EMERGENCY PLANNING: THE CASE OF DIABLO CANYON NUCLEAR POWER PLANT

June Belletto de Pujo
California Polytechnic State University

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SUMMARY

This study was undertaken to demonstrate how the behavioral profile of communities should be incorporated into the process of emergency response planning, and to test the level of preparedness of people living near the Diablo Canyon Nuclear Power Plant site. It specifically examines the social planning problems involved in responding to modern hazards. A telephone survey was administered to sample households in San Luis Obispo County. The interviews provided data on residents' attitudes toward and awareness of issues regarding emergency planning for the Diablo Canyon Power Plant, and therefore provided insights into the perceptions, preferences, knowledge, and levels of confidence of affected citizens. It was found that the San Luis Obispo County Nuclear Power Plant Emergency Response Plan inadequately addresses the behavioral components that contribute to plan effectiveness and that citizens are not prepared for an emergency at the plant.

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PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers be used as working documents by those directly involved in hazard research and as information papers by the larger circle of interested persons. The series was started with funds from the National Science Foundation to the University of Colorado and Clark University, but it is now on a self-supporting basis. Authorship of the papers is not necessarily confined to those working at these institutions.

Further information about the research program is available from the following:

William E. Riebsame
Institute of Behavioral Science #6
University of Colorado
Boulder, Colorado 80309

Robert W. Kates
Graduate School of Geography
Clark University
Worcester, Massachusetts 01610

Ian Burton
Institute for Environmental Studies
University of Toronto
Toronto, Canada M5S 1A4

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INTRODUCTION

Planning for protection from hazards is a recent development; comprehensiveness in hazard planning is newer still. Comprehensiveness means integrating physical, social, and economic concerns. It means combining technology with judgment and priorities. It calls for a well-rounded approach that incorporates various elements into the evaluation process. Finally, it requires a continuous process of review.

Nuclear power plants are defined by the California State Office of Planning and Research (1980, p. 133) as a "potentially hazardous facility;" they pose a definite risk to the surrounding environment. Yet communities cannot always control the placement of nuclear plants, any more than they can determine the course of a flood, hurricane, or fire. A case study approach, using the San Luis Obispo area as a laboratory, and the county's emergency response plan for the Diablo Canyon Nuclear Power Plant as the issue, provides an opportunity to examine policy development for emergency planning for such facilities.

Diablo Canyon Nuclear Power Plant is located in the county of San Luis Obispo, California, on approximately 750 acres of land adjacent to the coastline. The plant contains two reactor units of the pressurized water type. Each unit has the capability of producing over one thousand megawatts of power. At the time of this study the facility, which is owned by Pacific Gas and Electric Company (PG&E), was under review by licensing boards, and PG&E anticipated authorization of a low-power test license.

Construction of the plant began in 1968, and early projections estimated completion sometime in 1971. Ten years later, because of serious setbacks, neither of the domed units had begun to produce power. There had been a significant degree of debate over the potential dangers associated

with nuclear power generation at the Diablo Canyon site, and the long-term problems related to radiation and its effect upon the environment are still largely unresolved.

The site of Diablo Canyon is adjacent to growing communities as well as heavily used recreational and coastal areas. All levels of government have recognized the need to protect these areas and their inhabitants from potential radiation exposure, and have developed warning systems and evacuation plans. A final emergency response plan for the county has been adopted, but fulfillment of legislative requirements is not necessarily synonymous with successful preparedness of the public. The nuclear power emergency response plan for San Luis Obispo County focuses on bureaucratic solutions; human behavioral characteristics have been largely ignored.

Planning Approaches and Research Objectives

Once policies have been established, an emergency response plan can be developed in several different ways and take several different forms.

Approach A. The first approach is administratively centered; it utilizes planning from the top down, and emphasizes logistics and lines of authority. It favors well-trained officials and allows a more exact synchronization of administration, particularly in communications, transportation, and supplies, which tend to demand centralized authority. Roles (as well as task functions) are clearly defined. This approach assumes that reactions are highly predictable and that orders will be followed.

Approach B. The second method is decentralized; it utilizes planning from the bottom up, and emphasizes individual and small-group decision making. It relies heavily upon informed citizenry and outreach programs, and assumes that plan effectiveness stems from individuals' actions rather

than from central organization. This approach is highly dependent upon external systems such as transportation and communications.

Approach C. In essence, this approach is a combination of the first two. It limits administration to a framework focusing upon the most technical issues. The substance of effective response rests in the self-help choices of the public under general government supervision.

A conceptual framework for emergency response has been developed to illustrate the variables and parameters in the planning process (see Figure 1). Alternative choices will influence components of the system to different degrees. The acceptable plan is one in which the most vital components are most positively affected. An important part of the evaluation process is assessing the degree of importance of each variable.

Within this framework, the existing emergency response plan is called the independent variable. Its values determine the outcome (dependent variable), and, in the system illustrated, that outcome is a measure of overall effectiveness. Constraints are beyond the control of the independent variable: the degree of danger is a measure of the seriousness of the incident; human errors and technical malfunctions complicate that intensity; and environmental conditions like weather, topography, and other potential hazards compound the problem of response.

Intervening and bridging variables of the system also contribute to effectiveness. Implementation, an intervening variable, is the actual carrying out of the plan. Response, a bridging variable, is the result of the plan's implementation combined with the public's readiness. The level of preparedness, another bridging variable, denotes not only the intensity of readiness, but the type as well. Bridging variables are referred to as intermediate outcomes.

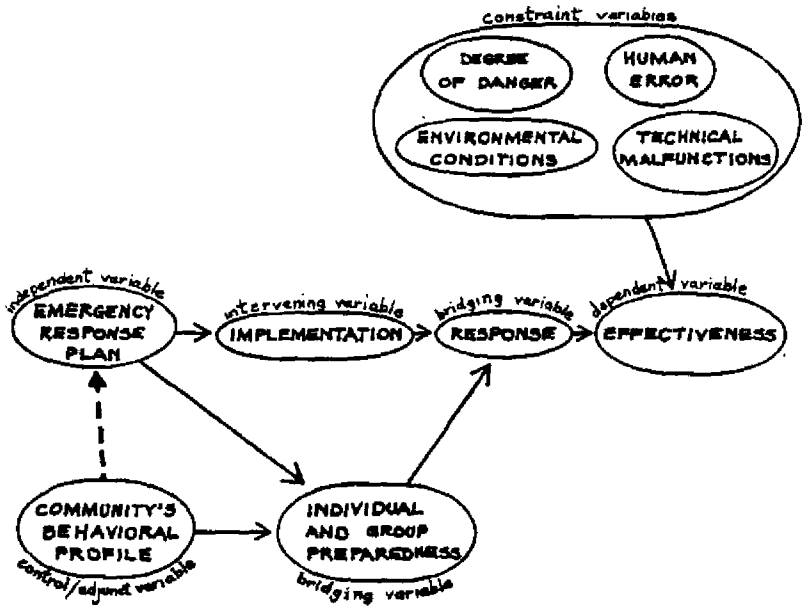

FIGURE 1

A CONCEPTUAL FRAMEWORK FOR VARIABLES
OF AN EMERGENCY PLANNING SYSTEM

In contrast to the constraints that cannot be controlled, the adjunct variable is responsive to the independent variable, and also affects the level of preparedness. The community's behavioral profile is the adjunct variable in this framework.

The aim of this study is to link the community's behavioral profile to the emergency response plan and the level of preparedness. No attempt will be made at analyzing the need for nuclear power or the veracity of scientific data concerning radiation exposure. The focus is on the social planning problems involved in responding to modern hazards. To be effective, any emergency plan must consider the people for whom it is designed. This includes those people's perceptions of need, preferences, confidence, and knowledge of what to do. An effective plan for emergency response can only evolve from and reflect the integration of expertise with those perceptions.

REASON IN RETROSPECT

Behavioral Research in Hazard Response

> The pre-eminence of prudence means that realization of the good presupposes knowledge of reality. He alone can do good who knows what things are like and what their situation is. The pre-eminence of prudence means that so-called "good intentions" and so-called "meaning well" by no means suffice. Realization of the good presupposes that our actions are appropriate to the real situation, that is, to the concrete realities which form the "environment" of a concrete human action; and that we therefore take this concrete reality seriously, with clear-eyed objectivity. (Schumacher, 1960)

> As potential hazards give rise to more complex emergency responses, preparedness agencies should devote more attention to methods of assessing, predicting and guiding public behavior in relation to disaster response planning. (Chanault et al., 1979, p. 140)

The need for prudence is particularly acute in emergency planning. The body of knowledge surrounding such planning is limited. In the 1960s and '70s, due to increased social awareness, there was some research on behavioral response to hazards. Originally, the development of nuclear power and nuclear weapons created interest in programs of civil defense. Today, a resurgent interest has developed as the result of recent disasters and near disasters. The once narrow field dominated by military and peacekeeping agents is now being examined by social scientists and psychologists, and their findings can be incorporated into any comprehensive emergency plan.

Five phases of a public emergency. One particularly useful finding of social scientists and disaster research specialists is a series of discernible phases in emergencies that can be used as a framework for study. Five phases that are commonly recognized are illustrated in Figure 2.

Pre-impact phase - The pre-impact period is described by Healy (1969, p. 275) as a time when the probability of danger is high. It is an early

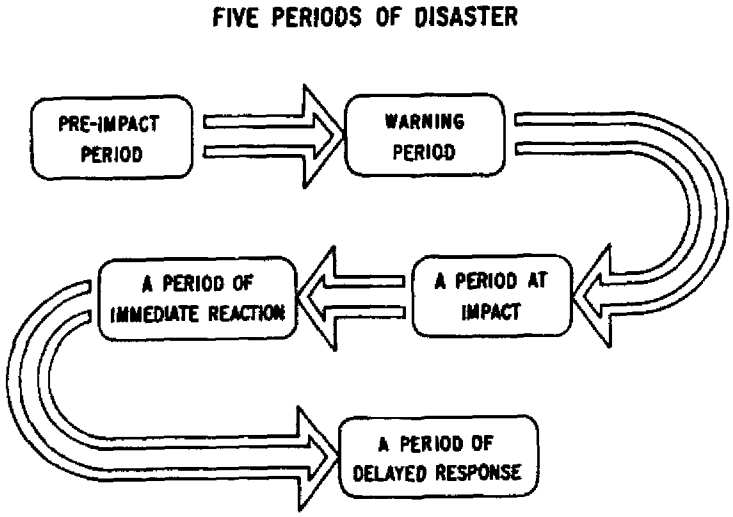

FIGURE 2

THE FIVE PHASES OF DISASTER

(Healy, 1969, p. 275)

warning phase that may last from hours to months, and examples might include a tornado watch, an approaching storm, or a pre-avalanche condition. For a radiation emergency, the phase might be initiated by a technical malfunction or recognition of an unusual event, but it is not likely that everyone would be cognizant of the threat.

Warning phase - When the danger becomes an impending reality, the seconds or hours before impact are referred to as the warning period. It calls for the implementation of emergency plans and conveyance of information to the public (Healy, 1969, p. 276). Reactions may vary, but generally it is a time of action and stress.

A study of response during this phase was conducted after the 1969 tsunami in Hilo, Hawaii (Lachman et al., 1961). A group was organized by the Hawaii Division of the Hawaiian Academy of Sciences to look into

warning response behavior. Sirens provided warning for more than four hours before the wave hit, and investigations showed that nearly all of the islanders heard the sirens. However, interpretation of their meaning varied, as shown in Table 1. The actions taken in response to the sirens were also tested in the survey. Researchers found three general categories of people. The "do nothing" group (15% of those queried) thought that they were in a safe place. The group was described as being either elderly, disabled, or "too tired" to respond. A larger group (32%) evacuated during the warning period. They were described as having "a desire for safety, awareness of danger, and fear" (Lachman, 1961, p. 1407). The final category, those who waited, made up the largest proportion of the population (44.5%). Their reasons for inaction ranged from thinking that there would be a more final notification to, once again, believing that for the time being they were safe. A statistical breakdown of the responses found in the Hawaiian study is shown in Table 2. The reactions to the warning appeared to result from a combination of perceptions, resources, and information.

Impact phase - The impact period is the climactic moment of the disaster. Reactions to this phase are often measured by the degree of confusion or shock, which authorities agree are of short duration (Healy, 1969, p. 277). Studies by Bristow repeat the findings of Healy in characterizing impact behavior.

> During the actual occurrence of the disaster, there is almost an overwhelming tendency on the part of those in the area to watch its visible elements: be it a fire, tidal wave, or dam collapse. This period of shock, confusion, disorientation, or hypnosis is usually quite short for most persons. The actual occurrence of the disaster may, in some cases, have a settling and motivating effect on those persons whose activities and reactions were not considered satisfactory during the warning phase. (Bristow, 1972, p. 70)

Immediate Response	Total Sample N	Total Sample %	Nonevacuees N	Nonevacuees %	Evacuees N	Evacuees %
Did nothing (continued normal routine)	44	15.0	40	23.3	4	3.3
Evacuated	94	32.0	12	7.0*	82	67.2
Waited (for advice, information, etc.)	131	44.5	100	58.1	31	25.4
Other (returned home, etc.)	25	8.5	20	11.6	5	4.1
Total	294	100.0	172	100.0	122	100.0

* Represents individuals who evacuated upon hearing the siren but returned home prior to time of impact.

TABLE 1

INTERPRETATION OF SIRENS BY VICTIMS
OF THE 1960 HILO, HAWAII TSUNAMI

(Lachman et al., 1961)

Interpretation	Total Sample N	Total Sample %	Nonevacuees N	Nonevacuees %	Evacuees N	Evacuees %
Alert	14	4.8	10	5.9	4	3.3
Warning	13	4.5	8	4.7	5	4.1
Preliminary signal preceding evacuation signal	71	24.4	55	32.4	16	13.2
Evacuation signal	84	28.9	10	5.9	74	61.2
Signal to await further information	26	8.9	24	14.1	2	1.7
Signal to make preparations	18	6.2	12	7.1	6	5.0
Subjective meaning not ascertainable	65	22.3	51	30.0	14	11.6
Total	291	100.0	170	100.1	121	100.1

TABLE 2

CATEGORIES OF REACTIONS TO WARNING SIGNALS
DURING THE HILO, HAWAII TSUNAMI

(Lachman et al., 1961)

Reports of the eruption of Mount St. Helens described the same reactions Bristow and Healy had found. On May 18, 1980, a 14,000 foot plume erupted from the volcano--the largest eruption on the North American continent in modern times. A Washington newspaper, on the day of the eruption, described the bewilderment, shock, and feelings of awe demonstrated by victims during the event. "Helicopter pilots had to persuade, entice, and threaten volcano watchers before they would break from their magnetic attraction to Mount St. Helens and flee from approaching disaster" (Spokane Daily Chronicle, May 18, 1980, p. 1). Rationality returned to the victims in a matter of minutes, and they then sought escape routes.

Immediate reaction phase - The phase of immediate reaction to a disaster is also referred to as the recoil period. Healy (1969, p. 277) identifies it as the victims' attempts to understand what has just happened, and as their initial recovery from shock. Healy and others associate this period with the need for people to locate family members and friends. He states (p. 278) that "much of the worried behavior of survivors will be motivated by this concern. This highlights the importance of the family relationship." A study of a 1957 Louisiana hurricane (Audrey) also found that, "If the family had become separated, this seemed to push most other thoughts from their minds" (Fogelman and Parenton, 1959, p. 131).

The majority of people recoiling from the impact of a disaster seem to engage in some activity. The productiveness of these actions depends upon their level of psychological stability or rationality. However, the degree of that rationality is a point on which new research and older theories differ.

The time of immediate reaction is also marked by the complete mobilization of emergency operations. Understanding the nature of human response at this phase, as well as during the warning period, can contribute heavily to the success of an emergency plan.

Delayed response phase - Delayed response, the final stage described by Healy (p. 249), encompasses the remainder of the recovery period. It may have a duration of weeks to months, and includes the re-establishment of community networks. A detailed study of this phase, concentrating on the experience of four communities, has been done by Friesma and others (1979). Typically, social and economic change were apparent in communities, but long term effects were not found to be as consequential as short term effects.

> Natural disasters cause deaths, injuries, property losses, and anguish. Many disaster losses are preventable. These are short term problems which deserve serious policy attention. When they occur, the role of disaster agencies in responding to the immediate needs of the victim can surely be improved. (Friesema et al., 1979, p. 179).

The disaster stages of pre-impact, warning, impact, immediate reaction, and delayed response are generally agreed upon by experts. Although the duration varies in different emergencies, the sequence remains intact. Each phase is typified by behavior patterns that vary primarily as a function of personality and social environment, not as a function of the hazard itself.

Generalized response categories. Healy (1969, p. 281) adapted material provided by the American Psychiatric Association and reduced a complex spectrum of response behavior to a manageable list of five categories:

1. Normal reaction
2. Depressed reaction
3. Overactive responses

4. Bodily reactions

5. Individual panic or blind flight

Normal reactions are those usually elicited during the five phases of a disaster. Individuals function reliably in the warning stage, experience a brief period of shock and bewilderment at impact, and resume rational decision making at some time during the post-impact phases. **Depressed reactions**, also referred to as the "disaster syndrome," occur largely after the phenomenon, and are characterized by dependency in the victim (Quarantelli, 1960, pp. 72-73). He or she can lose all initiative, and become incapable of making decisions. In contrast, **overactive response** is characterized by hyperactivity, excess involvement, and pertinaciousness. **Bodily reactions** occur temporarily, even in normal response, but in more severe cases appear earlier, last longer, and are more disabling. **Panic** or **blind flight** is characterized by a complete unawareness of reality and loss of judgment. Healy (1969, p. 285) identifies four factors characterizing a panic situation: partial entrapment, perceived threat, breakdown of escape means (real or imaginary), and breakdown in communication. These reactions and assumptions about them are continually being tested and modified as the limited body of knowledge about disaster response behavior expands.

Dispelling some past tenets. Policies, plans, and programs concerning hazards have been developed, in the past, based upon assumptions about human behavior in disasters. As these assumptions are examined and empirical knowledge takes their place, pragmatic applications should be re-examined. Field research within the last two decades has shown that the majority of people exposed to extreme hazards are resilient; they exhibit initative and employ critical judgment. This contrasts with the historical image of panic, bewilderment, and dependency following disasters--the

"disaster syndrome," an image that is still used as a basic premise in emergency policy formation. In his guidebook for emergency and disaster planning, even Healy states that

> The majority of people confronted with sudden danger will be stunned and bewildered. They are often unable to make decisions and are usually docile and suggestible. They will admit to a state of fear in describing their reactions. Although they recognize danger, they are relatively incapable of utilizing the information for constructive purposes. Their docility and suggestibility clearly demonstrate that they are unable to make decisions. (Healy, 1969, p. 272)

Yet this assertion has been questioned and finally refuted by researchers. Journalistic reports of mass panic have been discounted by follow-up research (U.S. Department of Defense, 1972a). Quarantelli (1960, p. 72) investigated stories of panic in hurricanes, dam breaks, explosions, war-time attacks, and even following the notorious Halloween broadcast of "War of the Worlds;" he identified very few cases of panic behavior.

> Additionally, when panic does occur it is seldom on a large scale. Panic flights are almost always highly localized episodes, with few participants, and of short duration. In fact, except for some instances involving armies, the author after eight years of intensively seeking for such cases cannot cite a single clear cut instance where more than three or four score people were involved. (Quarantelli, 1960, p. 72)

The Disaster Research Center at Ohio State University also studied over one hundred natural disasters and concluded that "in general, <u>people react in an active manner</u>. They show considerable personal initiative and a pattern of self and mutual help" (U.S. Department of Defense, 1972a). Although Healy claimed 75%, the Center's research identified under 20% of those studied as being afflicted with the "disaster syndrome" (Quarantelli, 1960, p. 23). The difference between the two opinions may be definitional and/or dependent on the duration of the problem. In contrast to theories which describe long periods of withdrawal behavior, field studies have found that

recovery is swift in most cases, and that the extent of the syndrome is small.

Activities during an emergency are structured around a hierarchy of informal groups and leadership. The primary focus is upon family, then small groups such as neighbors or co-workers. Analyses of responses have found that, when seeking help after a disaster, the order of priorities is usually from the informal to the formal. Membership groups (e.g., churches, clubs) were used only after help was sought from family, neighbors, and close friends. Government agencies were looked to only after other resources had been exhausted (Quarantelli, 1960, p. 75).

Choice factors under stress. Individual and group reactions to hazardous situations have produced theories about how choices are made. Burton, Kates and White, in particular, have related choice theories to reactions during disasters. In The Environment as Hazard, they cite Heberlein as stating that "a major component of any choice is the sense of responsibility that the individual has toward the cause of the situation and the possible remedial action" (Burton et al., 1978, p. 107). They further state that a person's capacity to act is related to his/her sense of efficacy, of confidence in knowing what to do and when to do it. Knowing what to do also affects the development of small groups and leadership that emerge during disasters. Burton, Kates and White also note that choices following disasters are linked to prior experience--an observation supported by Mileti. In examining why some people respond adaptively and others do not, he found that people who were trained or experienced in emergencies maintained greater efficiency. They also seemed to adapt to situations which might have created anxiety or incompetence in others (Mileti, 1975, p. 107). Experts studying the effects of Hurricane Audrey in Louisiana

also found that, "Individuals facing a new situation, even one as dangerous as an impending disaster, tend to react in terms of prior experience and earlier definitions, and in keeping with the organizational framework of their most meaningful groups" (Fogelman and Parenton, 1959, p. 130).

In summary. Reactions to emergencies do vary. Past research and field studies have shown that reactions are contingent upon the stage of the hazard, the personality of the victim, and the choices available to the victim. Choice depends on a complicated set of variables, including an understanding of the nature of the hazard, perceived knowledge of alternative actions, experience, resources, and confidence. Nonetheless, people remain discriminating, making critical judgments based upon their view of the situation. The evidence, then, is that organization at the individual and small group level does not disintegrate. Behavior--including responses to emergencies--is affected by personality, resources, confidence, and knowledge. Yet the development of response planning in the United States has given little notice to the implications of public knowledge and disposition--the public behavioral profile.

A Regulatory Chronicle: Post World War II Agency Development

The postwar "Atoms for Peace" campaign assumed that the industrial use of atomic power was utterly safe. The danger of escape of radiation beyond containment structures was judged to be so slight that emergency plans were a low priority. Until 1974, there was no planning assistance available from federal agencies to support local government endeavors. In addition, no regulatory agency had primary responsibility for off-site nuclear reactor emergencies (Rogovin, 1980).

Early government involvement in response planning centered on civil defense. After World War II, the Defense Civil Preparedness Agency (DCPA),

under the Department of Defense, was the federal arm responsible for that effort. Its primary function was to coordinate federal, state, and local preparedness in case of a nuclear attack upon the United States, although it also performed the perfunctory duty of supporting non-military planning and emergency response under a "dual use" doctrine (Chanault et al., 1979, p. 29). Although the organization originally operated at the federal and regional levels, the DCPA later channeled federal funds and personnel to state agencies. The DCPA was responsible for many of the shelter and fallout programs of the 1950s and '60s. Figure 3 is a diagram of its organization. The agency eventually merged with the Office of Emergency Preparedness (OEP), a division of the Federal Services Administration, in 1979, to become the Federal Emergency Management Agency (FEMA).

Also created following World War II, the Atomic Energy Commission (AEC), originally staffed by engineers from the Manhattan Project, also performed a regulatory function. However, it was a technical agency as well, promulgating the advantages of commercial nuclear power. Prior to 1974, the commission required on-site safeguards and preparedness plans, but did not require that any provisions be made for off-site areas (U.S. Federal Emergency Management Agency, 1980a, p. I: 4). Conflict of interest arising from the AEC's simultaneous promotion of the industry and its regulatory functions resulted in reorganization. In 1975, the agency was split into the Energy Research and Development Administration (now defunct), and the Nuclear Regulatory Commission (NRC).

> The stepchild relationship of the government and industry was somewhat altered by all of this. Although it inherited many AEC regulatory personnel, the NRC was dedicated to an increasingly strict system of regulation of the industry. The days of riding point for the industry were virtually over, except for an informal legacy of partnership which persisted at the staff level. (Rogovin, 1980, p. 183)

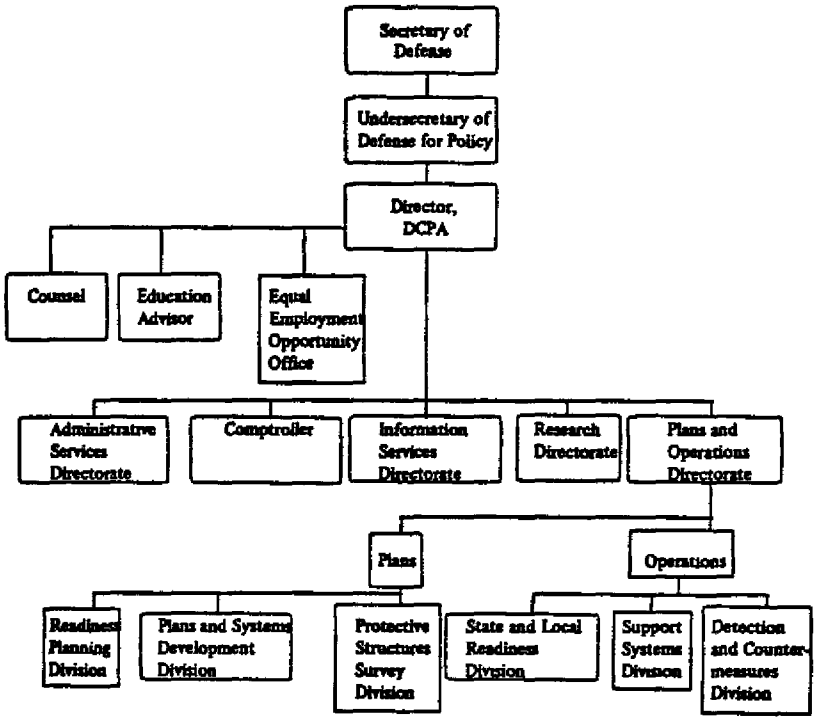

FIGURE 3

DEFENSE CIVIL PREPAREDNESS AGENCY
ORGANIZATIONAL CHART
PRIOR TO 1979

(Chanault et al., 1979, p. 32)

The first federal monies to assist local government in preparation of nuclear response plans were made available during this period of reorganization. In 1973, a Federal Register notice was issued by OEP designating the Atomic Energy Commission as the lead agency for assisting in the preparation of radioactivity response plans. Together with the DCPA, OEP and others, the AEC and later the NRC organized an infrastructure of interagency support (FEMA, 1980a, p. I: 4).

The new program of support was thoroughly voluntary, and in 1975 was broadened to include emergency preparedness assistance not only for nuclear

facilities but for transportation of radioactive materials as well. In 1975, the NRC issued a statement of its reponsibilities, which included:

1. Guidance to state and local agencies for emergency planning
2. Guidance to other federal agencies regarding their authority and responsibility in radiation incident planning
3. Review and concurrence of response plans
4. Guidance for radiation monitoring and detection systems
5. Review and analysis of potential hazards at fixed location nuclear power plants (FEMA, 1980a, p. I: 5-6).

In the assistance program's six year life span, the NRC aided in the development of 14 state plans, including California's, and continued to be the lead agency in guiding radiation emergency planning until the reorganization which took place after the accident at Three Mile Island.

A Near Miss: Three Mile Island and Its Effect

"To the American public, these towers have now become monuments to an epic industrial accident" (Rogovin, 1980, p. 1). The familiar towers referred to by Rogovin in his report to the Nuclear Regulatory Commission are those of the Three Mile Island (TMI) Nuclear Power Plant. The March 28, 1979 accident at Middletown, Pennsylvania brought the nation dangerously close to a major health disaster and increased the nation's awareness of the need for effective emergency planning. Immediately, a six month investigation was initiated. A commission headed by Dr. John G. Kemeny, President of Dartmouth College, was appointed by President Carter to review the performance of the utility, the contractor, the plant personnel, and the adequacy of the emergency response plan. The final report was highly critical. The major findings were:

1. The accident was initiated by a mechanical malfunction and was magnified by human error.

2. At all levels of government, planning for off-site consequences of nuclear accidents lacked coordination, urgency, and attention.

3. The utility company failed to acquire enough information on safety, failed to analyze it adequately, and failed to act upon the information it did have.

4. The incident revealed very serious flaws in the way government and the private sector manage and regulate nuclear power. Fundamental changes were found to be in order.

5. The NRC had not given adequate attention to safety issues. They had ignored them for years.

6. The training of power plant operators was inadequate.

7. The accident had "negligible effects on the physical health of individuals." The major health effect was mental stress associated with the accident (Kemeny, 1979).

President Carter made a series of decisions in response to recommendations of the Kemeny Commission. A Nuclear Oversight Committee was created which now reports annually to the president on the progress of the NRC, other federal agencies, the states, and utilities in improving the safety of nuclear power plants. The Federal Emergency Management Agency was instructed to review emergency response plans in states that had operating or planned facilities. The lead role in off-site emergency planning was transferred from the NRC to FEMA. In turn, the NRC was urged to assist FEMA in these operations (FEMA, 1980b).

In order to meet the new executive mandates, FEMA and the NRC entered into a Memorandum of Understanding (FEMA, 1980a, p. II: 7). The division of responsibility assigned to each agency presently complies with this agreement. The Federal Register lists these commitments:

1. To take the lead in off-site emergency planning. FEMA is held responsible for reviewing plans for adequacy. The NRC is obligated to consider FEMA's findings as part of the licensing process, although no legal requirement for a FEMA approved plan exists.

2. To review state and local emergency plans in states with operating or planned nuclear facilities. By January, 1980, all 31 states with operating plants had been assessed and those found deficient began amending their plans to meet new standards. The San Luis Obispo local plan was prepared in 1977, and California's emergency plan originally received voluntary NRC concurrence in 1978. In general, FEMA found both plans to have a good foundation in state legislation which mandated revisions and provided for reimbursement of up to two million dollars to local agencies by the licensed operators. FEMA commented that "the Diablo Canyon Plant is ready for licensing and may well become a focus for public and political concern over the public health and safety issues of nuclear power" (FEMA, 1980a, p. II: 5-7).

3. To assume the responsibility of training state and local officials.

4. To develop and issue interagency assignments to assess capabilities, define procedures, and assign responsibilities (an effort to coordinate emergency planning) (FEMA, 1980b, p. 42341).

The Nuclear Regulatory Commission's duties and responsibilities for preparedness were also entered into the Memorandum of Understanding. The NRC retains the primary responsibility for licensing commercial nuclear power plant operations. In support of FEMA activities the NRC has agreed:

1. To assess on-site emergency plans of the licensee for adequacy. They must verify the current feasibility of on-site plan implementation, taking into account equipment maintenance, training, personnel, resources, and procedures.

2. To review the findings and determinations of FEMA on the adequacy of state and local plans.

3. To report their findings with regard to the overall state of emergency preparedness (FEMA, 1980b, p. 42341).

As a final common measure for assessing plans, the two agencies have jointly developed criteria for emergency preparedness. Adopted in 1980 and known as NUREG 0654, they provide a planning checklist for state and local governments (FEMA and NRC, 1980).

NUREG 0654 endorsed the use of Emergency Planning Zones (EPZs) as the planning foundation (Figure 4). These zones define the area to be addressed in a nuclear emergency response plan. Two major divisions determine the

shape of the planning zone. The first is called the "Plume Exposure Pathway," and covers an area within approximately a ten-mile radius of the plant. Contamination in this area would consist of whole body exposure to gamma radiation or particle inhalation. The second division is the "Ingestion Exposure Pathway," an area within approximately fifty miles of the exposure point. Danger in this zone would be largely due to contamination of water and food-stuffs (FEMA and NRC, 1980, pp. 4-9). The new criteria also emphasized lessons learned from Three Mile Island. Notification methods, public education, and information procedures have been outlined, and the importance of clear, concise, and early notification was stressed. Dissemination of literature in utility bills, phone books, mailings, and posted signs was listed as a minimum requirement for informing the public (FEMA and NRC, 1980, pp. 43, 49). Moreover, it was required that these measures' effectiveness be tested statistically.

> Every year, or in conjunction with an exercise of the facility, FEMA, in cooperation with the utility operator, and/or the state and local governments will take a statistical sample of the residents of all areas within about ten miles to assess the public's ability to hear the alerting signal and their awareness of the meaning of the prompt notification message as well as the availability of information on what to do in an emergency (FEMA and NRC, 1980, Appendix 3, pp. 3-4).

In a report to the president, FEMA concluded that for the first time the new criteria combined "guidance to nuclear plant operators and state and local governments, thus showing the close relationship between the plan and preparedness of these entities" (FEMA, 1980a, p. VI: 6). NUREG 0654 advanced nuclear emergency planning from the civil defense sphere but still did not provide a link in planning between behavioral profiles of communities and the preparation and administration of emergency response plans. The Federal Emergency Management Agency itself has stated, "Since the

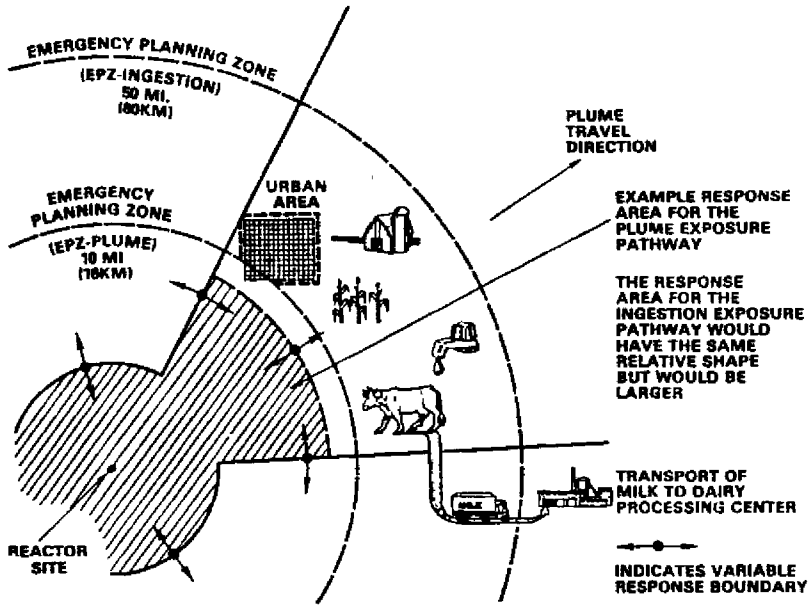

FIGURE 4

CONCEPT OF EMERGENCY PLANNING ZONES (EPZs)

(FEMA and NRC, 1980, p. 16)

accident at Three Mile Island, there has been a growing need for research in the area of human factors, such as the behavior of persons under stress during accidents at nuclear power plants" (FEMA, 1980a, p. VI: 14).

San Luis Obispo County Nuclear Power Plant Emergency Response Plan

The Diablo Canyon Nuclear Power Plant was one of the first facilities to fall under the new regulations, and its draft emergency plan was prepared following the criteria developed by FEMA and NRC. That plan is essentially a supplement to both the California State and San Luis Obispo County Basic Emergency Plans, and has been approved by the County Board of Supervisors.

The plan was developed by Stan M. Voorhees and Associates, Inc., Transportation, Environmental and Planning Consultants, with guidance and

assistance from the California State Office of Emergency Services and the regional offices of the appropriate federal agencies. Additional assistance was provided by Pacific Gas and Electric Company, particularly in covering funding not reimbursed by federal funds (Pursuant to SB-1183) (FEMA, 1980a, p. II:7). An organizational chart of the planning groups involved appears in Figure 5. It is interesting to note that in the chart, public participation is only slightly alluded to in the form of volunteers, and placed at a low priority.

The plan is divided into five parts: an administrative plan; implementing instructions; standard operating procedures (SOPs); support materials; and maintenance, training, and exercise programs. The administrative plan outlines definitions, concepts, and authorities. The implementation section specifies when an action should be taken, by whom, and what that action should be. The SOPs are more specific still and give operational level instruction on a smaller group scale. SOPs are satellite plans which may be developed for schools, hospitals, or large employers. The support material contains background information, and the final section summarizes the requirements for plan maintenance (San Luis Obispo County, 1981c, p. viii).

The emergency plan was submitted to both the California State Office of Emergency Services and the Federal Emergency Management Agency for review and comment. Legally, the relationship of county approval of the plan to the granting of an operating license by the Nuclear Regulatory Commission is ambiguous. Technically, there is no federal provision requiring an approved plan as a prerequisite for licensing. FEMA, however, must evaluate a legitimate plan and that evaluation must be taken into consideration in the licensing process by the NRC. Not being anxious to

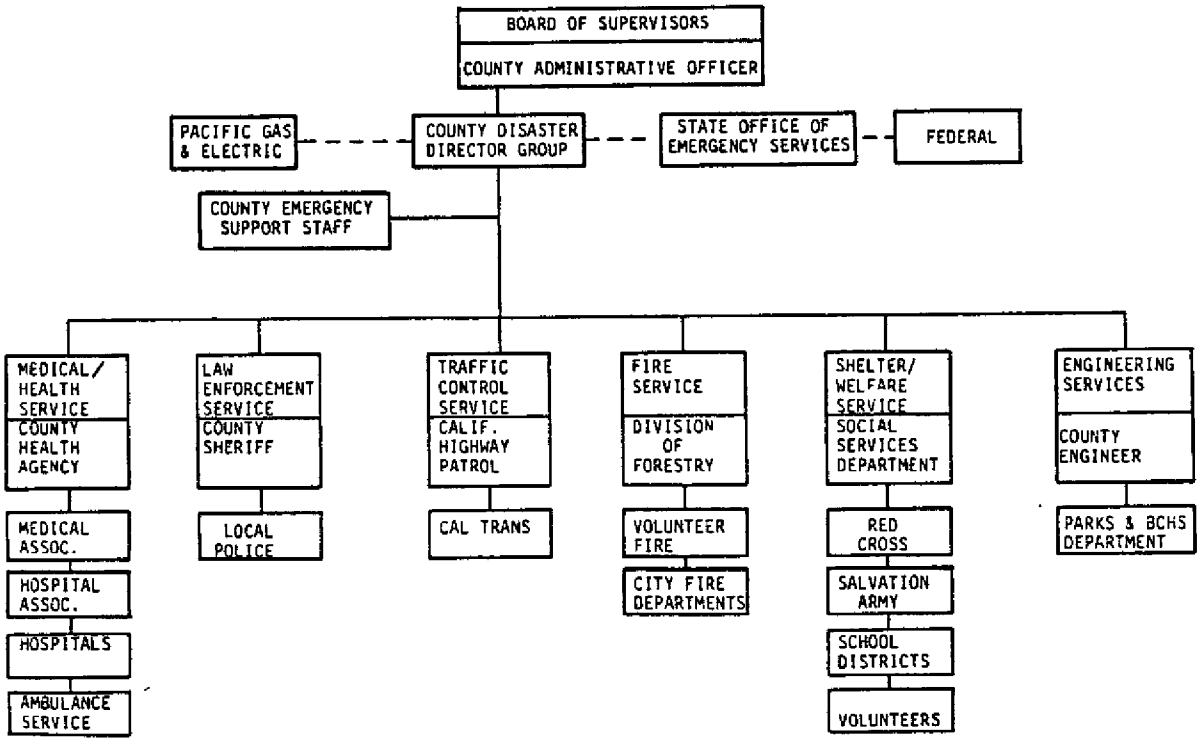

FIGURE 5

EMERGENCY PLAN ORGANIZATIONAL CHART

(San Luis Obispo County, 1981c)

test the case in court, interested parties felt pressured to obtain local approval (Woertz, 1982).

The San Luis Obispo County Nuclear Power Plant Emergency Response Plan is a document that took two years to draft, and is two inches thick. One hundred and fifty copies have been distributed to agencies, utilities, volunteer groups, and libraries, and authorities have met all requirements for public hearings. There has been newspaper and radio coverage of its development and ratification. An initial exercise has taken place; sirens have been installed. The County Office of Emergency Services has circulated samples of a prototype one-page instruction sheet for radiation

emergencies. Pacific Gas and Electric Company (PG&E) has included informational flyers with utility bills. Page A4 of the San Luis Obispo County Telephone Directory (October, 1981) gives information about the plan. All of these actions were required by regulations designed to educate citizens and aid in the preparedness of affected populations. However, although the authors of the document stated their goal as "the preparation of a response plan and the associated preparedness of government and citizens" (San Luis Obispo County, 1981c, p. I.1(1)), fulfillment of the legislative requirements is not necessarily synonymous with successful preparedness of the public. Unfortunately, the nuclear power emergency response plan for San Luis Obispo County focuses upon bureaucratic, administratively centered solutions emphasizing logistics and lines of authority. Human behavioral characteristics--attitudes, awareness, perceptions, confidence--are not well considered.