty-five percent increase in electricity prices. These data, combined with discussions with area businessmen, tended to reinforce the conclusions that much of the so-called image problem was directly associated with potential effects on the cost of electricity. Significant price increases would undoubtedly affect some relocation or expansion plans. Even the possibility of these effects could have serious consequences. (Pennsylvania Department of Commerce, 1979.)

5.2.2 Other Potential Longer-Term Economic Effects of the Accident

If there were no cost-of-power effects, the only other potentially significant aggregate economic impact of the accident would be the stimulus received by the local economy associated with the rehabilitation or replacement of Unit 2. Depending on the plans finally decided upon, the area could receive a long-term economic stimulus equivalent to a \$300-500 million construction project.

If the cost of power does rise significantly, however, there will be direct effects on power users and then additional secondary effects on all parts of the local economy. These would in turn induce demographic effects that could lead to impacts on community facilities, services, and finances.

5.3 Locational Preference, Settlement Patterns, and Longer-Term Effects on the Value of Real Estate

The NRC survey established that a large number of residents living in the vicinity of the plant had considered moving. It appears, however, that few have yet acted on this thought. A move within the greater Harrisburg area would probably allow existing employment to be maintained. For individuals who are single and presently occupy rental housing, the move might be relatively easy. For those who own property, however, or who have a spouse or children both the financial and the psychological costs of changing residence are likely to be substantial. Even more extreme is the case of a move out of the Harrisburg area. In addition to all the above considerations, decisions would have to be made with respect to employment and career options, and there would also probably be more uncertainty with respect to some of the potential costs.

It is not surprising, therefore, that there was not an immediate rush from the area. Similarly, the apparently small out-migration to date is not necessarily inconsistent with the fact that substantial numbers of residents may still be seriously considering leaving. The extent of the continuing stimulus to move will be influenced by the events of the next several years. The actual decisions reached, the extent of public participation in the decisions, the clarity with which these decisions are communicated, and the public's confidence in the decision-making bodies will affect the willingness of the area's residents to continue to live near TMI.

Potential effects on real estate values will be determined by similar considerations. Many persons assume that it is only rational that a prospective real estate purchaser demand, and be given, some compensation for the risk associated with TMI-related uncertainty about future real estate values in the vicinity of the plant. At the same time, many buyers may be oblivious to this fact. Moreover, a relatively large number of unconcerned buyers, compared to a small amount of property on the market in the vicinity of the plant, may result in no perceptible impact on selling price.

It must also be noted, however, that there is a potential for a self-fulfilling prophecy such that expectations of effects are themselves responsible for their realization. This carries the implication that market conditions can change rapidly.

Residents of the area have a vested interest in maintaining that there have been no adverse value effects, and their resolve has undoubtedly had much to do with the relative firmness of the market. If this resolve is maintained, market conditions could continue as they have, but if local attitudes or expectations change, cumulative effects would be set in motion that could seriously impact local real estate values in a short period of time.

5.4 Political/Institutional

The necessity for emergency preparedness is obviously increased if one or both units at TMI are restarted. At the present time, many institutions that would need good, comprehensive evacuation plans do not have them. In some cases, there are not effective means for notifying (particularly rural) residents quickly of the need to take cover or evacuate.¹ The confidence of residents in public officials was seriously eroded during the emergency. One key to restoring that confidence is for the public to become convinced that adequate plans exist for assuring their safety.

For some, however, even a small risk of a second emergency is too large; these people are committed to keeping both units closed permanently or converting the station to an alternate energy source. Such persons have organized into anti-nuclear groups with these goals and are presently using legal procedures to stop the reopenings. If they are successful, and are assured that neither unit will ever again operate as a nuclear plant, some groups will lose members, and at least one group (PANE) may dissolve completely.

However, if there is an attempt to restart Unit 1, it is the consensus of both pro- and anti-nuclear persons that there will be demonstrations in the area. Given the direct experience with the emergency period that many of these people had, it is not unreasonable to assume that feelings at TMI would run high. It is not surprising, therefore, that local law enforcement personnel are concerned about the implications of a ruling that TMI-1 be allowed to restart.

¹For example, the authors still do not know the difference between a "take cover" and a "get out quickly" signal for Middletown.

Another event that concerns local public safety officials is the anniversary of the accident on 28 March 1980. Local groups expect to have demonstrations on that date. The tenor of the demonstrations will be influenced, of course, by the perceived probability of the units restarting. The activity of anti-nuclear groups will also be affected by the perceived safety of the procedures chosen to clean up Unit 2.

The second potential long-term institutional effect of the accident is reconsideration of growth policies in the area. There are very preliminary indications that banks may already be red-lining new development within the five-mile ring. For instance, a developer with a partially completed project was unable to obtain a letter of credit for putting in the roads to the specifications recently passed by the planning committee (Smith, 1979). As a consequence, a question has been raised in one municipality as to whether it should encourage growth within five miles of TMI, especially if one or both units restart. Whether the municipalities and other units of government continue to promote growth near TMI, as has occurred during the last ten years, will have an important effect on the residents of the area.

5.5 Potential Longer-Term Effects on Individuals

Many of the effects mentioned in earlier sections of this chapter directly affect individuals. If the cost of power to the ratepayers eventually increases over and above what it would have without the accident, this will affect those ratepayers near TMI who are GPU customers. Furthermore, if the cost of electricity to GPU customers is substantially higher because of the accident, this may cost the area's jobs, since many employers in the area are heavy users of electricity. On the other hand, those ratepayers near TMI who are not GPU customers may indirectly benefit from the accident for a period of time if their utility earns extra profit by selling replacement power to GPU.

Among those who are likely to be especially impacted by negative economic effects on the area are those individuals with substantial investments in the area. These would include not only local businessmen, but also large property owners, especially farmers. Given the uncertainty about the plant's future, these peoples' assets are likely to be less liquid. In the event that either unit is restarted as a nuclear plant, there is likely to be an adverse effect on the price of adjacent farm land, given the hard choices farmers faced during the emergency.

Clearly, there were people in the area who were seriously upset by the accident and their own evacuation experience. Many of these people are concerned about the lack of warning when the major releases occurred and about their children's health. People with these feelings would feel compelled to move if either unit restarted as a nuclear plant; they would view it as irresponsible to subject either themselves or their children to any risk of additional radiation.

Another potential long-term effect is a change in attitudes among some who were affected very little during the emergency period. During construction, these people paid very little attention to TMI, and even during the accident they essentially went about their business. But continued contradictory news coverage of TMI has provoked a desire during the first six months for "it to be over with." Discussion of TMI drags on, and it is likely to be in the news for several more years. These people are already exasperated by the interminability of the discussion and are coming to resent the fact that TMI was ever built.

Finally, there is some potential risk to the health and safety of residents near TMI. It appears at present that the health effects from the accident itself are not large. However, it is unclear at this time what the possible effects of various rehabilitation scenarios might be. For instance, there is current concern about the tritium remaining in the waste water after EPICORE-II cleans as much as it can. Although the water is currently being stored on-site, this is not an effective long-term solution. There is also concern about the proposed venting of noble gases, which some local residents view as a small risk to their health. Pregnant women appear especially concerned. Given the disagreements among experts about the effects of long exposure to low-level radiation, it is not surprising that the general public would be concerned about the various rehabilitation options.

The inescapable conclusion, and a discouraging one for residents of the area, is that the accident continues to have the potential to affect their lives. The individuals of the area around Three Mile Island recognize this and understandably resent it. Until that vulnerability is eliminated, until more certainty surrounds the future of the facility, the accident will continue to be an unsettling influence on the lives of these people.

APPENDIX

The purpose of this section is to provide a brief description of the methodologies used for the surveys cited in the text. More complete discussions of the methodologies and findings are available from the published reports.

Brunn, Stanley D., James H. Johnson, Jr. and Donald J. Ziegler

- 1979 Final Report on a Social Survey of Three Mile Island Area Residents.
Michigan State University, Department of Geography.

A stratified sample of 178 addresses was chosen from the Harrisburg and York telephone directories, with a proportionately greater number chosen from communities nearer TMI. An additional 122 were randomly selected from the Carlisle, Duncannon, and Lancaster urban areas. One-hundred fifty responses were received to the mailed survey. The measure of distance used was perceived distance from TMI.

Flynn, C. B.

- 1979 Three Mile Island Telephone Survey: Preliminary Report on Procedures and Findings. Washington, D.C.: U.S. Nuclear Regulatory Commission.

A stratified sample of households were random-digit dialed. Households nearer TMI had a greater probability of selection. One-thousand five hundred and four half-hour surveys were completed, and weights are available for estimating population totals within fifteen miles of TMI. The measure of distance used in tabulations was the distance from the community to TMI. Perceived distance is also available (frequently referred to as the NRC survey in text).

Dohrenwend, Bruce P., Raymond Goldsteen, et al.

- 1979 Report of the Task Force on Behavioral Effects. Presidents' Commission on Three Mile Island.

Data gathered by Raymond Goldsteen (so cited in the text) used a variety of methodologies. They indicate "strict probability sampling procedures . . . to select households at random" from the twenty-mile radius of TMI and the Wilkes-Barre region (no further specification of methodology); place stratified-random sampling from telephone directories; birth listings in newspapers for mothers of young children; entire classrooms of students (selection procedures not specified); and a convenience sample of mental health clients. It appears that the data represent a combination of telephone, face-to-face, and mailed interviews.

Kraybill, Donald B.

- 1979 Three Mile Island: Local Residents Speak Out. Elizabethtown College, Social Research Center (unpublished).

Respondents were selected by a multi-stage, simple random sample of residential telephone numbers from three directories: Middletown, Marietta, and Elizabethtown. All respondents live on the east side of the Susquehanna River within a fifteen-mile radius of Three Mile Island. Polling began on Monday evening (2 April 1979) after the mass media reported that the immediate crisis had abated. Interviewing continued through Sunday evening (8 April 1979) in order to include returning evacuees. The results are based on 375 completed interviews.

Barnes, Kent, et al. (Rutgers Study)

- 1979 Human Responses by Impacted Populations to the Three Mile Island Nuclear Reactor Accident: An Initial Assessment. Department of Environmental Resources, Rutgers University. Unpublished.

A mailed questionnaire was sent to a sample of 922 respondents selected from reverse telephone directories stratified by distance (five 5-mile zones up to 20 + miles) and direction (north, east, south, and west) from TMI. Equal sample sizes were selected from each of the twenty units. Three hundred sixty surveys were returned; more were returned from closer to TMI. Distance was determined by telephone exchange (cited as "Rutgers study" in the text).

Pennsylvania Department of Health

- 1979 Preliminary tabulations, unpublished.

Exchanges within five miles of TMI were random-digit dialed in July 1979 to produce 690 respondents.

Smith, Martin

- 1979 Preliminary tabulations, unpublished. Franklin and Marshall College, Lancaster, Pennsylvania.

One hundred thirty-five households with Middletown exchanges were randomly selected from the Harrisburg telephone directory. One hundred twenty-three schedules were completed.

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- 1979 "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station."

Barnes, Kent et al. (Rutgers Study)

- 1979 Human Responses by Impacted Populations to the Three Mile Island Nuclear Reactor Accident: An Initial Assessment. Rutgers University, Department of Environmental Resources (unpublished).

Brunn Stanley D., James H. Johnson, Jr. and Donald J. Ziegler

- 1979 Final Report on a Social Survey of Three Mile Island Area Residents. Michigan State University, Department of Geography.

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Chariff, Candy. Volunteer, Red Cross. 6 April 1979.

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Maxwell, David. President of Supervisors, Londonderry Township. 18 September 1979.

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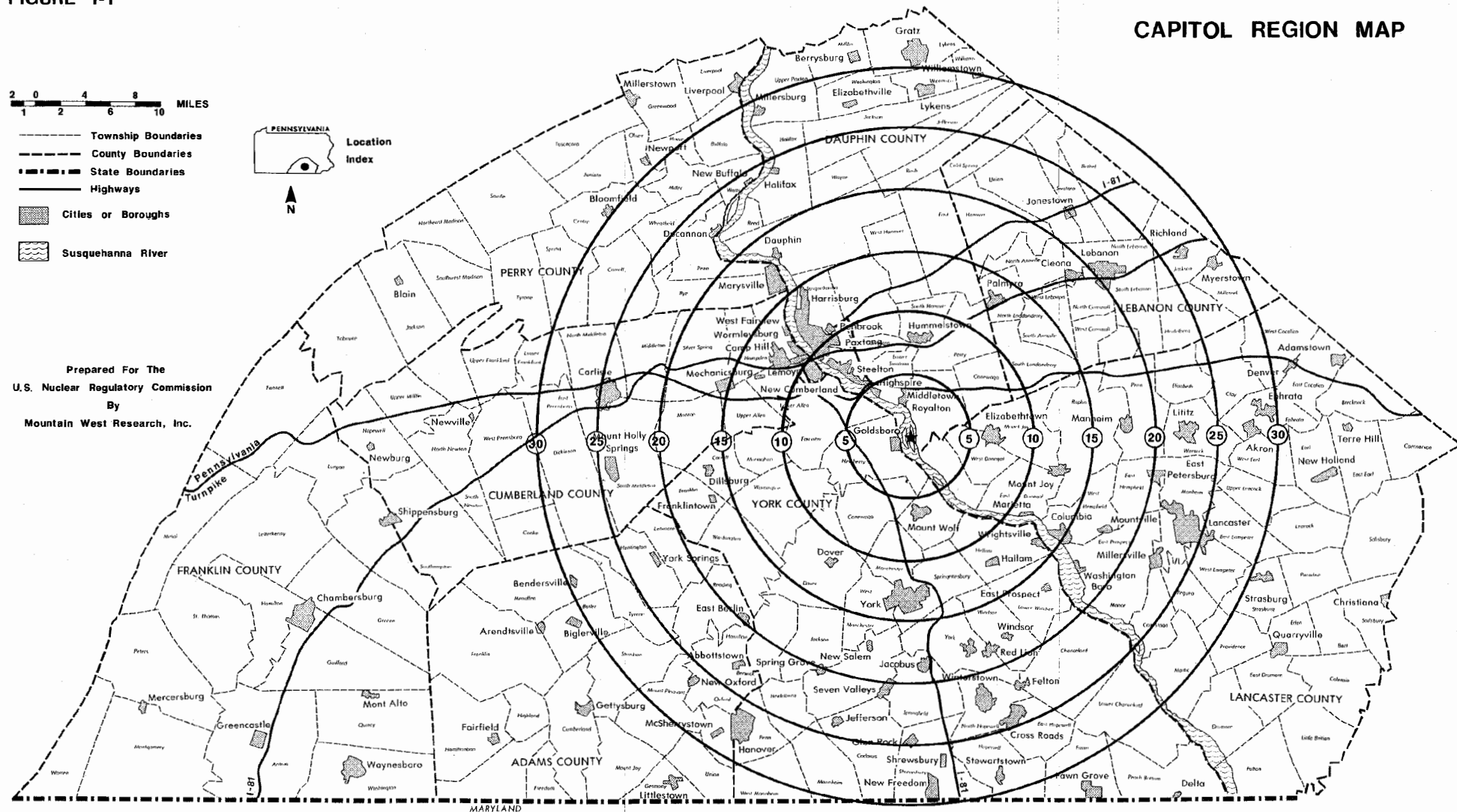
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FIGURE I-1

CAPITOL REGION MAP



| | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------------|-------------------------------|
| NRC FORM 335 (7-77) | | U.S. NUCLEAR REGULATORY COMMISSION BIBLIOGRAPHIC DATA SHEET | | 1. REPORT NUMBER (Assigned by DDC) NUREG/CR-1215 | |
| 4. TITLE AND SUBTITLE (Add Volume No., if appropriate) The Social and Economic Effects of the Accident at Three Mile Island - Findings to Date | | | | 2. (Leave blank) | |
| | | | | 3. RECIPIENT'S ACCESSION NO. | |
| 7. AUTHOR(S) C. B. Flynn and J. A. Chalmers | | | | 5. DATE REPORT COMPLETED | |
| | | | | MONTH YEAR November 1979 | |
| 9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Mountain West Research, Inc. with Social Impact Research, Inc. 1414 West Broadway, Concordia Building, Suite 228 Tempe, Arizona 85282 | | | | DATE REPORT ISSUED | |
| | | | | MONTH YEAR January 1980 | |
| 12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Division of Safeguards, Fuel Cycle and Environmental Res., Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D. C. 20555 | | | | 6. (Leave blank) | |
| | | | | 8. (Leave blank) | |
| 13. TYPE OF REPORT Topical Report | | | | PERIOD COVERED (Inclusive dates) March 1979 - September 1979 | |
| | | | | 10. PROJECT/TASK/WORK UNIT NO. | |
| 15. SUPPLEMENTARY NOTES | | | | 11. CONTRACT NO. NRC-04-78-192 | |
| | | | | 14. (Leave blank) | |
| 16. ABSTRACT (200 words or less) This report covers the social and economic effects of the accident at Three Mile Island during the first 6 months following the accident. A variety of data sources were utilized including published documents and statistics, household surveys, newspaper files, interviews, and other research about the accident. The findings can be grouped into effects on (1) the regional economy, (2) institutions, and (3) individuals. Direct economic effects during the emergency period following the accident were interrupted local production and reduced local income and employment. Losses were conspicuous during the first week of April but subsequently very minor. There is no evidence of any continuing interruption of activity because of the accident. However, there is concern within the business community about the effect of the accident on the continued growth & development of the area. Major institutional effects were a strain on the emergency preparedness network in the area & an increased focus on the issue of the TMI plant by the local populace. Major effects on individuals were the evacuation itself & increased stress during the accident period. For most people, the effects of the accident were short-lived, but for others, the accident has caused a more permanent change in their day-to-day activities. | | | | | |
| 17. KEY WORDS AND DOCUMENT ANALYSIS socioeconomic impact Three Mile Island | | | 17a. DESCRIPTORS | | |
| 17b. IDENTIFIERS/OPEN-ENDED TERMS | | | | | |
| 18. AVAILABILITY STATEMENT Unlimited | | | 19. SECURITY CLASS (This report) Unclassified | | 21. NO. OF PAGES 99 |
| | | | 20. SECURITY CLASS (This page) | | 22. PRICE \$ |

