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Review and Integration of Existing Literature Concerning Potential Social Impacts of Transportation of Radioactive Materials in Urban Areas

Prepared by C. Gordon, T. F. Gessell, H. Prichard, C. Anderson

University of Texas
Rice University

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REVIEW AND INTEGRATION OF EXISTING LITERATURE CONCERNING POTENTIAL SOCIAL IMPACTS OF TRANSPORTATION OF RADIOACTIVE MATERIALS IN URBAN AREAS

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ABSTRACT

The symbolic interactionist/collective behavior approach within sociology is applied to transport of radioactive materials through urban environs, indicating that social impacts of such transport would extend far beyond objectively-measurable radiological impacts of normal transport, accidents during transport (with and without radiation release), or diversion by terrorists.

This approach is used to delineate the major cultural frames of reference that interested publics and special groups might use in interpreting events surrounding radioactive transport, and to specify probable social impacts of seven scenarios. These impacts include: (1) uncertainty, fear and mistrust; (2) processes; (3) initial agency responses; (4) subsequent collective behavior responses; and (5) a wide range of more general impacts on U.S. culture and social structure.

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REVIEW AND INTEGRATION OF EXISTING LITERATURE CONCERNING POTENTIAL SOCIAL IMPACTS OF TRANSPORTATION OF RADIOACTIVE MATERIALS IN URBAN ENVIRONS

Executive Summary

Introduction: Objectives of This Literature Integration

Social impacts of transporting radioactive materials through urban environs are not objectively measurable physical consequences, but begin with largely subjective, social-psychological impacts involving fear of radiation, uncertainty concerning the effectiveness of official responses to any possible transportation accidents or incidents, and possible mistrust of the motives of the nuclear industry. These social-psychological elements of fear, uncertainty and mistrust set the stage for a wide range of overt behavioral responses and agency reactions which might be triggered by events relating to (1) normal transport (with and without unusual radiation release), (2) transport accidents (with and without release), and (3) diversion of the radioactive material by terrorists.

In any case, the overt social impacts could include:

a. Initial collective behavior processes as reaction to the transportation itself or to an accident or incident.

b. Initial agency responses to the transportation event and to any connected collective behavior activities.

c. Subsequent collective behavior responses to agency activities.

d. A wide range of more general impacts on U.S. culture and society of alternative agency policies and procedures regarding radioactive transport, and of alternative strategies and tactics regarding associated collective behavior.

The action units that might become involved in any given scenario or hypothetical sequence of events have been defined as:

1. Governmental--policy, regulatory, development, monitoring and coordinating bodies; state, county, and city governmental units;
2. Elements of the transportation industry;
3. Individual citizens--in their roles as employees, residents along transport routes, travelers, bystanders of an accident or incident, voters, etc.;
4. Collectives--acting as special interest publics, special interest groups, protest or counter-protest groups, crowds gathered around transport accidents, etc.; and
5. The mass media--both general-audience and special-purpose media that focus on nuclear issues.

In defining the relevant action units in this manner, we have stuck close to our proposal in focusing primarily on potential collective behavior processes and agency responses.

Collective Behavior

The generic term "collective behavior" refers to the actions (both mental and overtly behavioral) of groups of people in situations that do not provide regularized and clear-cut cultural direction for conduct. Collective behavior thus includes many forms of activity that might be triggered by the very fact of radioactive transport, and which would be especially likely in case of an accident or diversion incident Crowd processes such as milling, keynoting, blaming, rumor and panic flight are all possible in such situations, while more diffuse processes such as creation of special publics, the operations of special interest groups, and shifts in public sentiment about topics related to the use of nuclear energy would be likely to grow from some transportation events. The special interest groups may mobilize wider support for direct action in the form of social protest demonstrations, while counter-movements (pronuclear) might seek to activate their supporters for direct confrontation counter-demonstrations, and either side might attempt more indirect action by such political means as increased lobbying, requests for Congressional hearings, or litigation.

Information Flow

In all of these cases, a critical element is the flow of information from government and industry sources to the general public through the mass media. Special interest groups can be counted on to use the communications media at their disposal. Both "official" and "unofficial" viewpoints will go into making up the shifting patterns of public awareness, opinion, concern and evaluation of the wide range of issues comprising the general topic of radioactive transport.

Agency Responses to Transportation Events and Connected Collective Behavior

Every proposed change in current patterns of radioactive transport routes, rates, materials, vehicular modes, timing or security provisions has the potential for collective behavior. Varying forms of transport incidents would quite probably trigger various agency responses (police, fire department, local, state or federal governmental units, industrial or transport components, etc.). In addition, collective behavior processes may well be activated in response to the initial agency efforts, and then another round of agency responses would be activated in relation to the collective behavior. This cyclic process could conceivably continue for an extended period of time, with both sets of action units responding to empirical facts of the transportation as well as to each other.

Our collective behavior and agency response conceptual approach to analysis of the social impacts of radioactive transport is derived from the general symbolic-interactionism theoretical orientation within sociology, and seems well suited to the defined task. It should be noted, however, that other approaches within sociology, economics, and the newer area of risk analysis could have been used also, and doubtless should be employed in future efforts that involve systematic original research and more time and material resources.

Critical Issues Raised in This Review of Literature

It should be remembered that this report is a review and integration of existing literature, not a full research project in which hard evidence can be systematically marshalled to answer one or a very small number of clearly formulated questions. Furthermore, it was discovered in the course of our library search that there is no current scientific literature specifically dealing with social impacts of radioactive transport in urban areas. We had to utilize technical materials on radioactive transport, popular media accounts of current events in the field, economically or politically oriented discussions in special-interest group publications, a very wide range of sociological materials discussing the common collective behavior outcomes of situations only very roughly similar to the transportation events under consideration.

Thus, each of the sections of this report provides a discussion of potential social impacts regarding events that have never yet occurred, and that in fact, may never occur. This process can only raise a large number of important questions, and provide some ideas about the most probable sequences of events that might follow the selection of various alternative agency policies and procedures. Our integration of empirical information on transportation patterns with hypothetical scenarios concerning possible agency responses and collective behavior events was accomplished in the following structured discussion.

1. Frames of Reference for Public Interpretation of the Benefits, Hazards, and Costs of Radioactivity and Nuclear Energy

Public awareness and interpretation of nuclear energy is approached through suggestion of two major frames of reference, immensity of scale and limitlessness of sources and effects, that together tend to produce a rather magical and "gee whiz" attitude in the general public. This magical attitude is frequently combined with exceptionally great fear of radiation as a terrifying, invisible menace that brings disfigurement, disease and death. The dichotomy promotes acceptance of policies aimed at development of nuclear energy as a medical, industrial and electric power-generating resource, especially in the wake of recent disruptions of oil and coal supplies by groups that can easily be viewed as greedy and power-mad. At the same time, few want radioactive materials transported into and through their own residential and commercial areas.

The possibilities of accident and terrorist diversion have been made very real by recent new events, and can only add to the public's anxious, apprehensive ambi- ance toward radioactive transport. Many value concenrs are also called into play, especially when plutonium is proposed as a possible cargo: moral concerns about possible genetic defects in unborn generations, and about the link of nuclear energy to war; economic depiction of the nuclear industry as a greedy and polluting oligopoly; political worries about terrorist groups developing weapons with blackmail potential; and the fear of a concomitant decrease of civil rights in the wake of greatly expanded security systems.

Since social action is based fundamentally upon such value-drenched interpretations, ascertainment of the exact social impact of potential transportation events is an impossible task.

2. Normal Transport of Radioactive Transport

Consideration of the specific features of the empirical and "editorial" materials on radioactive transport led to formulation of the following specific issues:

a. What are the current and projected transport forms, modes, materials, amounts and radioactivity levels?

b. What are the key populations at risk from this transport configuration?

c. What information is being currently provided to the various action units?

d. What social actions may be expected from the various units if normal transportation increases as predicted?

e. What may be expected if plutonium becomes an important component of the transportation flow, and what are some possible implications for society as a whole?

After review of the best available data on current patterns and projections of radioactive transport (including the possible addition of plutonium), we go on to sketch the key problems faced by government policy makers, regulators, industry executives, shippers and courts as they approach this complex bundle of issues.

Special interest groups are discussed, as are the special publics that each may draw upon for support.

Two hypothetical scenarios are developed to illustrate the probable differences in collective behavior and agency responses within two different symbolic contexts: Scenario #1 (section 2.12) deals with trucking of radiopharmaceuticals in Houston's Medical Center, and suggests that no significant or difficult-to-handle collective behavior would result because of the "medical" context. Especially helpful would be the maximum possible amount of accurate information on the outside of the vehicle, preferably giving contents, destination, responsible officials (with phone numbers), maximum radiation emission under normal conditions, an indication of emission exceeding this maximum level, and ultimate purpose (tumor treatments, etc.). More will be said below about this idea of indication of excessive radiation displayed on the outside of the vehicle.

Scenario #2 (section 2.13) deals with a very different hypothetical (but quite possible) case in which the first load of fresh fuel is being trucked into the newly-approved Seabrook reactor in New Hampshire. In this instance, there is already a long history of protest demonstrations, counter-demonstrations, mass arrests and a wide range of other collective behavior associated with the Seabrook reactor. Official announcement of intent to deliver fuel to the reactor would, with great certainty, set up new demonstrations and counter-demonstrations, but any attempt to move the fuel into the reactor secretly would, in all probability, be ineffective because an active and resourceful interest group maintains a close watch on developments in connection with the Seabrook reactor. In a larger sense, the publicity attendant upon a secret attempt to fuel the reactor would be likely to increase the already present trends of mistrust, anxiety and anger toward both government and industry efforts to extend the scope of nuclear energy utilization. A further spread of alienation and mistrust of government intentions and honesty would perhaps make people now sensitive to nuclear issues distrust any form of new urban transportation if it once became known that unmarked or mismarked vehicles were on occasion being used for transport of radioactive materials. Government and industry should avoid the appearance of engaging in any collusion to subvert the democratic principle of open action, openly formulated.

Our conclusion from this scenario and the others to follow is that some forms of collective behavior are essentially unavoidable in the current climate of interpretation in which special interest groups exercise their legitimate rights to both written expression and collective demonstration of their support or opposition to new policies and procedures regarding transportation of radioactive materials. The policy question then becomes redefined as "How best to handle the various forms of collective behavior that are most likely to arise?"

3. Social Impacts of Accidents in Transportation of Radioactive Materials

   a. What are the most probable nonradiological impacts on the action units of various forms of vehicular accidents, with and without unusual radiation release?

   b. What forms of collective behavior are most likely to occur?

The likelihood of elemental crowd processes of collective behavior is much greater wherever there has been a concrete transportation accident to focus attention of bystanders. A crash involving a truck carrying radiopharmaceuticals would probably engender rapid crowd collection if it occurred in a location in which a substantial number of people were within sight or sound. The elemental collective behavior processes of milling, rumor, differential expression of both fear and safety themes, and, perhaps, some effective coordination between crowd members and rescue/monitoring teams would all be quite likely. Panic flight and resignation (apathy) would be quite unlikely in this instance because threat value would probably be interpreted as rather low (perhaps incorrectly), and there would be little sense of restricted escape route, the main trigger of panic flight.

The situation of Scenario #4 (section 3.3) is quite different, and hypothesizes the crash of a truck carrying spent fuel rods or high-level wastes near such storage locations as West Valley, New York; Barnwell, South Carolina; or Morris, Illinois. Here, the elemental crowd processes (collection, rumor, milling) initially may be much the same as with the crashed pharmaceuticals truck, especially if there is no significant difference in the outside markings on the two trucks. Thus, a crowd might well collect just where it should not: very close to a high-activity radiation source that may have had its container broached.

Now the importance of prompt, authoritative and clear agency communication can be seen. Especially important are specific instructions to monitoring teams on how to ascertain the extent of the release, if any, what to tell crowd members about any safety or decontamination actions necessary, and how police or other units should handle a forced evacuation if such were judged necessary.

It should be reiterated that high-level cargoes should be explicitly and understandably labeled. These markings should give accurate but simple instructions that actually tell the reader what to do. For example: "IF THIS SQUARE IS STILL YELLOW, THERE IS NO SPECIAL RADIATION DANGER, but alert local police and the regional office of the Nuclear Regulatory Commission [or whatever other agency is deemed most appropriate] at the toll-free number

1-800-xxx-xxxx." "IF THIS SQUARE HAS TURNED DARK RED, THERE IS SEVERE RADIATION DANGER. Call local police and then alert the State Radiation Monitoring Unit at the toll-free number 1-800-yyy-yyyy. Be sure to give your name, address and phone number so that any necessary radiation-sickness treatment can be given. Then move away from this vehicle at least two city blocks."

The specific details of the above message are only illustrative suggestions, and the idea of a section of the sign that might turn to a different color when radiation exceeded some specified limit may not immediately be feasible, but the intent should be clear. Dangerous forms of collective behavior and their concomitant possible increases in radiation dosage to participants can only be minimized by direct, authoritative and clear communication. Even though such ominous-looking placarding may seem unnecessarily alarming in times prior to an accident, such information could be of great value to both action agencies and the reporting citizens should an accident occur. Again, it is lack of information, especially when coupled with the suspicion that important information is being withheld, that tends to produce anger, anxiety, and mistrust.

4. Diversion of Radioactive Material by Terrorists

   a. What forms of diversion of radioactive material are possible and most probable?

   b. What are some of the most probable impacts of diversion on the action units and the wider society?

c. What are some of the most probable impacts on the wider society of the precautions that might accompany adoption of plutonium as a major fuel source?

d. General issue underlying all of the sections: What alternative policies and procedures might be developed to handle in the best possible fashion the complex problems of information flow, training, physical security, crowd control, evacuation and relations to social movements?

The topic of terrorist diversion of radioactive material is part of the much larger topic of political and economic blackmail through threat of harm that is now being used with increasing frequency by terrorist groups all around the world. Mass media coverage of such skyjackings and building takeovers, together with coverage of official attempts to remedy the situations through use of heavily armed tactical commando squads, have, in all probability. planted the idea in the general American public that the target of a terrorist's threatened disaster is likely to become a scene of fiercely violent activity. Thus, the hypothesized terrorist diversion of a truck carrying enriched uranium (Scenario #5, section 4.3.1), of a truck carrying a load of plutonium (#6, section 4.3.2) or release of the news that an inside job at a plutonium reprocessing plant had resulted in theft of large enough quantities of the material to produce a nuclear explosive (Scenario #7, section 4.3.3) could be expected to produce exceptionally high levels of public fear, overloading of information networks as police telephone systems, and a great call for mass searches, surveillance and other police activities that go far beyond our contemporary concepts of civil rights and civil liberties.

The issue of potential invasions and limitations of civil liberties may well be added to more practical consideration of radiation leakage and the possibility of accident and terrorist diversion when cities (such as New York) and states (such as Illinois, New Mexico and California) are arriving at political decisions as to whether or not to permit transportation or storage of radioactive materials within their jurisdictions. Thus, the possible addition of plutonium to the roster of radioactive materials to be transported greatly complicates the issues that must be considered because of the probable necessity for a whole new order of magnitude in security procedures and personnel, in surveillance of current employees, of security clearance for new employees and of follow-up on previous employees. Each of these increases in security consciousness would tend to produce pressures for blandness and conformity among all those who think they might someday want to apply for a job in the nuclear industry or its transport links. Development of an elaborate force of security personnel to guard every possible transportation link that might at some point involve plutonium would be a very costly and oppressive new element in American political and economic life, and would hardly be welcomed in a nation founded on the principle of freedom from government interference.

Yet, even if it is decided that the problems associated with the use of plutonium outweigh its possible benefits as a fuel source, the fundamental questions remain: Should any major radioactive materials be transported through urban areas for any but life-saving purposes? Should the American government and nuclear industry take on the mammoth task of trying to transport high-activity or other dangerous non-pharmaceutical materials through urban areas at all or should other options be investigated for even the medical uses, as well as for the industrial and power-generation applications?

"Soft" energy alternatives may reduce the need to depend upon nuclear reactors to generate electrical power. Development of nuclear parks that combine and integrate research, fuel preparation, power generation, fuel reprocessing and short-term storage of highly radioactive wastes, and even medical applications in remote and easily-guarded installations might reduce the need for radioactive transport down to the level at which even the use of plutonium in breeder reactors might be considered sufficiently safe. Both soft energy systems and remote nuclear parks reduce the problems of collective behavior. However, economic considerations have tended to expand the extent of radioactive transport through urban areas, and may continue to do so after the current slump in nuclear reactor starts has passed. While economic considerations must always be given due weight, the present report has indicated that possible collective behavior processes, inadequate agency responses and wider implications for civil rights and civil liberties, should now be taken into account in addition to previously-recognized moral, philosophical, environmental, safety, and political factors when attempting to formulate wise public policy in the area of radioactive transport.

INTRODUCTION

Objectives of this Review and Integration of Existing Literature

Many of the potential impacts of transportation of radioactive materials are not strictly "environmental" in the sense of objectively measurable effects on the environment that are reasonably easy to predict on the basis of long familiarity with similar effects in other situations in which radioactivity was present. Rather, these social impacts include a wide range of diverse and complexly inter-related effects that we have grouped under the following categories for purposes of this review:

a. Potential collective behavior in response to various aspects of transportation of radioactive materials through urban environs.

b. Probable agency responses, both to transportation incidents and to any collective behavior events associated with transportation.

c. Subsequent collective behavior responses to agency activities.

d. Selected potential impacts on U.S. culture and society of alternative agency strategies.

As set forth in our proposal, our general objectives were to assemble and synthesize the literature bearing on these topics, and utilize it in a set of scenarios that would plausibly follow (1) normal transport of radioactive material through urban environs, with and without unusual radiation release, (2) vehicular accidents, with and without release, and (3) diversion of the transported radioactive materials, with the threat of radiation release or even construction of a nuclear bomb. Wherever possible we offer suggestions as to probable social outcomes of alternative strategies on the part of action agencies, but it should be recognized at the outset that since neither past data nor solid social theory exist in this area, and since social impacts of transport of radioactive materials have not yet been written about in a scientific fashion, we can but offer suggestions, not scientifically confirmed conclusions.

1. Methods of Procedure

We have focused on the following units of action and on their specific activities in relation to normal transport, accidents, and diversions:

UNIT OF ACTION	SPECIFIC ACTIVITIES
Federal Government	General policy on nuclear energy Development programs; ERDA Regulatory efforts; NRC Radiation Monitoring; EPA Procedures for coordinating various agencies
State, County, City Governments	Economic development programs Health, safety and environmental protection programs Police, fire, emergency rescue teams Radiation monitoring and decontamination teams
Transportation Industry	Policy development Handling, storing and safety procedures
Individual citizens, in roles of:	Employees Residents along transport routes Travelers along transport routes Bystanders near storage locations Bystanders near transport incidents Voters

UNIT OF ACTION	SPECIFIC ACTIVITIES
Collectives, acting as:	Special interest publics Special interest groups Protest or Counter-Protest groups Crowds collecting around transport incident sites
Mass media	Establishing general context for individual interpretations of nature, importance, value, and problems of radioactive transport

Because of the extremely broad scope and complex interaction of these activities, both before and afte any actual transportation of radioactive materials in urban envir ns, and because of the necessarily speculative character of the action scenarios to be presented, we have chosen to stick close to our original proposal and focus our attention on potential collective behavior and agency responses rather than attempting to extend our analysis to include comprehensive and systematic treatments of such important but divergent topics as risk analysis, potential economic impact, the complexities of inter-agency coordination, or changes in industrial practice. This report does include occasional information on these topics where particularly relevant to our main concerns, and reference is made throughout to source documents in which much more extensive information may be obtained. (See for example, Starr, 1960; Brunner, 1976; Conley, 1976; Hull, 1976; Linnerooth, 1976; Lowrance, 1976; and Otway & Pahner, 1976.)

Literature Searched

As outlined in our proposal and amplified in the meetings that followed, the literature to be searched included specific material on transport of radioactive substances, more general material on disaster situations such as industrial explosions, escaping hazardous chemicals and hurricanes or twisters (all involving possible problems of rumor, crowd control and evacuation), sociological and psychological approaches to such collective behavior, and (to a limited extent) economic materials pertaining to forced shut-down of productive facilities as in large-scale evacuation of urban sections. The combined collections of the Rice University Library (a fine research library in addition to being a designated repository of U.S. Government documents), the University of Texas Public Health School Library, and the excellent Inter-Library Loan Service (giving access to the Houston Public Library, the University of Houston Library and the University of Texas at Austin Library) were searched for all relevant materials published since 1950. In addition, a wide range of documents, many unpublished, was made available through the cooperation of the Nuclear Regulatory Commission, the Nuclear Fuel Cycle Analysis Division of Sandia Laboratories, and many other individuals interested in related topics.

Our first finding was that no professional literature on social impacts of transport of radioactive materials can be said to exist. There are occasional chapters in books on general topics concerning radiation that give a little information about potential populations that might be at risk under various conditions of package failure or vehicular accident, but the focus is always on probably radiation exposure, not on truly social outcomes. Thus, in most instances we have had to use the professional sociological literature on general collective behavior topics (from rumor, to protest demonstrations, to social behavior in circumstances of natural disaster) by applying its perspectives in a completely hypothetical, speculative fashion to possible transportation scenarios drawn from the technical discussions of radioactive transport.

Only one source was found to contain actual discussions of possible social impacts, broadly conceived of transport as one aspect of larger questions concerning the use of nuclear radiation in medical, industrial and power-generation applications: the popular mass media, especially newspapers and magazines. During the course of our research, over two hundred newspaper and magazine articles were collected on our topics, and a large number of them have been used in the following report in either of two important ways. In some cases, these articles contain "news" stories on one of our topics and appeared in a reasonably "middle of the road" publication such as the Christian Science Monitor, the New York Times, or in a wire report from United Press International or Associated Press and reprinted in the Houston Post or the Los Angeles Times. Obviously, no single medium of mass communication can be considered truly objective, but the breadth of coverage, the rapidity of reports and the diversity of viewpoints seen in comparing many different mass communicated items provides a composite of current event information that would make its way into the professional literature only years later if at all.

The second body of mass-communicated articles on transport came from publications that have a clear stake or highly motivated viewpoint that they bring to their writing. The Ralph Nader organization's Critical Mass Journal publishes an unending stream of idealogical and political attacks on the entire operation of the nuclear industry, including many articles specifically on alleged problems of transportation. Industry trade magazines Nuclear News and Nuclear Engineering International carry pro-nuclear articles and stories on the problems caused by the "red tape" of governmental regulations and the "harrassment" by environmentalists and other antinuclear protestors.

Throughout the following report, both "objective" and "slanted" mass media articles have been cited wherever relevant along with a brief synopsis of their main contents, and in some cases have been reprinted here as "Exhibits" to give a strong rendition of how their particular viewpoints and data are being conveyed to the American public. The justification for this rather unusual practice stems from the equally unusual fact that collective behavior and other social impacts of any such activity as transport of radioactive materials are very strongly shaped by the public interpretation of mass-communicated news and editorial analyses.

Elements of Collective Behavior

Our proposal specifically sets out our intention to approach the complex question of social impacts of radioactive transport mainly from the perspective of collective behavior in response to transportation incidents, and secondarily from the perspective of agency responses to these initial collective behavior processes. Since the general field of collective behavior analysis is a social-psychological specialty within sociology and not very well known outside its own area, a brief overview of the main collective behavior concepts is included in this introduction to our report.

Collective behavior in general refers to the action, mental or overtly behavioral, of groups of people in situations that do not provide clear-cut cultural direction (Turner & Killian, 1972:10). Collective behavior thus includes a very wide range of social conduct in relatively unstructured or non-institutionalized situations through which people collectively attempt the following difficult symbolic and physical objectives:

(1) to assign meaning to ambiguous cues,

(2) to assess possible or actual danger after reception of threatening cues or actual warnings,

(3) to protect themselves and those with whom they identify most strongly, and/or

(4) to advance their perceived interests, even over opposition of others in situations of conflict and hostility, where the outcome is likely to be perceived as both urgent and doubtful.

Public awareness and major dimensions of meaning concerning any particular issue or idea refer to the general symbolic contexts into which the issue fits in the history and current situation of the perceiving citizens. Section 1 of our report deals extensively with transportation of radioactive materials as an issue that fits into the more general contexts of nuclear energy benefits and dangers. It is within this general context that the more specific collective behavior concepts come into play.

Rumor is the characteristic form of interpersonal communication in situations that are both threatening and ambiguous. Rumor involves information and directives for action that cannot be validated through the normal channels because they are disrupted, overloaded or mistrusted. Possible contamination hazard from radiation would be a perfect topic for the processes of rumor, and these are discussed in Section 3.2.1, in connection with a hypothesized truck accident.

Milling is a very elemental crowd phenomenon involving attempts to get a better look at some object of attention (such as a crashed truck) and the beginnings of social attempts to define and come to terms with the new situation. As brought out in Section 3.2.2 and 3.2.3, milling can convert to panic flight, but this is quite unlikely unless the situation becomes defined as extremely dangerous and the perceived escape routes seem to be restricted and difficult to use.

Resignation or apathy frequently occur when there is an "information overload" of continued bad news, or information so complicated that no single course of action seems to make sense. Nuclear radiation is such a complex and difficult topic with so many complex ramifications that citizens are likely to be fairly resigned to accepting anything that government and industry put forward, unless special interest groups can focus attention on alternative possibilities that may seem to offer less potential dangers.

Special interest groups act as mobilizers of members of special publics to move from mere interest in a topic (such as nuclear energy) to actually doing something concrete to promote or resist particular changes in the society that relate to that topic. For example, Sections 2.9, 2.10 and 2.11 discuss the special public that follows and is concerned about various topics (such as transportation) within the broad area of nuclear energy, and then briefly outlines the major pronuclear and antinuclear interest groups that try to mobilize support or opposition regarding specific projects or proposals.

Protest demonstrations and counter-demonstrations are solidaristic crowd behavior patterns that are mobilized by incipient or continuing social movements as tactical efforts designed to aid in achieving the movement's aim of producing or resisting changes in the society. In our particular context, we have discussed protest demonstrations and counter-demonstrations that might arise in connection with the first fuel shipments into the newly approved Seabrook reactor (Section 2.13).

Mass flight from an area perceived as very dangerous and governmentally ordered evacuation from such a site share the features of widespread confusion, uncertainty regarding what to take and where to go and how to get there, and have been discussed in the context of a hypothetical transportation accident involving high-activity spent fuel or radioactive wastes (Section 3.3).

Finally, terrorism involves creating threat and uncertainty in the situation of some target person, organization, or government that seems to be in a position to grant the terrorist some economic, political or ideological benefit. In relation to radioactive transport we have hypothesized various forms of terrorist diversion of enriched uranium or plutonium for use as a threatened environmental poison or perhaps as a nuclear bomb (Section 4).

Agency Responses to Transportation Incidents and Subsequent Collective Behavior

The full range of collective behavior processes outlined above would interact with the specific features of any given transportation incident to produce a situation in which key personnel of various federal, state, local or industrial organizations would perceive the necessity or desirability of direct action. Any overt action taken by regulatory officials, government administrators, corporate executives, union leaders, police officers, National Guard officials, radiological monitoring teams, transport security personnel, drivers, firefighters, etc., would in all probability feed back into the sense-making processes of rumor and the political processes of interest groups and social movements. We have therefore tried to build in possible agency responses in each scenario.

Characterization of our Theoretical Perspective

The features of transportation of radioactive material through urban environs even in normal circumstances are admirably suited to being interpreted by an anxious public as threatening, ambiguous, urgent, and mysteriously dangerous, quite apart from any objective radiological hazard that the shipments might actually present. These characteristics are just those most likely to trigger one or another of the wide range of collective behavior processes. We have therefore adopted the collective behavior perspective as the most useful and innovative one available for use in anticipating the social impacts of radioactive transport.

It should be noted that the general theoretical approach to the analysis of collective behavior being taken here is based on the symbolic-interactionist perspective within sociology. Symbolic interactionism deals mainly with the social processes through which persons make sense of the social situations in which they are involved by constructing alternate "definitions of the situation," and then negotiating an amalgam version of "social reality" that becomes normatively controlling. The major source of this "emergent norm" approach to collective behavior is the work of Ralph H. Turner and his collaborator Lewis M. Killian (see Turner & Killian, 1972; Turner, 1964 a,b, 1970; Killian, 1964), although the approach also draws upon many other symbolic interactionist writings on collective behavior (for example: Blumer, 1946, 1969; Foote & Hart, 1953; Wallace, 1956; Couch, 1968; and Shibutani, 1970).

With this theoretical orientation in mind, we may now turn to Section 1 for consideration of several major frames of reference that members of general and special publics may use to arrive at individual interpretations of the nature, importance and value of transportation of radioactive material in urban environs. Sections 2, 3 and 4 will deal respectively with normal transport (with and without unusual radiation release), accidents in transport (with and without release), and terrorist diversion of radioactive material. In each scenario, we will attempt to hypothesize the most probable collective behavior and the most probable agency responses to the transportation incidents and to the collective behavior that may follow.

It is, of course, quite obvious that these hypothesized collective behavior and agency response scenarios are merely sociological speculations, backed up in many instances with examples from an immense range of popular and professional literature. There is at present no meaningful way to assign probabilities to the various possible outcomes, nor do the projected scenarios constitute any form of proof that actual chains of events and responses would go exactly as hypothesized. The objective plausible event sequences take into account what we will next specify regarding the major meanings surrounding nuclear energy as interpreted by national, state, local or sub-cultural publics, as well as what is known about collective behavior in similar circumstances. Since transportation problems in the fuel cycle associated with generating electrical power through use of nuclear reactors are frequently in the popular media, they will be given special attention in this report, as will questions regarding plutonium recycle (see for example, Speth, Tamplin & Cochran, 1974; Feiveson, Taylor, VonHippel & Williams, 1976; and Salisbury, 1978). These event sequences can then be evaluated in terms of possible social, political, and economic factors that extend far beyond the usual environmental impact statement, but which are clearly important in the development of wise public policy and preparedness programs.

Critical Social Issues Relating to Transport of Radioactive Materials, and their Connection to the Structure of this Report

Section 1: Frames of Reference for Public Interpretation of the Benefits, Hazards, and Costs of Radioactivity and Nuclear Energy

What are the critical frames of reference used by the various action units in their collective interpretation of major aspects of radioactivity and nuclear energy as a unique composite of benefits, hazards, and costs?

Section 2: Normal Transport of Radioactive Materials

What are the current and projected transport forms, modes, materials, amounts and radioactivity levels?

What are the key populations at risk from this transport pattern?

What information is being currently provided to the various action units?

What social actions may be expected from the various units if normal transportation increases as predicted?

What may be expected if plutonium becomes an important component of the transportation flow, and what are some possible implications for the wider society?

Section 3: Social Impacts of Accidents in Transportation of Radioactive Materials

What are the most probable non-radiological impacts on the action units of various forms of vehicular accidents, with and without radiation release?

What forms of collective behavior are most likely to occur?

Section 4: Diversion of Radioactive Material by Terrorists

What forms of diversion of radioactive material are possible and most probable?

What are some of the most probable impacts of diversion on the action units and the wider society?

What are some of the most probable impacts on the wider society of the precautions that might accompany adoption of plutonium as a major fuel source?

General issue underlying all sections:

What alternative policies and procedures might be developed to handle in the best possible fashion the complex problems of information flow, training, physical security, crowd control, evacuation and relations to social movements?

1. Frames of Reference for Public Interpretation of the Benefits, and Costs of Radioactivity and Nuclear Energy

Public perception of the potentials for both destructive and constructive use of radioactivity and nuclear energy began in 1945, with the filmed obliteration of Hiroshima. Newsreels showed the destructive power symbolized by the mushroom cloud of radioactive dust and the gruesome pictures of scarred survivors assertedly carrying the seeds of genetic mutation. American scientists were shown explaining how "unleashing the power of the atom" could produce essentially limitless electric energy for peaceful purposes as well. This "atoms for peace" theme in fact became the dominant motif for the joint government/industry programs of development in a wide range of nuclear applications in the fields of radiopharmaceuticals, cancer therapy, industrial testing, oil technology, and especially the generation of electrical power from nuclear energy.

1.1 Perceptions of Limitless Sources, Effects and Scale of Nuclear Energy

The common portrayal of nuclear energy combines two major interconnected symbolic themes:

(1) Nuclear energy is portrayed as involving physical domains both infinitesimally small and infinitely large. These domains range from the invisibly tiny realms of sub-atomic particles to the ultimate blast of a world-destroying chain reaction. While these portrayals of nuclear energy can make fascinating Sunday-supplement reading, they encourage members of the public who are not trained in modern physics to take a very magical view of nuclear energy. This magical approach colors later views.

(2) Nuclear energy is also portrayed as limitless in both sources and effects. If everything is made up of atoms and held together by atomic forces that can somehow be "split," then it seems to follow that we can never run out of the raw material of nuclear energy. This view of nuclear energy as being obtainable from essentially any physical material was directly fostered by the grossly exaggerated claims that were put forward after Hiroshima. Now that rapidly developing shortages of fossil fuels are being foretold in the news, the concept of nuclear power as providing essentially limitless energy with which to support the nation's lifestyle becomes more and more attractive and eagerly grasped.

The second bi-polar theme's focus on energy is linked in fascinating ways with the first theme's contrast of spatially infinitesimally small and infinitely large. The effect of radiation can thus easily be conceptualized in terms of insidious and often irreversible damage such as radiation sickness, sterility, cancer and genetic mutation in future generations. Nuclear effects can also be seen as infinitely large in the sense that the "megaton" (translated as "huge") bombs were shown in the war films, desert tests and Hollywood epics as capable of turning any imaginable physical location into a crystallized desert unable to support plant or animal life for generations. Recent mass media presentations on the advantages and disadvantages of shifting to plutonium-fueled reactors have raised once again all of these meanings.

1.2 Moral and Political Values Surrounding Nuclear Energy

The above meanings of nuclear energy have of late been greatly reinforced and intensified by political debates and the attendant media reports and commentary on development of the Neutron bomb. Even while pointing out that the neutron bomb would be "good" because its radiation would "only" kill large numbers of persons without harming physical facilities, these reports restate the theme of huge blast and heat characteristics of "regular" atomic weapons. In both cases there is a very likely re-connection of nuclear energy and tremendous potentials for death, disease, defectiveness and/or destruction. The political aspects of the neutron bomb debate (and the whole range of previous Stragetic Arms Limitation Talks debates) again linked nuclear energy to competition with Russia in development of ever more powerful and deadly weaponry.

The assimilation of nuclear energy to aggressive international competition and warfare tends to add a strong sense of threat value (other countries now have atomic weapons, which may be used either intentionally or through accident), of uncertainty (we have no real experience or comprehension of the nature and consequences of atomic war), and of urgency (perhaps from the old maxim: "Do unto others before they do unto you"). It will be recalled that these very senses of threat, uncertainty and urgency were shown above as major components in establishing the context most likely to produce the forms of collective behavior that we know as rumor, panic, crowd behavior, social protest, mass demonstrations and social movements.

1.3 Plutonium as a New and Controversial Issue

The issues of threat, uncertainty and urgency regarding radioactivity in general are greatly intensified in the special case of plutonium. Generated in the course of uranium fission inside a nuclear reactor and capable of being combined with the plentiful non-enriched uranium-238 and fed back into a fast-breeder reactor that actually generates more fuel than it consumes, plutonium is receiving a great deal of consideration world-wide as a potential solution to the "energy crunch." But there are very serious potential drawbacks to the use of plutonium: severe radiation poisoning to humans and animals, environmental contamination aggravated by plutonium's half-life of almost 25,000 years, and the fact that only 8.8 pounds of plutonium are needed in order to produce a bomb in the one kiloton range (having the force of 1,000 tons of TNT). (Ayres, 1975:esp. pp. 375-384; Keeny, et al.,1977: esp. ch. 10-12; U.S. Nuclear Regulatory Commission, 1977a: Vol. 1, Appendix C).

Mass media coverage of the debate surrounding development of plutonium recycle and the fast-breeder reactor has included editorial calls for the United States to exercise leadership in controlling plutonium-fueled power generation, even while noting that neither the safety of plutonium-handling nor the efficacy of international agreements regarding spread of nuclear technology has been demonstrated (see Houston Post, 29 Sep 77). Antinuclear publications such as Critical Mass consistently oppose plutonium use (for example, "Proliferation threat: Princteon research team calls for a stop to the "plutonium economy" by Richard Pollock, January, 1977 issue). Even the presumably balanced and objective accounts of U.S. and international plutonium exports stress the fact that substantial transportation of extremely hazardous materials would be involved (e.g., Christian Science Monitor, "The N-bomb, detente, and plutonium spread: U.S. has shipped millions in plutonium," by Gary Thatcher, 14 July 77).

The lure of the ultimate alchemy (turning spent uranium fuel that is not only worthless but also a great disposal problem into plutonium, now selling to eager foreign buyers at around $40 a gram or $18,000 a pound) has proved irresistible to nations seeking both independence from Middle Eastern oil states and from the U.S. as the major supplier of uranium fuel. The rather elaborate compilation by Thatcher in the Monitor outlines the political, economic and transportation aspects of recent shipments of plutonium from American companies in Pennsylvania, California, and New York through various American transport facilities to such destinations as Iraq, Italy, West Germany and Japan. Not only do the geopolitics of such nations in relation to the United States make for fascinating consideration, but at the same time that President Carter is calling for a cessation of plutonium commerce, a European consortium of five nations (Belgium, Italy, France, the Netherlands and West Germany) announced its plan to build and sell breeder reactors, using U.S.-supplied plutonium (CSM, 14 July 1977). The relative shortage of both coal and hydroelectric power resources in Europe has in the past few years has given rise to the hope that use of breeder reactors and plutonium reprocessing will reduce Common Market dependence on the United States and Canada as sources (now 80%) for ever more scarce uranium and also do away with the need for large storage space for the problematic and dangerous uranium spent fuel (Washington Post and New York Times, 17 July 1977; CSM, 9 September 1977:19). The various countries in the Common Market have quite different current levels of nuclear power generation (ranging from no present nuclear-powered electricity generation in Austria to a high of 20% in Switzerland, with most countries around 10%), but they all have plans or actual construction under way. They are also beginning to meet various forms of social protest and political opposition that often focus at least in part on issues of transportation of radioactive materials.

Over the course of the summer of 1977, President Carter and his representatives at the meetings of the 70-nation International Atomic Energy Agency (IAEA) in Salzburg, Austria and at the meeting of the 15-nation Nuclear Suppliers Group (NSG) were arguing for minimization of plutonium commerce as the best way to reduce the likelihood of terrorist diversion of the material (other nations have pressed for reliance on and toughening of the 1970 Non-Proliferation Treaty that is allegedly binding on some 100 states [CSM, 26 April and 2 May, 1977]). One result of these negotiations was an agreement that would allow Japan to send its U.S.-supplied uranium spent fuel to France for reprocessing into fresh uranium and plutonium, while at the same time starting up its own experimental reprocessing plant at Tokai-Mura. This agreement between the U.S., Japan and France has been interpreted as a possible first step on the part of the Carter administration toward the prevalent worldwide view that well-regulated and controlled commerce in plutonium is both economically/politically desirable and environmentally/politically safe. (See CSM, 22 September, 1977:6).

It seems quite probable that plutonium shipments will increase dramatically on the world market (even if delayed as a major part of the domestic nuclear energy program), and shipments from U.S. suppliers to foreign recipients will therefore increase greatly the problems and hazards of domestic transportation to and through the urban areas that serve as ports of exit to world markets.

Obviously, political conflicts concerning allocation of priorities and resources to starting, accelerating, maintaining, reducing or stopping development of both nuclear weaponry and nuclear power generation are based upon the moral, economic, and social status values of the participating interest groups. These values also interact in very complex ways with the technical features inherent in the physics, chemistry and engineering aspects of nuclear energy and its products. Consideration of plutonium's special characteristics can only complicate the structure of public responses to transportation of radioactive materials, whether the specific topic at hand be (A) normal transport through urban environs, (B) various forms and severities of accidents during transport, or (C) terrorist attempts at diversion of radioactive materials.

1.4 Economic Values Surrounding Nuclear Energy in Relation to Transportation

Examination of the complex relationships and (possible trade-offs) among nuclear fission, coal, oil, wind, solar, geothermal, nuclear fusion and other possible sources of energy for electrical power generation and other uses is far beyond the scope of this report. These "soft" alternatives have been advocated previously (e.g. Lovins, 1977), and these relationships have been analyzed in great detail in a recent book reporting the results of three years of effort by the large diverse Nuclear Energy Policy Study Group, sponsored by the Ford Foundation and administered by the MITRE Corporation in Cambridge, Massachusetts. Their report Nuclear Power Issues and Choices (Keeny, et al., 1977) devotes long chapters to synthesis of a large amount of information on many crucial aspects of nuclear energy, including economic comparisons with the use of coal over the next twenty-five to thirty years. These economic factors have relevance to questions concerning public acceptance or protest in regard to various forms of transportation of radioactive materials, due to the obvious fact that exposure to potential or actual hazard can only be acceptable if those affected can be convinced that the economic, moral, political, or social benefits outweigh the risks.

1.5 Comparison of Coal and Nuclear Power for Generation of Electricity

The Nuclear Energy Policy Study Group gave the following summary of the economic situation:

> Like so much else in the nuclear debate, the comparative economics of nuclear power and other energy sources for electric power has become shrouded in controversy. The comparative economics of coal and nuclear power is a genuinely complex problem about which there can be honest differences of opinion. Plants committed today will not begin operation until 1986 and are intended to have a useful life of thirty years. On such a time scale, the projection of lifetime costs is a very speculative business. Not only have construction costs of both coal and nuclear power plants escalated substantially in recent years but so too have the prices for uranium and coal. Moreover, stricter environmental controls on nuclear power and fossil fuels could have far-reaching economic effects. Finally, new scientific information on long-range environmental effects or events relating to safety or nuclear proliferation could lead to decisions which would have major economic effects. In such an uncertain environment, projections must be made with considerable caution.
>
> Despite these large uncertainties, our analysis leads us to the conclusion that nuclear power will on the average probably be somewhat less costly than coal-generated power in the United States. However, coal will continue to be competitive or preferable in many regions since there substantial large

> regional cost differences and wide variations even with regions. The advantage for nuclear power is likely to be most significant in New England and in parts of the South. In large areas of the West, containing a small fraction of the country's population, coal-generated power is likely to be less costly than nuclear power. In much of the country, however, the choice is so close and the uncertainties sufficiently large that the balance could easily shift either to increase or to eliminate the minimal advantage that nuclear power presently enjoys. (Keeny, et al., 1977:8).

However the long-term economic comparison between coal and nuclear energy turns out, it seems fairly clear that a present neither enjoys an overwhelming economic superiority.

1.5 The Nuclear Industry as a Governmental Related Oligopoly

Other aspects of the economic structure of the nuclear power industry, however, may have great impact on public interpretation of the industry's moral position and right to continue business as usual. In 1977, public media carried allegations (1) that the nuclear industry is largely owned and controlled by large oil companies, and thus the two fuel systems are not likely to compete vigorously against each other; (2) that oligopolistic and collusive practices in the domestic market and cartel operations in the international market had served to drive up prices to companies outside the "Club;" and (3) that use of government subsidies and facilities had given nuclear power generation an artificially low intial cost and an opportunity to make proportionately higher profits in regular operations.

These charges were published by Richard Pollock in Ralph Nader's Critical Mass in August of 1977, in an article asserting that Exxon, Gulf, Royal Dutch Shell, and Getty Oil control the bulk of uranium mining, milling and enrichment, reactor sales, and spent fuel reprocessing. Other, less openly antinuclear voices have since charged that operations of an international uranium cartel had conspired to drive up prices to domestic utilities buying uranium fuel for their reactors. For example, Representative Albert Gore of Tennessee on 16 August charged that this cartel was responsible for a 700% uranium price rise between 1972 and 1975, increasing the cost to the Tennessee Valley Authority by $320 million over the next few years, necessitating a commensurate rate hike (Houston Post, 16 August 77). Rep. Gore subsequently opened a House Sub-committee hearing on the effects of price fixing of uranium on public utilities.

Several large court cases are now under way in which some companies within the nuclear industry are charging that others conspired against them in violation of the anti-trust laws in the matter of uranium pricing, and such litigation can not help but weaken public confidence in the motives, ethics, and practices of least a large portion of the industry, (and this in turn will make the companies' claims that transportation of radioactive materials through urban areas is both safe and in the pubic interest just that much more difficult to swallow). A brief quotation from a characterization of these suits and counter-suits appeared in one of the nation's largest circulation magazines, describing

....one of the largest and most complex corporate lawsuits ever filed in an American court--a $2 billion-plus action by a New Mexico uranium mining company, United Nuclear Corp., against General Atomic Co., a 50%-owned subsidiary of Gulf Oil Corp., for fraud, coercion and breaches of the nation's antitrust laws.

The case, which has already produced more than 10,000 exhibits, is a key part of the continuing legal fallout from the operations of the now notorious world uranium cartel. The cartel included companies from Canada, Australia, Britain, France and South Africa, as well as the governments of all those countries except Britain. Gulf Oil, the only known American participant, was represented through a Canadian subsidiary. The cartel existed only from 1972 to 1975, but it cashed in on a bonanza that would make an OPEC oil minister jealous: during those three years, world 'yellowcake' prices zoomed from less than $6 per lb. to about $42, where they have since remained.

As prices climbed, United Nuclear found that contracts it had signed with a now defunct Gulf subsidiary and with General Atomic to deliver more than 27 million lbs. of uranium at set prices ranging from $9 to $14 per lb. could be filled only at a huge loss. All the time, it now claims, officials of both

Gulf and General Atomic, neither of which were formal cartel members, concealed their knowledge that Gulf's Canadian subsidiary was helping to drive prices up by participating in the cartel. United Nuclear now seeks not only to have the contracts voided but to collect damages of $2.27 billion from G.A. In a countersuit, General Atomic denies all allegations and asks that United be forced to fulfill the contracts.

Whatever the courts rule, the cartel's shenanigans are certain to refuel congressional demands that the nation's oil companies divest themselves of their nonpetroleum activities. At the least, the trials will give yet more ammunition to oil-industry critics who charge that some of the world's largest and most powerful corporations think they have become a law unto themselves. (Time, November 21, 1977)

Pollock (1977) asked why the public and the appropriate regulatory agencies do not perceive the "nuclear monopolies" in the same way as in other fields, and move in the direction of breaking up the vertical and horizontal forms of integration in the atomic energy industry. One answer may lie in the fact that the American political economy has from its inception granted governmentally chartered franchises or at least near-monopolies to enterprises conceived of as public service utilities (street car lines, telephone systems, bus companies, etc.), and especially electrical power generation and delivery systems). The other major model exists in the realm of military suppliers: not quite sole monopolies, but instead highly concentrated industries made up of a few large firms that have the relevant governmental unit as their primary customer, and which tend to have cooperative rather than competitive relationships with each other. The nuclear energy industry fits this model of oligopoly much as do the defense industries, and in fact the nuclear energy industry seem to have been assimilated to both "defense oligopoly" and "public service monopoly" models in public attitude and regulatory stance.

The American public for most of its history has richly rewarded both public service monoplies and defense-related oligopolies, but only so long as they could be interpreted as functioning "in the public interest" rather than primarily for private gain. Sometimes it takes a long while before public sympathies and regulatory control turn against those who become sufficiently portrayed as "robber barons" enriching and aggrandizing themselves at public expense. The effects of Thomas Nast's cartoons on Tammany Hall and of Thorstein Veblen's The Theory of the Leisure Class on public interpretation of Fisk, Gould and others among the corporate magnates at the turn of this century are cases in point.

For the most part, the companies that make up the nuclear energy industry (including especially the large oil and gas corporations) have been and continue to be able to count on America's general positive orientation to secular and economic power. Those at the top of our economic structures benefit from ideas such as "what the boss says goes," "big is good, bigger is better," and "rich guys must be smart if they made it instead of inheriting it." In a society that enshrines and rewards both individual achievement and effective power, we see another affirmation of the Golden Rule of Control: "They who have the gold make the rules."

1.7 The Ecological and Fairness-to-the-Consumer Issues

Yet two particular value themes that are also well-institutionalized in American culture provide areas of vulnerability for these same corporations: damaging the physical environment, and raising prices unjustifiably to the "little man" caught in the necessity of the service but without means to pass along the price increase to someone else. Both the ecology theme and the fixed prices theme have been highlighted by the critics of nuclear power in general and of plutonium in particular. Transportation and storage or disposal of the full range of radioactive fuels, products, and waste materials have become the orienting foci of the ecologically based protest movements that have come forward at all levels to seek elimination, reduction or restrictions on such transportation of radioactive materials. The specific viewpoints of these antinuclear protest groups will be discussed in Section 2.11.2.

1.8 Pronuclear Views and Votes

It should not be inferred from the above discussion that only antinuclear ideas, literature and organizations have characterized recent socio-political rhetoric and action. There is an active industry press (Atomic Industry Forum and Nuclear News) and there have been many pronuclear statements in the popular literature, especially in the science press (for example, Weinberg, 1972; Hammond, 1974; and

Bethe, 1976). Political and regulatory processes of the federal level frequently generate information designed to build support for the expansion of nuclear power generation. On 23 September 1977, the House of Representatives voted 317 to 47 to approve a $6.7 billion bill for federal agency research and development that includes $1.9 billion item for the Clinch River breeder reactor. Although the Carter administration has opposed continued rapid development of the Clinch River breeder, the Senate has already approved $75 million to continue research personnel for the coming year (UPI report, Houston Post 24 September 1977). In other symbolically important developments, President Carter has appointed three new members to the Nuclear Regulatory Commission, two of whom are thought to favor development of the Clinch River breeder (Los Angeles Times of 2 August 1977). On July 27, the NRC granted permission for the Seabrook, New Hampshire nuclear reactor project to resume construction after a spring and summer of demonstrations, counter-demonstrations and regulatory reconsiderations.

1.9 Psychological Orientations Toward Nuclear Radiation That May Affect Responses to Radioactive Transport

1.9.1 Risk Assessment

A particularly interesting and quite recent development in behavioral science approaches to analysis of nuclear energy-related topics has centered around a group of researchers working at the International Institute for Applied Systems Analysis, in Laxenburg, Austria. The original thrust of their work centered around mathematical and statistical approaches to risk assessment in relation to various nuclear topics (Otway, et al., 1971; Otway, 1975; Otway, Pahner & Linnerooth, 1975; and Otway & Pahner, 1976). Later publications carry a more directly social-psychological flavor, focusing on the kinds of positive and negative imagery regarding nuclear energy that have been discussed in the opening sections of this chapter (Pahner, 1975; Otway & Fishbein, 1976; and Nowotny, 1976). It is especially interesting that Pahner, a member of a research group that makes heavy use of statistical "risk assessment" approaches, sees that members of the public at risk do not take a probabilistic stance with regard to their own deaths, and fear radiation death as among the most repugnant:

> As developed in Otway and Pahner (1976), the risk-benefit methodology fails to consider conceptual differences in how risks are perceived by the public and by those compiling such statistics. There is a tendency to "technologize" the probability of death without considering that it is the consequence or mode of death with which people are most concerned. . . . Risk-benefit methodology also fails to consider the possible influence that a perceived threat may have on the psychological well-being of persons, irrespective of how low the risk is estimated.
>
> . . .
>
> Needless to say the anxiety regarding radiation release is closely related to the fear of death, because it is through radiation that death would occur in the event of a nuclear power plant accident. To die by radiation exposure may be one of man's greatest fears.

The only scientific account of how such fears affect large groups of people is again provided in Lifton's study of the survivors at Hiroshima. The rumours that circulated after the bombing give substantial evidence of the pervasive anxiety that exposure to radiation (or the threat of exposure) generates in individuals. People expressed fears that Hiroshima would be uninhabitable for 75 years--a direct expression of the fear that there was a "deadly and protracted contamination from a mysterious poison" (Grosser, 1971). There were also rumours that all forms of plant life would fail to grow. Perhaps most frightening of all was the belief (and later realization) that the invisible radiation exerted a deadly influence on those exposed, and that the effects might manifest themselves <u>at any time</u>. There were no means of knowing who had been exposed or to what degree and whether or not one would die. The forms of physical death from radiation were also particularly devasting and grotesque--(nausea, vomiting, bleeding, loss of hair, infections resulting from depleted white cells) all manifestations of the consequences of leukemia.

It is unlikely that these consequences of exposure to radiation are unknown by individuals in contemporary societies. They are not likely to be appeased by estimates of the low probabilities of exposure to radiation, but they are likely to respond to the perceived consequences in the event of an accident. (Pahner, 1976: 14, 16-17).

1.9.2 Disease, Disfigurement and Death Themes

This segment from the IIASA papers takes us into the realm of the unconscious or deeply rooted and repressed fears concerning nuclear radioactivity as a terrifying source of disease, disfigurement and ultimately of death itself. In other sections of his 1976 paper, Pahner applies the work of Robert Jay Lifton on the many meanings of death to the Hiroshima survivors (1963, 1964, 1968) to more recent work of others specifically on the fears and worried interpretations of persons living or working very close to large nuclear facilities. The result is the most powerful statement in the literature on the nature and functioning of these very real but difficult-to-recognize feelings. To the extent that Pahner's analysis of the unconscious but powerful association of nuclear radiation with terrifying disease, disfigurement and death is valid, this relationship can help us to comprehend some of the great emotional heat generated by apparently innocuous proposals regarding nuclear materials transport. The fact of empirically infinitesimal probabilities of radiation leakage under most transportation circumstances misses the essential point of the entire array of social and psychological themes sketched out in this chapter. Quite apart from any objective or scientific considerations, personal orientations toward so complex and emotionally-heated a topic area as nuclear energy and transportation of radioactive materials will always be a changing and most delicately balanced mix of positive and negative power themes, and of positive and negative destruction themes.

1.9.3 Ambivalence and Social Efforts to Arrive at a Symbolic Definition of the Situation

Within the thought processes of any one individual, there will generally be a condition of ambivalence, because both positive and negative orientations toward the various differentiated aspects of any given situation of even remote relevance to nuclear energy. This ambivalence is reflected in the results of a recent poll conducted by the Louis Harris organization. According to Richard Pollock's article in the January 1977 issue of Critical Mass, Harris characterized his results to the 30 November 1976 meeting of Washington's National Press Club in terms of a growing "softness" of public support for nuclear power development as compared to the data in his survey of 1975 (down an insignificant 2 percentage points). But 82% opposed such construction if federal regulatory agencies considered it unsafe, with 60% opposing construction if environmentalists declared the plants to be polluting. Harris pointed to a perfect example of the working of individual ambivalence: "If you look, you'll notice that the 'negatives' (attitudes about nuclear energy) have risen and some of the 'positives' have slipped some."

Since each individual tends to feel continued ambivalence, and since new aspects of situations are constantly arising, there are from time to time attempts to offer new or reworked suggestions as to possible modification of the currently prevailing views. The processes of give and take, stability and change, and of normative constraint over the situation, contrasted with periods of redefinition, can go on indefinitely, but also can intermittently erupt into vigorous action.

This "emergent norm" approach to the full range of collective behavior responses to situations of ambiguous, non-institutionalized, confusing and yet somehow urgent circumstances has been articulated in Collective Behavior, by Ralph Turner and Le is Killian (1972). It will be systematically utilized to develop maximally plausible and probable scenarios covering the most important forms of radioactive transport situations, including normal transport, minor and major accidents, severe and moderate radiation release circumstances, orderly and disrupted agency response, and highly politicized situations including large-scale protest, nuclear terrorism, and large-scale agency responses to them.

2. Normal Transport of Radioactive Materials

2.1 Nuclear Regulatory Commission's Estimates for 1975 and 1985

The most comprehensive and current summary of radioactive transport within the United States is that provided by the Office of Standards Development, U.S. Nuclear Regulatory Commission in NUREG-0170 (draft published in February, 1977a) and the final version (December 1977b). The Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes gives very detailed estimates of the radiological impact to the American public from normal transport (without any unusual form of accident or incident), from accidents in transit, and, to a much more limited extent, from incicents such as attempts by a terrorist group to damage, destroy, or divert a transport vehicle for political or extortion purposes.

The data on normal transit are drawn from the 1975 survey conducted for NRC by Battelle Pacific Northwest Laboratories (BNWL) (see NUREG-0073, published by U.S. NRC in May 1976), using a sample of 2,275 from over 15,000 licensees authorized by NRC to transport radioactive materials. The estimated total number of packages of any size, from a tiny cardboard box up to a massive cask on a railroad car or a barge load of uranium ore, was 2.5 million for the 1975 year (p. 1 of NUREG-0073). The larger activity shipments had the characteristics outlined in Table II-1.

TABLE II-1

Transportation in 1975 of Major Radionuclides

	Estimated No. of Pkgs	Av Miles per Pkg	Av TI per Pkg	Av Activity per Pkg (Ci)	Most Freq Tr Modes	
Non-"Special"						
I-131	270,000	850	0.7	0.05	Truck	53%
Tc99m	230,000	140	0.2	1	Pass. Air	35
MO-99	130,000	1100	2.	4.3	Freight Air	11
I-125	68,000	1000	0.04	0.008	Auto	1
Co-60	7,000	640	6.5	500.	(Other,less)	-
Ir-192	6,000	1200	2.	180.		100%
"Special Nuclear Material"				Av weight per pkg(gram)		
U (nat. & depl.)	280,000	1300	1.2	160,000	Rail	51%
U (enriched)	44,000	2900	.5	2,800	Truck	48
Pu-239	4,300	1100	.9	90	Boat	4
Total	1,039,300				Pass. Air	1
					(Other,less)	-
						100%

SOURCE: NRC's NUREG-0073, (1976: Tables 5 & 7).

The detailed data from the Battelle study have now been entered into a computerized data-base and transport model that allows calculation of total annual exposure for specific groups such as crew members, passengers, and bystanders on the basis of type of radionuclide, exposure rates, shipment data and transport mode splits. The total annual radiation exposure for the American public was estimated to be about 9790 person-rems, distributed as shown in Table II-2:

TABLE II-2

Sources of Radiation Exposure to American Population

Medical-use radionuclides	52%
Industrial shipments	24
Waste shipments	15
Nuclear fuel cycle shipments	8
TOTAL FROM ALL SOURCES	100% = estimated 9,790 person-rem/year

SOURCE: NRC's Draft NUREG-0170, (1977a: p.xx)

The authors of the NRC report then go on to estimate that since radiation exposures for those exposed during normal transport tend to be at very low radiation levels, the average exposure in 1975 amounted to about 0.5 millirem per year, as compared to average natural background exposure of about 100 millirem per year. "Based on the conservative linear radiation dose hypothesis, this would result in a total of 1.2 latent cancers distributed statistically over the 30 years following each year of transporting radioactive material in the United States at 1975 levels. This can be compared to the existing rate of 300,000 cancer fatalities per year from all other causes." (1977a: xx). It should be noted that this small estimated increase in "latent cancer fatalities" refers only to normal transport, without accidents or incidents.

The December version on NRC's Final Environmental Statement (1977b) gives a breakdown of normal transportation according to transport mode, including information on dose levels being received by various population groups. Table III-3 is an adapted version of this information.

TABLE II-3

Annual Normal Population Doses (Person-Rem)
for 1975 Shipments, by Transport Mode

Transport Mode	Dose	% of Total	Major Population Groups at Risk
Truck	4406	45	Crew (2580), Population around stopping points (999)
Passenger Aircraft	2902	30	Passengers (2330), Handlers (433)
Secondary Modes	2233	24	Handlers (1143), Crew (534), storage workers (310)
Rail	117	1	Handlers (92)
Cargo Aircraft	21	-	Handlers (16)
Other	10	-	Crew (6)
Total Dose	9,790 Person Rem	100%	

SOURCE: Adapted from NRC, 1977b: Table 4-15, on p. 4-38.

The final NRC environmental statement then goes on to estimate the average annual dose from normal transportation for the segments of the American public most directly at risk:

> The total population at risk for radioactive material transport is estimated to be about 20 x 10^6 people (1975), based on estimates of numbers of aircraft passengers, persons in air terminals, and persons living within 0.5 mile of truck and van routes. Thus, the average annual individual dose is approximately 0.5 mrem, which is a factor of 300 below the average individual dose from background radiation. (NRC, 1977b: 4-49).

When the same form of averaging is carried out on the 25,400 person-rem total annual population dose predicted for normal transportation in 1985, the estimated average annual individual dose is 1.27 mrem using the same 20,000,000 estimated population at risk, (or 0.8 mrem if that population is assumed to have increased to 30,000,000). Estimated annual LCF's and genetic defects more than double as computed to 1975 rates (increasing to 3.1 and 4.4).

While it is plausible that miniscule estimates of fatalities from normal transport might be meaningfully generated from the computer model and the 1975 Battelle data base, the apparently precise numerical estimates regarding an accident in a densely populated urban area seem arbitrary and doubtful:

> In spite of their low annual risk, specific accidents occurring in very high density urban population zones can produce as many as 1 early fatality, 150 LCF's and decontamination costs in excess of $200 million. Although such accidents are possible, their probability of occurence is very small (estimated to be less than 3×10^{-9}). (NRC 1977a: xxi).

The writers conclude that the benefits to the nation in terms of medical treatment and diagnosis, oil exploration, quality control, electrical power generation and industrial products outweigh the probable few deaths and possible decontamination costs that might result from both normal transport and accidents (p. xxiv and xxv).

Before acccepting any such conclusion, it would be wise to consider many additional aspects of both normal transport and "regular" accidents, and then go on to consider the potentials for terrorist diversion of radioactive material, all within the context of recent estimates suggesting that amounts of all radionuclide shipments are and will be accelerating very rapidly, especially in the areas of the nuclear fuel cycle where both accidents and terrorist incidents become ever more likely. These accidents and incidents clearly would involve types and magnitudes of collective behavior and agency response that with a very high probability would produce economic costs, social impacts and political problems far greater than ever envisioned in the terse NRC impact estimates.

2.2 The Nuclear Fuel Cycle and the Probable Future of Related Transportation

Exhibit II-1 provides a schematic view of the major transportation links (designated by the arrows) in the fuel cycles of many of the current systems for producing electrical power through nuclear fission processes: the "light water" reactors (LWR) (including the pressurized water reactor and boiling water reactor), the high-temperature gas-cooled reactor (HTGR), and the liquid metal fast breeder reactor (LMFBR), (NUREG-0170, 1977:I-11). In the LWR's, the most difficult tranportation and storage problems are presented by the enriched uranium UO_2 fresh fuel going into the "front end," and the spent fuel coming out the "back end." This spent fuel has as its major components the long-lived fission products (for example, Cs-137 and Sr-90), unfissioned fuel (U-233 and U-235), and transuranic isotopes (five isotopes of plutonium and other elements). After the recovered uranium is returned to the enrichment plant and the transuranic wastes are stored in liquid form, the high-level fission product wastes are solidified and held on-site until the federal government decides where and how they are to be stored. Even in past

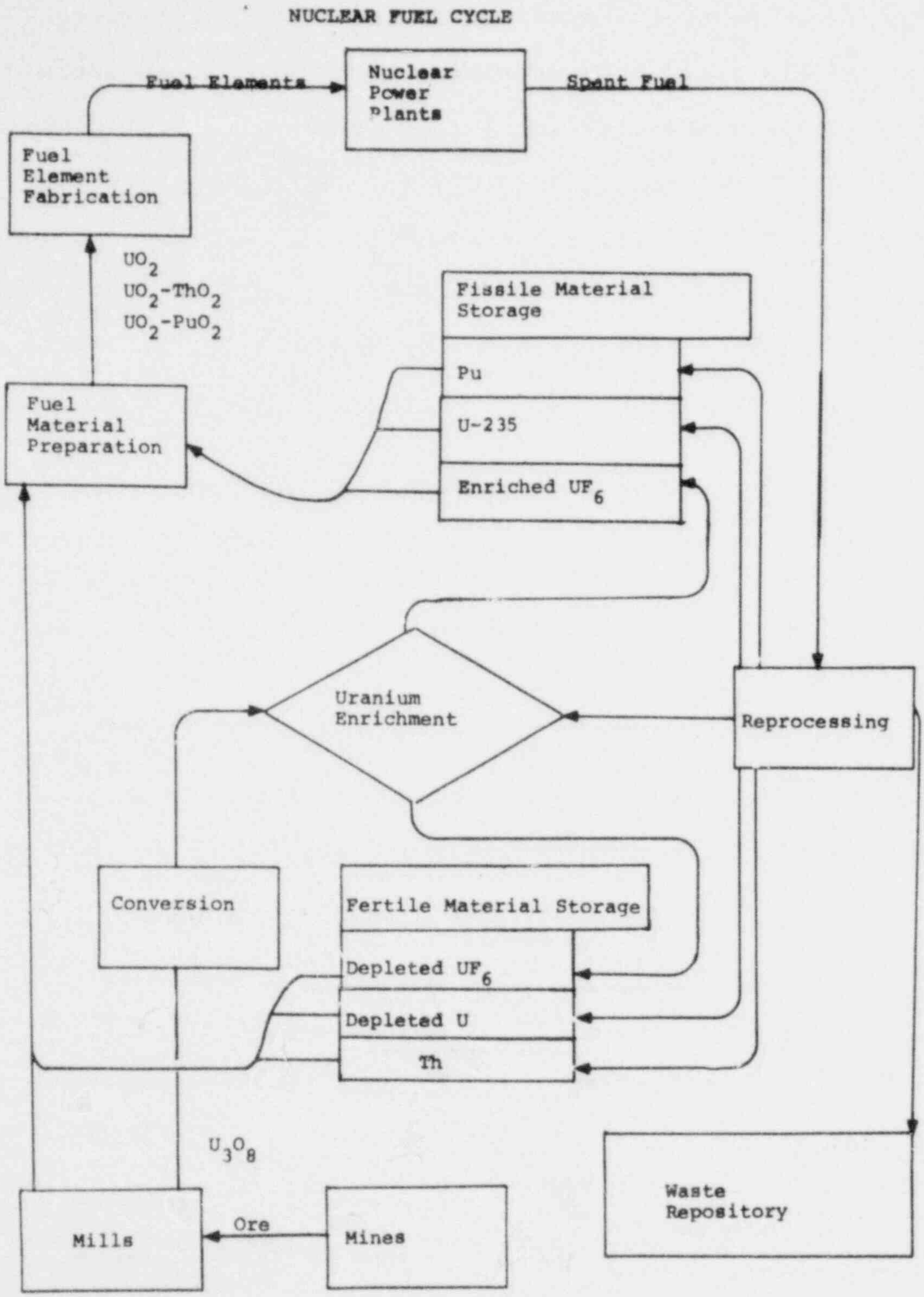

Exhibit II-1. Schematic of Major Transportation Links years, when the amount of radioactive waste and spent fuel being produced was relatively small, there were very great problems encountered in transporting them from one storage site to another as one plan after another was found to be inadequate to the task of safe storage or disposal. (See Rosenthal, 1976 [in Exhibit II-2] for a brief characterization of the geographic location of reactors, low-level ERDA waste storage sites, high-level ERDA waste storage sites and inactive uranium mill sites, and for a set of assertions about problems in the transportation and storage of radioactive materials associated with the fuel cycle.)

2.3 Plutonium as a New and Complicating Element in Transportation

The upcoming decision on development of the Clinch River Fast Breeder Reactor will have a strong impact on the amount and type of transportation of radioactive materials in the forseeable future. If development of the fast breeder is stopped or substantially delayed, then larger and larger amounts of fresh enriched-uranium fuel will have to be transported to the nation's reactors (68 reactors operating in the U.S. in 1977, but estimated by the Atomic Industrial Forum, the industry's trade group, to increase to 93 reactor by 1985, as reported in the New York Times' International Economic Survey, 5 February 1977:11). The much more highly radioactive spent fuel will also have to be transported from these reactors to various forms of storage locations, and this transportation poses complex problems of logistics safety and possible public response, but does not necessarily pose severe problems of security against terrorist attempts because the materials being transported are extremely bulky, toxic and difficult to convert into an atomic weapon, although they could conceivably be used as a threat of environmental poisoning.

Radioactive Waste Disposal Problems Mount

by Bruce Rosenthal

Radioactive wastes from uranium mining and the atomic reactor fuel cycle are becoming an increasingly large blemish for the pro-atomic establishment. Senator John Pastore, chairman of the Joint Congressional Committee on Atomic Energy and a staunch nuclear advocate, says, "The most important problem facing nuclear power is waste management."

Not only have the government, the utilities, and the atomic industry spent vast sums of money and been unable to devise a permanent means of storage for these wastes, but many of the storage sites are also leaking like sieves, emitting radioactive particles. And the US Court of Appeals has recently chastised the Nuclear Regulatory Commission (NRC) for failure to adequately consider the problems of wastes in licensing nuclear plants.

CRITICAL MASS has highlighted instances of radioactive emmissions from the remains (tailings) at uranium mining and waste storage areas (see CM Oct. 1975, p. 3; Feb. 1976, p. 1; May 1976 p. 30), but similar occurrences have become more prevalent in recent months. For example:

--In June 1976 workers wearing protective jumpsuits and using respirators began a year-long task of removing 400 cubic yards of radioactive dirt contaminated by plutonium at the Rocky Flats (Colo.) nuclear weapons plant. The contamination was caused by corrosion in 55-gallon metal drums used in the storage field. The year-long effort will be necessary to clear an area the size of an average living room. The dirt will now be shipped to Idaho for storage in another form.

--A park in Chicago was closed in July 1976 as a result of apparent dumping of radioactive materials there in the 1930's and 1940's by the now defunct Light and Chemical Co. The 100-acre Reed-Kempler Park has been closed for further testing. The NRC discovered the abnormally high radiation levels as the result of an anonymous telephone call to a newspaper reporter.

--Traces of radioactive substances were recently discovered in the ocean 120 miles east of Ocean City, Maryland, a prime tourist and vacation area. Traces of plutonium were found 40 miles from San Francisco near the Farallon Islands in another underwater waste disposal site. The area is inhabited by sablefish, which are sold commercially by fishermen.

--Leaks of radioactive wastes at the Turkey Point atomic reactor near Miami, Fla. exemplify many of the problems surrounding waste storage. Although leaks were known to exist in the storage pits in 1972 before the reactor began operations, Florida Power and Light considered the problem "minor" and made no repairs. Today, water that surrounds the radioactive wastes has itself become contaminated and is leaking from the storage area at the rate of 90 gallons per hour.

Attempts to repair the leaks have not been successful thus far, partly due to the high concentration of radioactivity in the area. And since permanent storage sites and waste reprocessing facilities have not been developed in the United States, even though 58 power plants are operating, the radioactive wastes cannot be emptied from the storage tanks so that the leaks can be repaired.

Storage at Sea

In the early days of this country's atomic program, offshore sites were used to dispose of radioactive wastes. Beginning in 1946, more than 28,000 55-gallon drums were dumped into the

(continued on next page)

Exhibit II-2

Atlantic and 47,000 into the Pacific Ocean as a result of the government's atomic weapons and research programs.

The Environmental Protection Agency (EPA) is currently searching for these drums in an attempt to develop "effective controls on any ocean dumping of low-level radioactive wastes, and in order to assess the effectiveness of past packaging techniques," according to Robert S. Dyer of the EPA's radiation office. One of the problems facing the EPA effort is that it is not certain where the drums were dumped. Although the dump sites are designated in the records, apparently a minimal effort was made to use the specified sites. The EPA investigation has thus far discovered the radioactive releases near Ocean City, Md. and the Farallon Islands in California.

Storage on Land

Attempts to find suitable land storage of radioactive substances have taken several forms. Some of the radioactive remains from uranium mining - uranium tailings - have been stored at 21 sites in the west. In other areas, the tailings have been neglected by officials and used by contractors as land fill or have been washed away by erosion or rain water. The EPA and the NRC are presently investigating the extent of the contamination and the possible solutions from these careless activities (see accompanying map of tailings sites).

Wastes f m the reactor fuel cycle are o a stored in pools of water on site due to the lack of sufficient permanent storage facilities and reprocessing systems.

Some te ary storage facilities have been constructed for waste disposal. Some of these 19 sites are for high-level wastes and some are for low-level wastes (see accompanying map of waste sites).

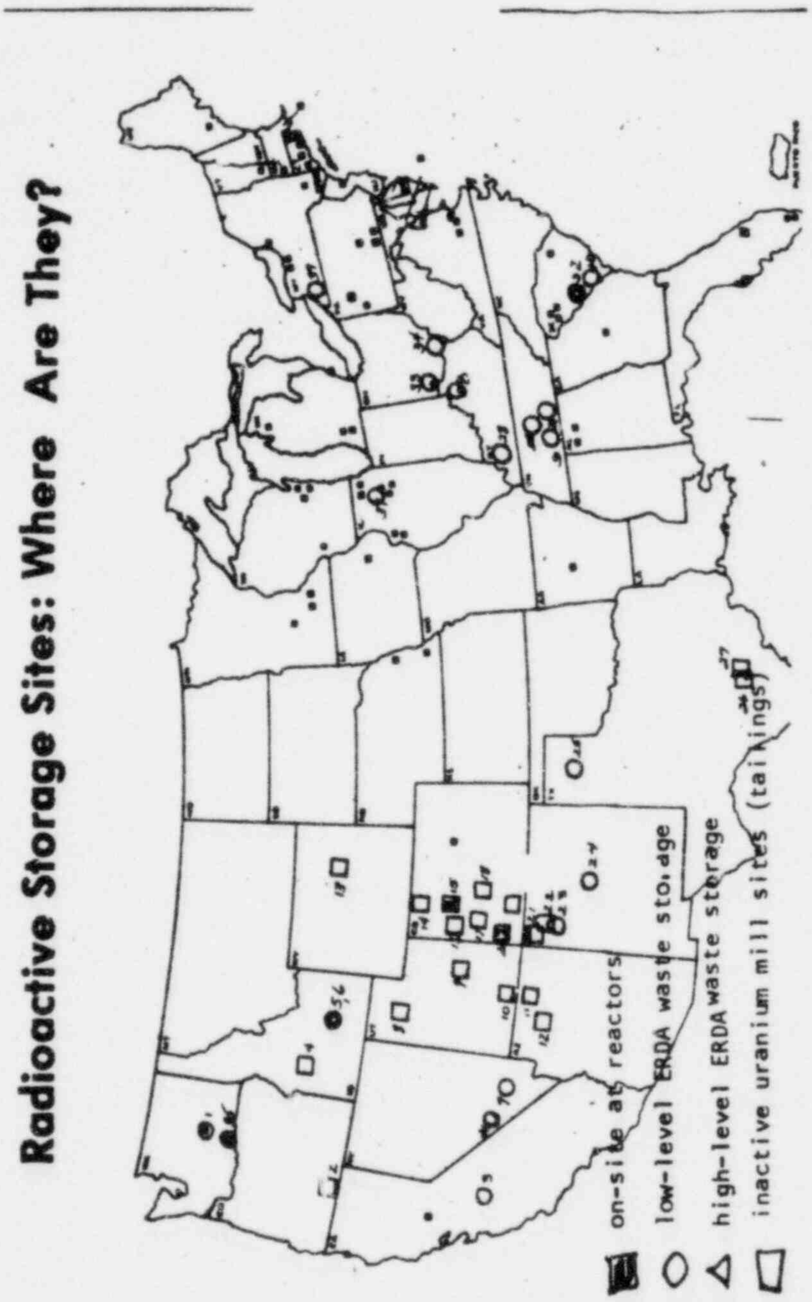

Exhibit II-2 (concluded)

For much more information, see Morgan, et al, (1961), McCluggage (1971), Eisenbud (1973), and Shappert (1973). If, on the other hand, the fast breeder program is approved and plutonium recycle processes become widely adopted, there will be rapidly increasing amounts of plutonium to transport, presenting new problems of security and safety precautions (see Ayres, 1975; NRC, 1977a: Appendix C, 1977b: Appendix C).

The U.S. Environmental Protection Agency's Transportation Accident Risks in the Nuclear Power Industry 1975-2020 (1974) combines a large amount of detailed and specific information on current and projected transportation of radioactive materials with assumptions about delayed but eventually approved plutonium use, fuel reprocessing, and the transportation mix to develop a model that predicts relative amounts of spent fuel, plutonium, high-level solid waste and Noble Gas requiring transport for each year from 1975 through 2020. (See Exhibit II-3). Although it is obviously true that no 50-year prediction table will turn out to be precisely accurate, the EPA has the advantage of specifying its assumptions, including those that are political or more broadly social rather than strictly technical. For example, the EPA model assumes that breeder reactors will be introduced commercially in the mid-1980s, and then will rapidly become the dominant form, while HTGRs are hypothesized to increase over the same period but at a much slower rate, and the LWRs to level out thereafter. Further, it is assumed that underground storage or permanent waste repositories will be located in the deep salt beds of New Mexico and Kansas by the early 1990s.

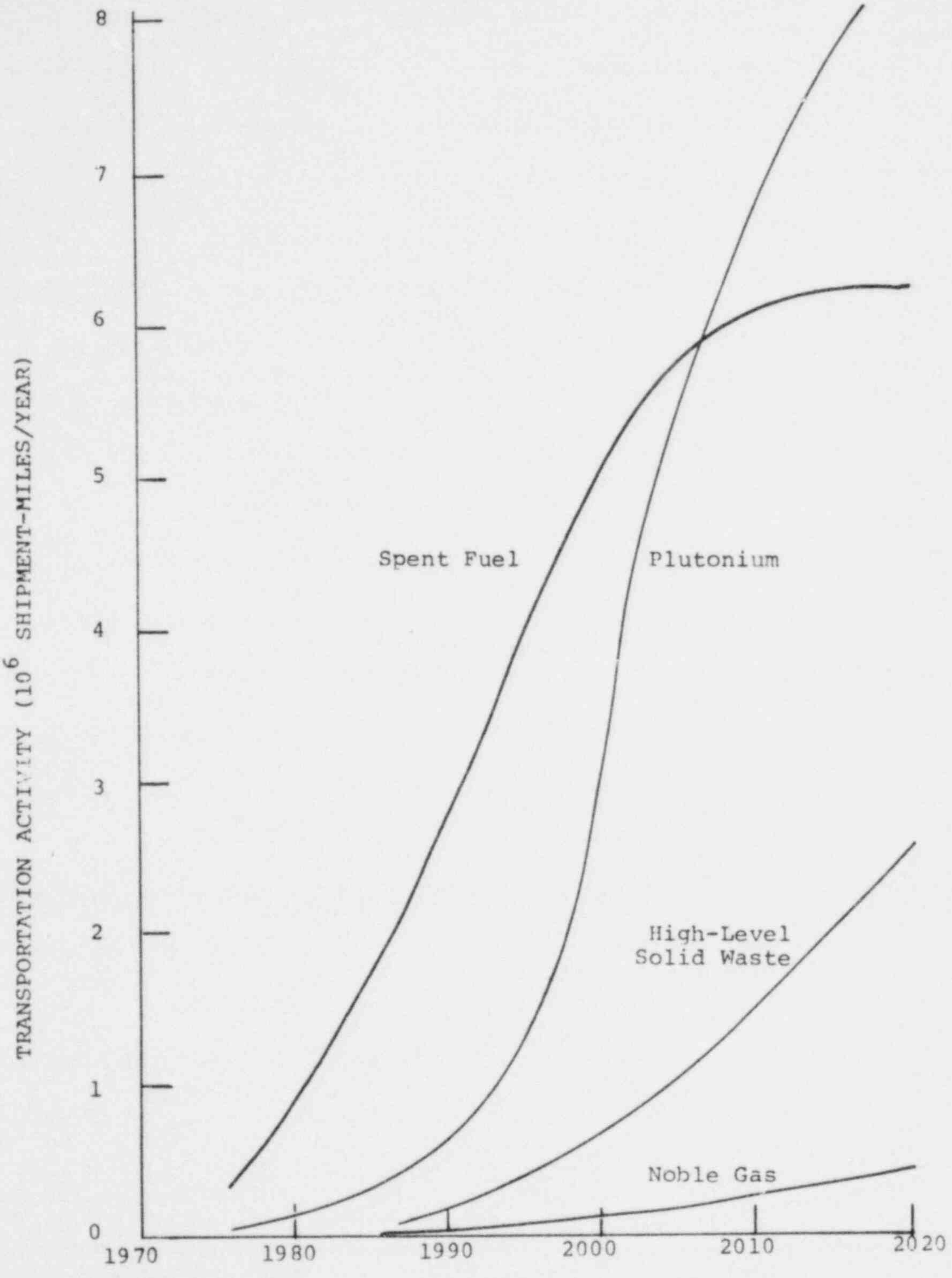

Exhibit II-3. Summary of Annual Transportation Activity

Source: U.S. Environmental Protection Agency, (1974:62)

2.4 Predicted Transport Mode Mixes for Spent Fuel and Plutonium

Besides yielding predicted amounts of transportation of the four major forms of radioactive material generated in the process of producing electrical power (expressed in millions of miles of transport of each type of material in Exhibit II-3), the EPA study gives probable transport mode mixes for each type of material, sizes of the containers involved and their security/safety features, and a good deal of information on probable routes to be taken, distances to be traveled, and the like. This information has provided some of the basis for selecting the transportation scenarios to serve as hypothetical case studies in the analyses that follow in later sections of this report.

Most relevant for purposes of this report are the EPA estimates concerning spent fuel and plutonium, since these materials are more likely to raise public antagonism than are the much more frequently transported radiopharmaceuticals and industrial materials. Exhibit II-4 provides the EPA estimates of the tonnage of spent fuel and of plutonium for the years 1975-2020. Although the average number of miles per shipment are presumed to decrease as new facilities are built around the country, the number of shipments per year is estimated to increase so rapidly that total units-times-miles figures increase over the 45 year period by a factor of 18 for spent fuel and 138 for plutonium. Consideration of the number-of-shipments columns might well give one pause, since each shipment provides an opportunity for an accident or a diversion, in addition to possible public response to "normal" transport. The esimtated increase from 363 spent fuel shipments in 1975 to over 2,000 by 1985 might be enough cause for concern, but the estimated increase from 60 plutonium shipments to 400 in the same period is potentially much more serious.

Exhibit II-4

Summary of Annual Spent Fuel Shipping Data

Year	Mass Transported (MT)	Radioactivity Transported (MCi)	Number of Shipments	Average Shipment Distance (Mi)	Shipping Units (10^6 Shipment-Mi)
1975	850	3,820	363	920	0.33
1980	2,400	11,070	1,026	860	0.88
1985	4,920	23,330	2,103	810	1.70
1990	8,420	37,510	3,598	750	2.70
1995	12,990	51,940	5,551	690	3.83
2000	17,580	56,210	7,513	640	4.80
2005	23,130	164,080	9,885	580	5.73
2010	27,100	209,530	11,581	520	6.02
2015	30,900	255,790	13,205	460	6.07
2020	35,200	305,420	15,043	410	6.16

Summary of Annual Plutonium Shipping Data

Year	Mass Transported (MT)	Radioactivity Transported (MCi)	Number of Shipments	Average Shipment Distance (Mi)	Shipping Units (10^6 Shipment-Mi)
1975	8	90	60	940	0.06
1980	24	280	183	880	0.16
1985	53	650	400	820	0.33
1990	93	950	704	760	0.54
1995	248	1,680	1,887	700	1.32
2000	627	3,090	4,764	640	3.05
2005	1,189	5,100	9,037	580	5.24
2010	1,678	6,770	12,755	520	6.63
2015	2.192	8,510	16,658	460	7.66
2010	2,729	10,340	20,737	400	8.29

This added seriousness derives not only from the fact that plutonium is more toxic and more likely to become airborne in case of rupture of protective shielding. Part of the added seriousness of plutonium shipment increases can be seen in the EPA's analysis of the shipment modes used in regard to the two materials: as shown in Exhibit II-5, 85% of spent fuel shipments are by way of rail, and thus much more insulated from public contact in urban areas than are plutonium shipments, estimated to be 50% by truck over the public highways. Not only are highway modes more open to traffic accidents and potential diversion of the carrier trucks by a small band of armed and dedicated terrorists, but us of the public highways makes the shipments much more visible to a wide range of potentially alarmed, aroused and angry citizens.

The main point to be made here is that public reaction to various types of transportation events is not dependent upon or even very strongly related to actual radiation release. It is the unknown menance in the ambiguous situation that is most likely to trigger large-scale collective behavior, in scenarios such as those to which we now turn.

Exhibit II-5

Spent Fuel Transportation Scenario

Mode	Use (Percent)	Capacity (MTU Equivalent)
Legal Weight Truck	5	0.45
Overweight Truck	5	0.90
Small Cask on Rail	70	3.15
Large Cask on RAil	15	6.75
Barge and Overweight Truck	5	3.15
AVERAGE	100	2.34

Plutonium Transportation Scenario

Mode	Use (Percent)	Capacity (MT Pu)
Small Shipment by Truck	40	0.068
Large Shipment by Truck	10	2.022
Small Shipment by Rail	10	0.068
Large Shipment by Rail	40	2.022
AVERAGE	100	0.132

SOURCE: U.S. Environmental Protection Agency, (1974: Tables 9 & 17).

2.5 General Governmental Policy Regarding Normal Transport Through Urban Environs

Chapter IV, "Transport Impacts Under Normal Conditions" of NRC's Final Environmental Statement on the Transportation of Radioactive Material By Air and Other Modes (1977a) ends with the following summary regarding the "normal" population dose that occurred in 1975 and that predicted for 1985:

The estimated total annual population dose is 9790 person-rem in 1975 and 25,400 person-rem in 1985. This dose has the same general characteristics of other chronic exposures to radiation, such as natural background. The predicted result of public exposure to this radiation is approximately 1.19 latent cancer fatalities in 1975 and 3.08 latent cancer fatalities in 1985. While the value of 9790 person-rem may seem large, it is small when com pared with the 4 x 10^7 person-rem received by the total U.S. population in the form of natural background radiation. (p. IV: 56-57).

If it is to be the nation's objective to develop nuclear energy and its pharmaceutical, industrial, and power-generating applications, then maximum effort should be directed to making the American public aware of the relative benefits, costs and hazards of nuclear technology as compared to alternative sources. Along with a governmental commitment to develop nuclear energy should go an equal commitment to minimize the amount of transport to maximize safety considerations in the utilization of that energy, including close consideration of avoiding urban areas to the greatest extent possible. The safety and security efforts should include research into the feasibility of "nuclear parks" or other such arrangements for concentrating milling, fabricating, power-generation, recycling and at least short term storage in sites that are removed from large population concentrations and the water or air paths that might carry radioactive materials to the unsuspecting populations. One of the major assumptions of the sociological and value perspectives presented in the introduction to this report is that it is to the advantage of all concerned to maximize rather than minimize information, since attempts at secrecy tend to engender suspicion, cynicism, paranoia, alienation and an unwillingness to cooperate.

2.6 Government/Industry Policy and Practice on Safety Precautions

Employees of firms engaging in aspects of nuclear technology and transportation, residents along transportation routes, other travelers along the same routes and bystanders near any delayed vehicles or stored materials cannot very well take active measures to protect themselves unless government and industry policies maximize the flow of valid and timely information, and procedures maximize the likelihood of safe actions. For example, it would be very helpful if shipping containers and the vehicles on which they are loaded could carry some form of material associated with the placarding that would turn some bright color such as red if radiation levels on the outside of the package began to exceed prescribed levels. In any case, each vehicle should carry radiation monitoring equipment, and should be checked at various points along each journey. Government and industry might well enter into large-scale insurance pools to share the risk of any very costly nuclear spill, dispersal or cleanup operation. Finally, government procedures should be streamlined in such a way that interest groups could present their viewpoints on any newly proposed transportation plan. Of course, the relevant regulatory body must be free to act with dispatch in approving, disapproving or modifying the plan.

2.7 The Difficult Position of Regulatory Agencies

At the level of regulatory agencies and public health organizations interacting around the topic of transport problems, there is the published report Radiation Benefits and Risks: Facts, Issues and Opinion from HEW's Eighth Annual National Conference on Radiation Control (1976). This report contains a paper by Philip Brunner of the Illinois Department of Public Health revealing that train and truck accidents were quite common in that state, that there had been at least 21 transportation-related incidents involving radioactive material since the start of 1974 (but without major release, due to package design strength), and that some 50% of the surface vehicles required by federal regulations (Department of Transportation, 1976) to be placarded with radiation warnings were placarded improperly or not placarded at all. Alfred Grella of the U.S. Department of Transportation told the same conference tha shipment of any radioactive material by pasenger aircraft was now prohibited unless for research or medical use, and that shipment of plutonium by air was banned in all cases. He also informed the conference that transportation had recently been included in the areas of concern for federal radiological incident planning, and that several other regulations were being tightened. Mr. Grella's comments to the conference are instructive because they show the way in which regulatory and other governmental officials sometimes move in response to perceived public concerns:

> I would point out that, as has been the case for all nuclear matters generally throughout the public domain in the past several years, things can be characterized as having been quite hectic, at least with respect to the

> public relations, public awareness and acceptance, and emotionalism aspects. Many of you are probably aware of the wide publicity and media coverage which has been given to most transportation 'events' in recent months. You may also be aware of such things as tne railroads' recently adopted position on carriage of spent fuel and the current action on this within the Interstate Commerce Commission. The actions by several states and local jurisdictions in adopting very restrictive rules on transport of nuclear materials have also come to the forefront. Also, the Congress has been somewhat restive on certain transportation issues, resulting in some recent legislation on such issues. (1976: 369).

If regulatory or other governmental officials do enact stiffer procedures for safety and security, the media coverage and the very act of increased regulation (once communicated to interested publics) often focuses attention on the problem at hand, but may also engender the cynical interpretation that conditions actually may have been even worse than the regulators were willing to admit. Full and honest communication is essential because hints of a "cover-up" raise public cynicism and mistrust. If segments of the regulated industry (airline pilots, the rail carriers, etc.) and lower jurisdictional levels (the cities and states) are pushing for stronger controls over potential dangers, regulatory officials will be under great pressure to avoid even the appearance of a "sweetheart" arrangement with the regulated industries. example of this conflict can be found in the testimony of two participants in the 1976 U.S. HEW conference on radiation control: Andrew Hull, of the Safety and Environmental Protection Division, Brookhaven National Laboratory and Dr. Leonard Solon, Director of the Bureau for Radiation Control of the New York City Department of Health. Mr. Hull projects very little concern for safety as compared to the convenience of spent fuel shipments out of the Brookhaven reactor, and labels the motives of those less than enthusiastic about the value of nuclear power and the associated transportation as "ulterior":

> I think that most of you are aware that back about last November (1975), the City of New York proposed some regulations within their health code having to do with the transporation of radioactive materials through the city. These regulations essentially prohibited, except under a certificate of emergency, the transportation of Class B type shipments through the city. The final approval, I think, softened this a little bit in regard to large sources used for medical purposes. The upshot was that, since New York City is on the straightest line between Brookhaven out on Long Island and Savannah River, where our spent fuel was shipped for reprocessing, the straightest line by land was no longer available. ERDA, as soon as this was passed, went to court to seek an injunction against this de facto prohibition. The injunction was not granted, but the matter is in the courts, and I presume that in due time it will be heard. This may be a long drawn out process.

Meanwhile, the Laboratory is under some pressure to transport fuel, and a couple of shipments were made via the Orient Point Ferry and through Connecticut, in a roundabout route. (p. 359).

I think we are into a value area here, as I see what is going on. People who pose these value judgment reservations about nuclear, for whatever ulterior reasons that do not have much to do with safety, have been looking for the achilles heel, the weak spot that will get a lot of headlines and create a public atmosphere of distrust in nuclear power. (p. 360).

Dr. Solon's statement in support of New York City's action first outlines some of the health hazards as he saw them, and then calls for stronger federal action to prevent the large-scale transport of spent fuel and plutonium from Brookhaven and the commercial reactors on Long Island through New York City by truck:

Public Health Concerns of Spent Reactor Fuel Truck Shipments

I would now like to treat another aspect of the New York City regulation: the question of the transportation of spent reactor fuel elements by truck.

For about a decade, Brookhaven National Laboratory has dispatched through the City of New York a limited number of highly radioactive shipments of irradiated fuel elements comprised principally of 93 percent enriched uranium-235.

Since the first of January 1975 and through the end of October 1975, there have been 12 shipments from the High Flux Beam Reactor at Brookhaven. Each shipment, involving of the order of 300,000 curies of mixed fission products were carried by truck in a specially engineered shielded cask. While in the City of New York, it is escorted by a New York City Police Department vehicle until outside City jurisdiction. Subsequently, our surveillance of such shipments has intensified and radiation specialists of the Bureau for Radiation Control have augmented the regular police escort. These are intrinsically hazardous shipments completely unrelated to national security or defense and were terminated under the provisions of the amendment to the Health Code.

However, as dangerous as these Brookhaven shipments are, they are only the tiny tip of an almost unbelievable radioactive iceberg which is contemplated for New York City by an electric power company neighbor to the East - the Long Island Lighting Company - LILCO. What is the scenario which Long Island Lighting Company is orchestrating - without having consulted the City of New York Health Department - nor, to our knowledge, any other responsible agency of this city?

At Shoreham, Suffolk County, on the north shore of Long Island - 56 miles east of the borough of Queens, Linc, the Long Island Lighting Company has completed about 50 percent of a boiling water nuclear power station with a generating capacity of 819 electric megawatts (MWe). This reactor will employ fuel only slightly enriched (between 3 percent and 5 percent) in the fissionable isotope uranium-235. It should be mentioned, parenthetically, that fresh unirradiated reactor fuel of this low enrichment does not constitute either a radiological or nuclear criticality hazard and will not be influenced by the New York City Health Department transportation regulation.

However, when the Shoreham reactor becomes operational in 1978 and begins shipping its irradiated fuel to reprocessing centers, the City was supposed to become host to between an additional 35 and 70 truck shipments each year through New York City streets - each shipment carrying several million curies of mixed fission products and tens of thousands of curies of plutonium and other actinides.

In addition, Long Island Lighting Company has in an advanced state of planning two pressurized water reactors each of 1150 electrical megawatt capacity at Jamesport, Suffolk County, about 18 miles east of Shoreham. These are scheduled to begin operation in 1983 and 1985, respectively. These reactors will have added an additional 150-160 shipments annually of spent fuel through City streets - again each shipment carrying of the order 2.5 million curies of mixed fission products and between 30,000 and 40,000 curies of plutonium and other actinides. Thus addding up the totality of shipments from Brookhaven, Shoreham, and Jamesport, there was to have been between 200 and 250 shipments of these cargos of potential malignancy inducing materials traversing New York City each year. (385-386).

. . .

Alternatives to Transportation Through New York City

There are alternatives available to both Brookhaven National Laboratory and the Long Island Lighting Company instead of the unacceptable, unwanted, and unscientific truck shipments of irradiated fuel through New York City. (1) For the immediate short-term, one can bypass New York City by the use of barge shipments on waterways bypassing New York City. (2) For the longer-term future developments of nuclear technology in this area and throughout the United States, we endorse the nuclear center concept--secure integrated facilities where the entire nuclear cycle from fuel element fabrication through nuclear power generation and fuel element reprocessing can be achieved in one place - essentially eliminating the very dangerous and highly vulnerable transportation link.

Science, Public Health, and the Legal Aspect

Finally, I would like to reassert the primacy of the scientific and public health questions over the legal construct in the whole matter under review. If the legal posture of certain opponents of this amendment is correct, and we by no means concede this to be the case, and the Department of Transportation and the Nuclear Regulatory

Commission have indeed preempted this vital area of local public health and safety regulation. I submit that the people once again must invoke Federal legislative action to rectify a grotesque situation which goes against good science and good public health.

Conclusions

To synopsize the principal points of this paper:

(1) Good science and good public health dictate the avoidance of heavily populated urban centers for hazardous shipments of radioactive materials.

(2) Accidents and/or criminal or terrorist diversion of large shipments of radioactive materials maximize the population risk in large cities.

(3) Integrated nuclear centers with co-location of important elements of the nuclear fuel cycle such as power generation, fuel element fabrication, spent fuel reprocessing, and waste product management, will reduce the very vulnerable and hazardous transportation link. Necessary physical security and radiological surveillance can be obtained in no other way. (386-387).

The testimony of Dr. Solon is particularly interesting because it represents the pitting of a city's health establishment against a federal agency (the Brookhaven Laboratory) and against large private corporations, in the very public arena of a federal conference. This same issue also entered state and federal courts when Connecticut and several of its local jurisdictions objected to rerouting of radioactive materials from New York City. (See the clipping file of some 150 items clipped from the March, 1976 issues of many Connecticut newspapers, on file at the Sandia Laboratory.)

2.8 The Courts and Radioactive Transport

The courts constitute a particularly important set of interlocking structures that have provided opponents of nuclear power generation with a wide range of legal approaches, two of which apply directly to accidents. The first (discussed in CSM 22 Apr 77:12) is the recent ruling by a U.S. district court that the Price-Anderson Act limiting a utility company's liability for nuclear catastrophe to $625 million is unconstitutional. Publicity concerning the raising of this already huge-sounding limit cannot help but bring to public attention the massive scale of potential nuclear radiation damage, and may also serve to further slow the pace of new reactor construction and thus of transportation as well.

The second case (Houston Post, 23 June 1977) deals more directl with radioactive materials transport: on 22 June 1977, the Texas Supreme Court ruled that fear of nuclear accident in transportation of reactor wastes could be used by juries in land condemnation cases.

A couple owning land near the Texas Electric Service Company's Comanche Peak generating plant had contended that TESCO's establishment of a rail spur totalling 7.7 acres, to be used for shipment of nuclear wastes through their property, had lowered the value of their remaining 350 acres by the sume of $105,000. The court sustained their contention, even though no actual accident had taken place along the railroad spur; just the fear of possible damage was held to have dramatically depressed the value of the adjoining land. If this principle (which has not held up in previous cases involving other hazardous substances) holds up in subsequent court challenges, the possible economic liabilities will have to be considered in any activity that includes transportation of radioactive materials.

2.9 The Nuclear Public and Normal Transport

The "public" for a specific cluster of issues as a sociological entity refers not to the "general" public (all citizens in the society) but rather to those who are particularly interested in some issue or cluster of related issues (like the general area of nuclear energy and its application to the society). The members of such a specific public at least occasionally get involved in some form of discussion or debate with a view toward establishing a climate of public opinion that in turn can have some impact on societal decision-makers who control the flow of policy and resources in that area. Turner again presents the necessary analytic distinctions in a strong and clear fashion:

> The public, as a diffuse collectivity, consists of persons in interaction and consequently must be something more than a mere audience or mass. A public is a dispersed

group of people interested in and divided about an issue, engaged in a discussion of the issue, with a view to registering a collective opinion which is expected to affect the course of action of some group or individual. (Turner & Killian, 1972: 179; emphasis in original).

. . .

> For our purposes there is no public opinion without a public.
>
> We shall define public opinion as that which is communicated to decision makers as a consequence of the functioning of a public. Whether it consists of majority or diverse opinions, or some other kind of summation depends on the organization of the public and the nature of the decision-making structure toward which it is directed. (p. 181; emphasis in original).

Viewpoints of specific publics must be communicated to relevant decision-makers through some structural means, such as interest groups promising voting support in the next elections or in congressional balloting, or promising financial support, future jobs, or any other consideration of value, including all kinds of appeals to moral principle.

2.10 Special Interest Groups and Their Media of Communication

Whatever the exact amount of radiation dosages than can be expected from "normal" transportation, they are apparently so small in their total, so widely diffused over huge numbers of recipients, and so easily assimilated in public awareness to the more general concept of "hazardous but necessary" industrial transport, that little public attention or concern may be expected unless and until some person or group more directly connected to radioactive transport "blows the whistle" in order to focus public attention on potential dangers and possible causes of specific problems. Such directly-concerned persons are most likely to be found among transport workers who handle the radioactive materials, public health officials charged with protecting citizens against environmental hazards, regulatory officials, public interest groups without official responsibility but with continuing concern over this and related issues, and anyone with a direct financial interest may be affected by transport of radioactive materials. In each of these cases, the concerned parties may try to bring their viewpoints to public attention directly, through their own media such as books and newsletters (as in the case of the Nader organization's Critical Mass Journal), or the public may be reached through news media reports on court cases, statements of officials, or specific transport incidents that highlight the possible dangers of normal radiation serious accidents and incidents that might occur in the future.

A specific instance of this kind of communication about possible dangers can be seen in the 1974 report Fallout on the Freeway prepared for the Public Interest Research Group in Michigan (PIRGM) by Marion Anderson. PIRGM has no official status, but because of its connection to the Nader organization, its report probably had a fairly wide distribution to other eocology and public-advocacy constituencies. The general form of the possible truck accident that is outlined in the PIRGM report will be used in the sections of this report to follow, because it illustrates very clearly the kind of dangers that are most likely to catch public attention.

2.10.1 Interest Groups as Mobilizers of Public Opinion in Support of Their Viewpoint

Interest groups provide the dynamic, the motivation for the resolution of uncrystallized and multi-faceted public viewpoints into sharp focus around defined issues and perhaps down to single yes-or-no, either/or votes or other registrations of public opinion directed to key decision makers.

But interest group spokesmen must be able to reach the geographically and socially dispersed members and potential members of their constituencies, and so they try to gain access to existing mass media or perhaps establish their own media. Specifically regarding the nuclear energy issue, Exhibit II-6 presents Time Magazine's pro-nuclear article "Less Delay, More Supply," (5 September 1977), which simply assumes that nuclear power generation is the way to meet future power needs, and characterizes environmentalists' objections before regulatory boards as needless "delay" and "red tape." The opposing point of view is argued consistently by the staff of the Critical Mass Journal. The Critical Mass article "Plutonium Pork Barrel" (April, 1975) attacked the Atomic Energy Commission's plan to establish an atomic fuel reprocessing plant at Barnwell, South Carolina, largely on the grounds that transportation of enriched uranium, high-level wastes, and especially plutonium would constitute severe environmental contamination hazards.

Energy

Less Delay, More Supply

The U.S. and the world badly need more energy in all forms, and quickly. But efforts to increase energy supplies often alarm critics who fear damage to the environment—or, in the case of atomic power, to public safety—and the critics have become increasingly adept at fighting long delaying actions. Last week, however, brought three important pieces of evidence that the need is beginning to overcome the fear. In Washington, the Carter Administration readied a bill to untie the red tape that has been strangling construction of nuclear-power plants. In Canberra, the Australian government decided to open that country's vast deposits of uranium to the world market. And in New York City, a federal appeals court ruled that oil companies can start underwater exploratory drilling in the Baltimore Canyon, one of the areas of the continental shelf where oil and gas are believed to lie relatively close to U.S. shores.

Speeding Up the Nuclear Plants

A draft bill to cut red tape

"I do not foresee that atomic energy is to be a great boon for a long time." So said Albert Einstein in 1945, and how right he was. Some 20 years after the start-up of the first U.S. commercial reactor in Pennsylvania, the nation has only 63 nuclear-power plants that supply merely 12% of its electricity; lately the number of reactors on order by utilities has [illegible]ed. One reason: snarls of red tape [illegible] all levels of government, and vehement objections by citizen groups on safety or environmental grounds, slow the process of getting approval. A dozen years can pass from the time a utility proposes a nuclear plant to the throwing of the first switch. In a classic example, land for the Seabrook nuclear reactor was first bought by the Public Service Co. of New Hampshire in the late 1960s; the plant is still only 2% completed and will not go into full operation until 1984. Besides, prodded by environmentalists, the Government forced the utility to build a long sea wall to protect the plant from tidal waves, which company officials estimate will occur literally once in a million years.

Last week the Carter Administration circulated drafts of a Nuclear Regulatory Reform Act, to be sent to Congress this month. The aim is to enable nuclear plants to start generating power six years after they are proposed. The bill would:

Authorize utilities and states to create "site banks" of preselected locations on which nuclear-power plants can be built, and get most necessary environmental clearances even before a plant is proposed. At present, where to put atomic plants is a major headache; somebody is likely to object to almost any site proposed, and wrangles can consume years.

Give quick approval to plants following standardized designs. Now the Nuclear Regulatory Commission (N.R.C.) often forces a utility to keep changing the design of a plant even while it is under construction, adding enormously to delays and costs.

Grant combined construction permits and operating licenses to utilities building standardized plants. Currently, a utility may win state approval, then apply to the N.R.C., which will hold two sets of hearings, one on environmental considerations and one on design safety, before it allows construction to start—and then, after the plant is finished, the utility must go back to N.R.C. for its operating license.

Cut delay by prohibiting anti-nuclear groups from raising the same objections at successive hearings before different regulatory bodies. If a state authority, for example, overrode specific environmental objections, they could not be brought up again before the N.R.C.

To support environmentalists and safety critics, the bill also orders the N.R.C. to pay the legal expenses—how much is so far unspecified—of groups fighting nuclear-power plants on environmental or safety grounds. Thus the bill has been carefully drafted to give something to everybody: more power for state governments, the promise of faster construction for utilities, federal money for their enemies.

In practice, the bill also provides something for everybody to hate. States get the power to issue certificates attesting to the need for a new nuclear plant and its environmental acceptability, but the Federal Government reserves the right to preempt the state if it deems that a state is not following federal guidelines. Some Governors are grumbling about that. Utilities are upset by the promise of federal cash to people fighting atomic plants; environmentalists are disturbed because they nonetheless will get fewer chances to block a "nuke." Says one official of the Government's Council on Environmental Quality: "The bill is a real stinker."

For all the carping, the proposed bill is likely to become law some time next year. The need for atomic power in a U.S. grown dangerously dependent on imports of foreign oil is simply too obvious. During the campaign, former Nuclear Engineer Carter argued that the U.S. should regard atomic power as a "last resort." His support of the bill shows that he recognizes it is time to call on that last resort, especially since his own Administration forecasts a need for an additional 320 plants by the year 2000. ■

Unfinished atomic plant in Midland, Mich.; at Seabrook, N.H., protesters say "no nukes"

Exhibit II-6

Plutonium Pork Barrel

Citizens of South Carolina may be the recipients of the most radioactive pork barrel ever peddled, thanks to Allied General, State Senate President Soloman Blatt, and the South Carolina Legislature. In 1966, Mr. Blatt wrote letters to the Atomic Energy Commission extending South Carolina's invitation to a nuclear reprocessing facility. And in 1976, South Carolina's Barnwell reprocessing plant is scheduled to begin operation.

The job of the Barnwell plant is to re-process atomic fuel, and for this reason it will house more radioactive material than any other commercial plant in the world, producing approximately 7 tons of plutonium a year. (Twelve pounds are sufficient to make a bomb.) Routine emmissions from the plant will contaminate Barnwell, resulting in high levels of heart disease and cancer in the community. And should the Barnwell plant be subject to an earthquake or saboteur's attack, five east coast states, or 33,000 square miles, could be contaminated with excessive radioactivity.

That's after the fuel wastes arrive at the Barnwell plant. Trucks and trains will routinely carry the wastes, sealed in special containers, across the country's miles of fertile farmland and grazing pastures, to the reprocessing facility. The special shipping containers give off enough radiation so that anyone near them for 17 hours will receive the allowable radiation dose for an entire year. Residents of the nearby countryside will get about one quarter of their yearly dose. Railroad derailments, fires, automobile accidents and similar unavoidable occurrances would radioactively contaminate the nation's land and food crops. According to Allied General, the company constructing the Barnwell plant, "such an accident might occur every eight years."

When fuel wastes arrive at the Barnwell facility, they will be reprocessed to extract uranium and plutonium, leaving behind radioactive wastes.

After the fuel has been reprocessed, the uranium will be prepared for use in the light water reactor plants, the plutonium will be stored until it can be used as a reactor fuel, and the radioactive wastes prepared for storage. The materials which are not stored at the plant or lost during reprocessing will again be put in special containers and transported across the countryside to their new destination. On this leg of the trip, carriers will be in touch with the Washington office of the Nuclear Regulatory Commission on an hourly basis—whenever their radios are not rendered useless by the hills and valleys they travel. If not detained by saboteurs, terrorists, weather conditions, automobile accidents or malfunctions, the radioactive fuels will reach the nuclear plant and the cycle will begin again, possibly endangering every form of life with which it comes in contact.

The Barnwell plant provided nearly 2,000 jobs during construction and will employ 400 people after it begins operation, now scheduled for sometime in 1976 at best. In a few years, Barnwell's population is expected to grow from 4,500 to 7,000, and Sol Blatt will have brought an industry to his county. Blatt's law firm will also have grown as a result of the contracts it handles for Allied General, and several State Development Board members will be enriched by the new jobs the company has given them. But when the hazards of Barnwell become evident, how many people will still be around to question the need for this dearly expensive prosperity?

Exhibit II-6 (concluded)

These two articles illustrate the major functions that mass media perform in linking interest groups with interested publics: authentication of the factual nature of events; validation of opinions, preferences and values; legitimation of unpopular viewpoints and behavior; symbolization of diffuse anxieties and discontents; creation of focal points for audience attention and action; and hierarchicalization of persons, objects and issues by amount of attention given, indicating prestige and importance. (Turner & Killian, 1972: 215-216).

2.11 Social Movements in Favor of and Opposed to Transportation of Radioactive Materials

We are now prepared to move to the level of social movements in relation to transport of radioactive materials as one issue in the general cluster of issues concerning utilization of nuclear energy in modern society.

Lewis Killian has made some of the best contributions to the literature on social movements within the general field of collective behavior (Killian, 1964; Turner & Killian, 1957: last half; Turner & Killian, 1972: Part IV), and has framed this concept in a way that is very useful for the objectives of this report:

> <u>Definition of a Social Movement</u> - A social movement is a collectivity acting with some continuity to promote or resist a change in the society or group of which it is a part. As a collectivity a movement is a group with indefinite and shifting membership and with leadership whose position is determined more by the informal response of the members than by formal procedures for legitimizing authority.

The movement is marked by continuity in several respects. First, the movement's objective must require sustained activity. A movement could hardly develop over so short-range an objective as lynching a kidnapper, though the determination to control kidnapping in general could give rise to a movement. Likewise, there will be some continuity in movement strategy. There will also be continuity in the division of function, with some stability of leadership and other roles. There will be continuity in the sense of group identity, so that even with rapid turnover of membership the sense of group continuity prevails.

In saying that a social movement promotes or resists change we are differentiating it from an informal group whose activities are entirely self-contained in their implications. A group of people who assemble strictly for their own enjoyment or their own betterment without making any demands on the community have not formed a social movement. (Turner & Killian, 1972: 246; emphasis added).

We have observed that the crowd tends to develop and enforce on its members a uniform course of action. The public determines a course of action that takes account of acknowledged differences of position. If the crowd develops a more enduring sense of group identity and pursues a plan of action requiring more sustained activity than can be maintained through crowd conditions, a social movement is emerging. Or if members of a public who share a common position concerning the issue at hand supplement their informal discussion with some organization to promote their own convictions more effectively and to insure more sustained activity, a social movement is incipient.

In spite of the relation to other forms of collective behavior, social movements are different in important respects. Popular writers often treat the social movement as an extended crowd made up of people acting under a delusion fostered by the mechanism of crowd behavior. Because the members are in constant contact with persons who do not adhere to the movement, because sustained activity and enthusiasm over an extended period of time is required, and because some sustained division of labor is required within the movement, the members' activities on behalf of the movement must be disciplined rather than chiefly impulsive. At times the provocation and manipulation of crowd behavior is an effective tactic in making the opposition afraid of the movement, in arousing the enthusiasm of outsiders for the movement, or in strengthening the esprit de corps of the members through crowd experience. At other times the spontaneous resurgence of crowd behavior may lead members of a movement to excesses of behavior that discredit the movement within the public to which it is appealing. In either case, however, the crowd behavior is a phase of the movement rather than the whole of it. (Turner & Killian, 1972: 245-246; emphasis added).

2.11.1 Social Movements in Favor of Nuclear Energy and Transport

Much of the support for utilization of nuclear energy for generation of electricity has obviously come from the nuclear power industry, which has long been advocating and working toward a society primarily reliant upon large-scale centralized power generating grids, and was until recently almost without effective opposition. Those who favor nuclear power basically believe that it is necessary for the economic well being of the nation, where energy and jobs must be assured at all costs. The construction of the $1-2 billion plants is also profitable, and a source of revenue for hundreds of corporations. Their financial interest in nuclear power is strongly connected to its expansion, and they believe that their financial success will ultimately spell prosperity for the rest of the marketplace and workforce.

The support for atomic power extends beyond the corporations to organized labor. The AFL-CIO, especially the Building Trades Council, strongly favor the expansion of light water reactors on the grounds that it provides more jobs for the nation. A powerful corporate-labor alliance helped to defeat anti-nuclear ballot measures in seven states in 1976. In the Congress, despite stiff opposition from President Carter, both the House of Representatives and the Senate voted to support the controversial Clinch River Breeder Reactor.

In New England, the "Voice of Energy" was formed to counteract the public demonstrations against the Seabrook facility. Over 3000 members of the public demonstrated outside of Seabrook to show their support for the project.

Public interest organizations designed to support nuclear power plants have also been created. Prodded by the powerful Atomic Industrial Forum and the American Nuclear Energy Conference, these groups have decided to act as a countervailing force to environmental and consumer groups. For more detail, see Roger William's "Massing at the Grass Roots" (1977).

2.11.2 Social Movements Opposed to Radioactive Transportation

Public attitudes toward the transportation of radioactive materials generally reflect public perception of the risks and benefits of radioactive materials to society, and it has already been affected by social movements that oppose and favor the expansion of commercial nuclear power. Those who oppose the expansion of the nuclear fuel cycle, for instance, perceive little value and high risk with the handling of radioactive substances. These individuals and groups come from both the technical and scientific communities as well as the general citizenry. It includes such scientists as Dr. Henry Kendall, John Gofman and Arthur Tamplin, who were affiliated with the Atomic Energy Commission and national scientific laboratories. In 1975, the 13,000-member Union of Concerned Scientists published a "Declaration of Conscience" signed by 2300 scientists, engineers and doctors that called for a moratorium on nuclear power on moral, political and health grounds. Among the signatories were dozens of nobel laureautes including Dr. Linus Pauling. Included in the declaration were also government policymakers such as President Eisenhower's science adviser Dr. George Kistiakowsky.

The opposition to nuclear power largely stems from the fear of ionizing radiation on plants, animals, human beings and the inanimate world of food chains, air, water and land pathways. It is also predicated upon the belief that further expansion of highly-centralized, capital intensive electrical generating stations are unneeded and undersirable for the ratepayer. Finally, there is the concern that nuclear materials can pose national security risks if atomic weaponry proliferates vis-a-vis civilian nuclear power, or if political extremist groups should obtain the volatile and dangerous material.

As the technical and scientific debate has deepened the divisions within these communities, the public at large has joined the controversy. Consumer advocate Ralph Nader and environmentalists such as David Brower of Friends of the Earth have entered the fray.

Residents near proposed nuclear power plant facilities are challenging the construction of the installations. While not stopping nuclear plants in themselves, the citizens have radically altered the rules by which policy decisions are to be made. In 1971, a citizen's group opposing the Calvert Cliffs nuclear reactor in Maryland won a precedent-setting victory in the United States Supreme Court which required all federal licensing reviews to abide by the National Environmental Policy Act (NEPA) Dozens of other court challenges have either changed the federal licensing procedures or altered plans for proposed nuclear plants.

Still, the "social movement" was small and largely undetectable, except to the nuclear industry and those whose attention had been directed toward nuclear energy in some respect. The legal challenges were also difficult to mount and extremely costly. Some groups were entangled in the regulatory and court process for nearly ten years.

As these challenges increased, the public perception of the "dangers" of nuclear power spread. Public interest focused most clearly in a legal challenge to the Seabrook nuclear power plant in New Hampshire. Despite seven years of opposition and two town votes against the plant, the Nuclear Regulatory Commission in July 1976 approved a construction permit for the reactor. The "Clamshell Alliance" then staged a series of "occupations" of the plant site. The action culminated in mid-1977 when over 1400 persons were arrested for such occupations. Other collective behavior actions have proliferated in dozens of other areas.

On the institutional side, states and localities have also begun to place restrictions on the transportation or handling of nuclear material. In Illinois, the state Attorney General attempted to halt the operation of the Sheffield radioactive waste burial ground. In New York City, the Health Department prohibited the transportation of certain radioactive materials through the cities. In California, after much work by the Sierra Club and others, the General Assembly imposed the stiffest restrictions on nuclear power plant locating.

Thus, the two loose configurations of separate groups are deeply entrenched and highly polarized into two different social movements that may be on a collision course. These two groups may eventually affect the transportation of radioactive materials by shaping political, institutional and economic forces.

2.12 Scenario #1: Trucking of Radiopharmaceuticals

According to NRC's NUREG-0170, the largest proportion of total population exposure from transport of radioactive material in the U.S. (some 52% of the estimated 9,790 person-rem per year at the 1975 transport rates) comes from shipment of medical-use radionuclides, with the largest proportion of shipments going by truck (some 53% of "non-special" shipments): "Shipments by truck produce the largest population exposure, resulting from relatively long exposure times at low radiation levels of truck crew and large numbers of people surrounding transport links." (NRC, 1977a: xx; NRC, 1976: Table 7)

It is obvious that the American public is by now fairly familiar with the idea that hazardous cargoes are trucked around in urban areas; the warning placards reading EXPLOSIVES, CORROSIVES, COMBUSTIBLE, POISON, FLAMMABLE OXIDIZER, and DANGEROUS are not at all uncommon (U.S. Department of Transportation, 1976: U.S. EPA: 1974).

Presence of the RADIOACTIVE placard obviously calls up a number of additional fears and feelings (many of which were discussed in the earlier sections of this report), but if the outside of the truck were also placarded "RADIOPHARMACEUTICAL," many observers' interpretations would be more like "possible danger, but for good purpose," rather than "possible danger, money-making purpose." This labelling-for purpose and also for final medical destination, with a contact phone number, would probably serve to reduce the threat value and suspicion of the general public toward pharmaceutical shipments during normal transport, and would also help in alerting the appropriate medical officials in case of delay in route. These officials presumably would have greater understanding of the radiological nature and potential hazards of the radiopharmaceuticals than would typical police or fire personnel, and would also probably have quicker access to (and understanding of) radiological monitoring devices that could detect any radiation release.

2.13 Scenario #2: Delivery of Fresh Fuel to the Seabrook Reactor

When there has been a history of symb cally-presented opposition to a course of action (such as the Clamshell Alliance staging the Mayday "citizen occupation" of the Seabrook reactor construction site), and especially where there has also been a history of publicly present counter-presentation (as in the case of the "Silent Majority" or "New Hampshire Voice of Energy" parading on the 4th of July), there then develops a strong possibility for conflict between the two groups, and perhaps also with the agents of social control that would come onto the scene. (It should be noted that the NRC on 8 Jan 1978 approved construction of the Seabrook reactor. It will be the nation's largest atomic generation plant, and cost $2 billion.)

Suppose now tha the Public Service Company of New Hampshire (owners of the still-under-construction Seabrook nuclear power generating plant) were to announce some time next April that the plant was fully completed and would be started up upon arrival of the first truckloads of fresh enriched-uranium fuel. On the basis of past behavior and expressed intentions carried in the nation's papers of July 25, 1977, it can be predicted with confidence that the Clamshell Alliance would stage some form of "environmental protection blockade" or other such collective disturbance in such a way as to try to prevent the fresh fuel rods from being delivered to the Seabrook plant. Given the recent history of events of last July 4th, it can also be predicted with confidence that the "New Hampshire Voice of Energy" or "Silent Majority" would stage some form of counter-move to protect the fuel shipment and usher it into the Seabrook reactor. Whatever the precise nature of the proposed and actual collective behaviors involved in the confrontation between the two groups (and between each of them and the various "official" agencies concerned), the whole scene would probably be portrayed for (and interpreted by) the mass media in terms of expressive social protest rather than as conventional instrumental criminal activity, even though many laws would be broken on all sides. Specifically, the meanings that would be expressed would fall under all of Turner's categories regarding the interpretation of disturbance as expressive protest:

Elements of Protest	Meanings Expressed By: "Clamshell Alliance"	Meanings Expressed By: "Silent Majority"
1. Grievance; injustice	danger of reactor disaster environmental contamination by radioactive wastes danger of diversion to weapons use of enriched uranium	loss of jobs and $ to area loss of good energy source falling behind in power technology giving in to hippies
2. Protestors unable to correct condition on own	nuclear power industry and government alliance seen as very strong	environmentalists seen as weak but articulate, and effective at stalling
3. Attempts to draw attention	placards and banners; desire for media coverage	placards and banners; desire for media coverage

Elements of Protest	"Clamshell Alliance"	"Silent Majority"
3. Attempts to draw attention	placards and banners; desire for media coverage	placards and banners; desire for media coverage
4. Ameliorative action desired from target group	get U.S. to stop using nuclear energy (and weapons); shift to "clean" sources	speed up development of nuclear energy as way of decreasing prices & avoiding foreign energy source control
5. Sympathy and fear themes in combination	willingness to suffer exposure to heat or cold to protect American public from danger. Threat of possible damage to public property; civil disturbance	asking only for jobs and energy that government is already committed to. Threat of "hardhat" violence.

2.13.1 Possibility of Violence

The exact outcome of any confrontation between the Clamshell Alliance antinuclear demonstrators and the New Hampshire Voice of Energy counter-demonstrators cannot be predicted in detail, but consideration of past events such as the Wall Street hard-hat attack on peace demonstrators and the 1968 Democratic Convention police attack on anti-war demonstrators suggests that the potential for armed violence and severe physical damage is quite high, especially where the sympathies and values of the police are rather clearly on one side of the conflict. Other and earlier such confrontations between opposing protest groups (especially when the agencies of social control become active participants favoring or even becoming one of the sides) have formed the starting points of much larger-scaled collective behavior phenomena such as social movements.

2.13.2 Suppression of free speech and assembly (both of which are guaranteed by the U.S. Constitution) by police or political authorities is the new element that often moves an initial protest demonstration concerning a specific issue into a long-term social movement that then has the added grievance of unjust and illegitimate treatment by authorities as an appeal in its search for support. The Berkeley Free Speech Movement of 1964 (see Milgram and Toch, 1969:556-562; and Heirich, 1971, among many other sources) drew upon the memory of the San Francisco police suppression of demonstrators against the House Un-American Activities Committee in the late 1950's, and innumerable ghetto riots of the mid-1960's drew upon the suppression of black and pro-black demonstrators by southern police in the early 1960's as well as upon memories of police tactics in previous ghetto arrest situations (Hundley, 1968; Kerner, et al., 1968; Graham & Gurr, 1970; Lang & Lang, 1970). Many other sources treat the development of protest demonstrations and escalated riots (with use of weaponry) as interesting and politically important collective behavior phenomena in their own right, even without their necessarily developing further into social movements (Myers, 1948; Swanson, 1953; Mack & Snyder, 1957; Jackman, 1958; Turner, 1964a; Shellow & Roemer, 1966; Turner; 1969; Fogelson, 1971; Fisher, 1972; Niebing, 1972; Eisinger, 1973; Danzger, 1975; Gamson, 1975).

2.13.3 Summary on Movements Pro- and Anti-Transport of Radioactive Materials

What can be said about the role of the general anti-nuclear social social movement in such a possible transportation scenario? The primary impact would be on situations that give a substantial lead time (such as our hypothesized announcement by the owners of the Seabrook reactor that they would start operations as soon as a shipment of fuel arrived). Such an announcement would provide a period of time in which the anti-nuclear movement could plan blockade operations, marshal large numbers of supporters, coordinate travel plans, arrange for media coverage, etc. The same period would be used by the pro-nuclear movement forces (including the companies that stand to benefit from construction and operation of nuclear power generation stations). It is very likely that large groups of pronuclear demonstrators would be assembled to "escort" the first shipments of fresh fuel rods into the Seabrook plant. What would happen if and when the two groups, blockaders and escorters, came face to face at the entrance to the plant?

2.13.4 Role of Police

What would be the role of the police? They would probably end up escorting the escorters, riding "shotgun" around the trucks bringing in the fuel. When the first truck reached the assembled blockaders, there would be a seemingly endless interchange of "official" pronouncements about private property, national energy programs, and the economic development of New Hampshire on one hand, and about environmental hazards, monopoly capitalism and international weapons proliferation on the other. Presence of the audiences of hard hats and simple bystanders who would have assembled around the actual and symbolic combatants now would propel the police and the resistant blockaders into increasingly antagonistic postures. Eventually there would come a "final" order to the blockaders to disperse, and a "final" declaration from the leaders of the blockaders regarding the necessity for free citizens to stand up against tyrannical oppression. Since the capacity for police and civil authorities to call up a functionally unlimited supply of military personnel and weapons far exceeds the capacity of social movement leaders to marshall similar levels of trained personnel and effective force, the ultimate outcome of this one episode of crowd conflict would, in all probability, favor the pro-nuclear forces. However, there might well be widespread injury, especially if the "escorters" had by this time developed a definition of the situation justifying (and essentially requiring) that they "show their loyalty to their country, against the hippie-commies," etc. In that case there would probably be a good deal of interpersonal violence in addition to the "official" confrontation itself and its own potentials for violence and injury. The potential for development of martyrs and heroes is great.

2.14 Linking of Pro- and Anti-Nuclear Social Movements to Other Issues

What would happen if, instead of considering only a single confrontation over a fuel shipment, we apply the perspective of the social movement as involving interlinked public/organization/media components to a currently developing proposal that would increase dramatically the amount of transportation of radioactive materials through many urban areas? The new Department of Energy (DOE) is offering to take charge of the spent-fuel and other radioactive waste outputs of nuclear reactors all over the world, to transport them to a few sites (presumably in the U.S.) near underground rock formations that might in the future be used to permanently dispose of the fuel, and to store the rods and other radioactive wastes for perhaps 15 years until some decision is made about U.S. reprocessing of spent-fuel into fresh, enriched uranium and plutonium.

The major purpose of the plan is to reduce the pressure on other nations to reprocess their wastes and to re-cycle their plutonium as they run short of fresh uranium and as their re-cyclable wastes pile up. Presumably, the U.S. would simultaneously offer to provide these nations with fresh uranium fuel at reasonable prices so that they would be out from under the major economic incentive to extract the plutonium now embedded in the rapidly accumulating radioactive waste.

There is some urgency about such proposals because many utilities now report that they will be reaching their on-site spent-fuel storage capacity by 1981, but the government estimates that no storage sites will be ready until sometime in 1985. However this particular issue turns out, the general pro- and anti-nuclear movements will actively seize upon transportation and other aspects of its resolution for their own purposes.

3. Social Impacts of Accidents in Transportation of Radioactive Materials

Fear of potential nuclear accidents or incidents, quite apart from any actual radiation releases, may be greatly increased in public perceptions by reports of past and current foul-ups in official safety procedures, detection/monitoring systems, security precautions throughout the nuclear industry and responses to accident or incident signals. Not only in such directly opposed media as Critical Mass, but also in the conventional press there has appeared over the past few years a continuing stream of such "foul-up" reports. Each report can add to public mistrust of the capacity of officials (both public and private) to cope with accidents in the very complex transportation systems involved, and the string of reports probably has had more than an additive effect. There is no space here to do more than list some of the major references on the impact of mass media, especially news media, on various aspects of public opinion, but the thrust of this wide literature is quite definite. The media, operating together, do shape public opinion (see for example, Davison, 1959; Noelle-Neuman, 1959; Bauer & Bauer, 1960; Klapper, 1960; Wertnam, 1962; Daly, 1968; Weiss, 1969; and Simon, 1974).

One of the most thoroughly documented failures of safety, emergency fire-fighting and general procedural systems concerned the near-disastrous fire at the Browns Ferry Plant in Alabama early this spring. While not directly involving transportation, this accident report concerns a situation in which procedures and practices should be at their very best. Practices in transit could be expected to be much looser. The substantial story in the National

Observer (see Exhibit III-1) outlines a series of individual mistakes and procedural breakdowns that led from a small candle flame being used to test for leaks in the reactor building walls to an out-of-control fire that crippled the electrical system used for the reactor's back-up safety mechanisms. The account showed that the emergency command and notification systems could generate nothing but chaos for many hours, thus produced some $50 million in damage to the General Electric reactor. Far from being an isolated case, it should be noted that the New York Times of 2 October 77 reported an examinination by a safety expert of 23 nuclear power plants built by Westinghouse, in which it was found that their back-up emergency systems were also controlled by the same electrical supplies as their main systems, thus, in his judgment, rendering them unsafe.

Two other well-publicized failures in procedures can be seen in the case of the complex and diffuse allocation of governmental responsibility for setting radiation standards and monitoring to insure adequacy of compliance and current condition. As described in a Critical Mass article by Richard Pollock (1976), the federal radiation monitoring system was not properly activated in October of that year, when a large radioactive cloud from a Chinese nuclear test drifted across the U.S., even after rain brought fall-out to ground level.

The Frightful Log of a Nuclear Near-Miss

Candle Starts a Fire, Shakes Faith in Safety Systems at Power Plants

By William J. Lanouette

IT BEGAN with a candle, which accidentally lit some flammable insulation, burned some cables, and nearly caused one of the most serious nuclear-power plant accidents possible —a "meltdown" of the heat-producing, radioactive core.

From the Browns Ferry Nuclear Plant near Athens, Ala., where the seven-hour blaze began, warnings and misinformation fanned through the emergency network of the Tennessee Valley Authority (TVA), the plant's owner, to state and Federal officials in nearby cities. One official recalls reports that the plant's reactors were "wiped out" and that the only way to keep the radioactive fuel from melting was "to bring in river water and circulate it to and from ditches for cooling."

That's history now, although the March 22 fire sparked a controversy about the safety and reliability of nuclear power that is sure to smolder for years. And while some public officials and nuclear-industry executives were angered with the spread of misinformation about the accident, they are equally disturbed about coming so uncomfortably close to serious trouble.

The Other Close Call

How close? A spokesman for the Nuclear Regulatory Commission (NRC) now considers the March fire at Browns Ferry to be one of the two most serious accidents in the U.S. nuclear-power industry's 18-year history. The other close call was a partial core melt-down at the Fermi fast-breeder reactor near Detroit in 1966. But in many ways the shadow cast by the candle at Browns Ferry may be darker. For that fire has raised new questions about the reliability of the safety systems that protect the nation's 53 nuclear-power plants.

In the hours and days after the accident, the Browns Ferry fire was reported as just that—a fire. No members of the public received abnormally high radiation doses, the NRC reported. No plant employes were seriously injured, the TVA said. And it appeared for a while last spring that the most serious public impact of the $50 million accident fell on TVA's customers. The utility must spend an extra $10 million a month to buy the 2 million kilowatts of electricity that the Browns Ferry units can't produce.

Now the NRC has released a 463-page report on the fire, based on a four-month investigation, and its details reveal just how close the Browns Ferry reactors were to being "wiped out" and how they were saved from core meltdown. What follows is an account of the fire based on the NRC's report and augmented by Observer interviews with NRC inspectors and administrators, TVA officials, nuclear engineers, representatives of the General Electric Co. (the plant's designer), and spokesmen for groups that favor and oppose the spread of nuclear power.

Maintaining a Vacuum

To prevent escape of radioactive air around a reactor's core, nuclear-power plants use a vacuum to maintain a "negative pressure" in the buildings that surround the core. Then, if a radiation leak develops, air would rush *in* to those buildings, not out.

Whenever wires, pipes, and cables pass through the concrete walls of the reactor building, the space around them must be sealed to prevent air from constantly rushing in. At many nuclear plants, including Browns Ferry, the wires and cables that monitor and control the reactor go through the reactor building's walls, into an adjacent cable-spreading room, and then to the control room one floor above.

On March 22, several plant workers were in the cable-spreading room testing the polyurethane foam used as seals around cables that pass through the walls of the unit-one reactor.

A common method to find air leaks at the Browns Ferry plant was to hold a lighted candle up to the wall openings, then watch to see if rushing air moved its flame. It was 12:20 p.m. when, as one engineering aide remembers:

Horizontal Flame

"We found a 2-by-4-inch opening . . . with three or four cables going through it. The candle flame was pulled out horizontal, showing a strong draft. [An electrician] tore off two pieces of foam sheet for packing into the hole, but he could not reach the opening. I inserted them as far as I could into the hole. . . . I rechecked the hole with the candle. The draft sucked the flame into the hole and ignited the foam, which started to smolder and glow. [The electrician] handed me his flashlight, with which I tried to knock out the fire. This did not work and then I tried to smother the fire with rags. Someone passed me a CO2 [carbon dioxide] extinguisher . . . which blew right through the hole without putting out the fire, which had gotten back into the wall. Then I used a dry-chemical extinguisher, and then another, neither of which put out the fire. . . . In the past, on three or four occasions, I have had fires started by the candle . . . which [were] readily extinguished."

Another electrician ran out to a guard post nearby and returned with a fire extinguisher. This alerted the guard to report the fire by telephone. But he dialed the wrong number. The person who answered in turn dialed the control room, warning the unit-one operator about the fire. In the control room, an assistant shift engineer flipped on the fire alarm. It was 12:34 p.m.

Reinforcements

The assistant shift engineer then grabbed a dry chemical fire extinguisher and ran into the reactor building. Flames were shooting along the cables through the air leak.

Recalling that fires had been set by the use of candles before, another engineering aide said later, "The flames were always easy for me to extinguish with my gloved hand." At least two other employes interviewed by the NRC also recalled setting fires with candles, but these were always contained by using gloves, extinguishers, or bare hands.

A candle fire two days earlier had been noted in the plant's operating logs, and some supervisors said later they were concerned about continuing this method of testing for leaks. It appears that concern hadn't reached senior administrators, however, for as one assistant superintendent told NRC investigators: "I do not know of any requirement to make written reports of small fires."

At about 12:40 p.m. the spreading-room fire began affecting the plant's operations. Unit two's operator lost power in half the systems used to shut down the reactor. But he managed to control his unit.

'Conditions Unstable'

Unit one was another story. Just after 12:40 p.m. the control-panel instruments indicated that the two pumping systems of the unit's emergency core cooling system had begun to run automatically. "I checked, but the pumps were not running," the operator said. He called for help at the control panel because, he said, "conditions were unstable."

Exhibit III-1

Candle Starts a Fire, Shakes Faith in Safety Systems at Power Plants

Alarms signaled that two more unit-one pumps were running, yet the operator's panels didn't show it. The unit-one operator remembers that "the lights on the [cooling-system] panel . . . began getting bright and then getting dim. These were more unknown conditions." Smoke began drifting up from behind the cooling-system panel. "Numerous alarms occurred on all control panels and the unit [was] in unstable swing," according to the operator's log.

At 12:51 p.m. the operator said, "Let's scram the unit." A "scram" is the sudden shutdown of a nuclear reactor. "Safety rods" are inserted between the radioactive fuel elements to interrupt the heat-producing process of nuclear fission. A scram is not enough to prevent the radioactive core from melting, however, because the radioactive fuel still generates much "decay heat." The core must constantly be cooled by circulating water.

If the fuel had melted from its own heat—"a meltdown"—it could have destroyed the building that contained it, released plumes of radioactive clouds and steam, and endangered people for miles around.

Confirming a 'Scram'

Just as the unit-one operator confirmed that the scram had occurred, he lost his ability to monitor the core's radiation and heat.

Then pressure began building rapidly within the steel chamber that surrounds the core. Water must be continuously pumped into this chamber to replace what is boiled away as steam by the core's heat. Electrical failures had limited the operator's choices to two pumping systems, then to one as 7 of the 11 relief valves used to lower pressures were also lost.

At 12:59 p.m. the water level in the chamber began to drop. Normally the radioactive core is covered by more than 16 feet of water, but in the next half hour this level fell to less than 4 feet above the top of the fuel, which always must be covered by water. "At this [illegible] knew that the reactor water level could not be maintained, and I was concerned about uncovering the core," the operator said later.

At 1:35 p.m. an assistant operations supervisor recalls, the control room "was full of smoke and the operators were wearing Scott Air Paks." Adds an assistant shift engineer: "I saw people forcing rags in holes under the electrical operator's desk. CO2 was coming through them."

Meanwhile, the fire continued to run along the cable trays, in the cable-spreading room, and farther into the reactor building. In the cable-spreading room, the plant's fire fighters couldn't turn on an overhead CO2 spray system because metal construction plates, in which the system had been shipped to the plant, could not be removed without a screwdriver. "A wheeled dry-chemical cart had been brought . . . [in' but its nozzle was broken off . . . ," an assistant shift engineer recalls.

"I hit my mask against something and got a leak," he continued. "I got quite a bit of smoke and passed out . . . . I remember reviving on top of a table in the lunchroom. I didn't know how I got there. I rested a bit and, since the first-aid room was locked . . . went back to the control room."

Air Packs Fail

"The whole fire-fighting effort was hindered due to lack of air," a reactor operator said later. Many of the air packs were designed to provide 30 minutes of breathing, but because the recharging equipment was broken, the refills diminished as the afternoon wore on. Some men were forced to use 10-minute air supplies.

Just after 1 p.m. the Athens Fire Department was called. The department's chief said later that he recommended putting water on the fire in the cable-spreading room, but the plant's superintendent, who was in control, objected because he didn't want water used on electrical wires. The chief said it was not an electrical fire. "Throughout the afternoon, I continued to recommend use of water," the chief said.

When the plant superintendent agreed, there were still problems. Fire-fighters didn't pull a water hose completely from its rack, restricting water pressure for several minutes. With the nozzle on the plant's hose, water couldn't reach to all the burning trays, but when Athens firemen tried a substitute nozzle they found that the threads didn't match. Nevertheless, once the use of water was authorized, the fire was extinguished in 20 minutes—at about 7:45 p.m.

Throughout the afternoon's fire-fighting efforts several more problems arose. At 1:57 p.m. the control room lost its phones and public-address system to the rest of the plant, making it difficult for supervisors to dispatch men to manually open and close various valves. At times as many as 75 people were in the 40-by-100-foot control room, an eyewitness remembers.

A computer needed to monitor events during the accident ran out of tape. Electrical fuses blew. Attempts to record all telephone calls in and out of the plant failed because of faulty recording equipment. Some valves that had been opened manually had to be wired to prevent closing.

With widespread electrical failures throughout the plant it also became impossible to monitor automatically for possible releases of radioactivity to the atmosphere. Some air samples were taken at a meteorological tower near the plant beginning at 5:14 p.m., but at 6:05 p.m. the tower was abandoned as smoke headed toward the tower. Other samples showed that radiation levels were within NRC limits.

At 5:45 p.m. TVA's health-laboratory director reported that environmental air sampling for possible radiation had started in Athens, 10 miles northeast of the plant; in Hillsboro, 10 miles southwest; and in Rogersville, 25 miles northwest. "The sampler at Decatur, Ala., [20 miles southeast] was thought to be inoperable," the NRC staff reported, and ". . . at 7:50 p.m. there was air sampler available at Decatur," a city of 40,000 directly downwind from the plant. No radiological samplers were available at Decatur that evening, the NRC notes, although an air-pollution sampler was set up there at 9 p.m. At 8:37 p.m. the aircraft-warning lights on the plant's 600-foot stack went out.

Delays in Reporting

NRC investigators also discovered some serious gaps in the response of public-safety officials. Limestone County's (Athens) sheriff heard about the fire after it was out, and said he would rely on the county's civil-defense co-ordinator for information about possible public evacuations. The county's civil-defense co-ordinator said he heard about the fire two days later, and thinks the plant's emergency plan needs updating and revision. And the sheriff of Morgan County (Decatur) said he heard about the fire that afternoon, but "I was asked to keep quiet about the incident to avoid panic. . . ."

How close was unit one to a meltdown? Opinions vary. "It gets awfully fuzzy to play 'what-if' on this," says Norman Moseley, director of the NRC's Atlanta regional office. "There are just too many variables." A TVA spokesman says, with a nervous chuckle, that "all that would have had to occur is to lose all cooling water." But, he insists, unit one always had at least one high-pressure and one low-pressure cooling pump working. Adds a spokesman for General Electric, the plant's designer: "We really weren't very close, but I'd just as soon not be that close again."

Exhibit III-1 (concluded)

The second failure, of both hardware and command structures, was covered world-wide when Canadian radiation monitoring teams detected, then lost, then misinterpreted, then detected again the radiation from the debris of a uranium-powered Russian spy satellite that crashed near Yellowknife and Great Slave Lake on 25 January 78. As carried in the AP reports in the Houston Post, Canadian Defense Minister Danson said that the satellite and its 100 pounds of highly radioactive enriched uranium had in all probability burned up in the atmosphere, and that the 8,000 citizens of Yellowknife stood chances of being imperiled by the radiation which were "somewhat less than being struck by lightning." This phrase is reminiscent of American discussions of nuclear accident probabilities. Yet when the lightning did strike, the radiation monitoring teams sent to the area at first reported that their high readings were probably either from natural uranium outcroppings or from equipment malfunction. Admiral Falls, Chief of the Canadian Defense Staff told a news conference that, "It is unlikely there is anything on the ground" (26 January). However, by 3 February, two radioactive segments of the satellite had been found (one found accidentally by an ecological team working routinely in the remote area). The papers soon were carrying descriptions of the 1,600 llb. lead shield being specially constructed and rushed with great urgency to the site to permit safe movement of the more highly radioactive segment. One can only speculate that public anxiety and fear about nuclear accidents and incidents were probably raised by the very fact that such large shielding was necessary to hold a flat piece of metal measuring only 10 inches by 3 inches by 1/2 inch.

The point was made even more clearly by the statement to the press by Lt. Col. Totman on 3 February: "To give you an idea of what we're dealing with, exposure to the radiation from this fragment in one hour is 50 times more than the dosage permitted for a nuclear worker in one year."

Obviously, radiation detection is very difficult from the air over the great distances and under the extreme weather conditions faced by the joint Canadian/U.S. monitoring teams, but conditions are never ideal in potentially serious emergencies. The recent two year study by the Senate Govermental Affairs Committee found very poor coordination between the 15 agencies charged with responsibility for monitoring the U.S. public's radiation exposure. What if such a highly radioactive satellite segment had landed in a crowded urban area? Would monitoring teams have been any more successful at locating it or have trusted their equipment any more fully? Would the public relations function have been performed any better, with less "there is no danger" false announcements? Before any such actual urban radiation release there can be no certain answer, but the issues seems at least doubtful.

3.1 Truck Accidents Involving Radioactive Materials

Although truck accidents are estimated by the NRC to be rather rare occurrences (1.06×10^{-6} accidents per kilometer), the total distance traveled each year is so great and there are so many possible hazards on the roads that accident frequency in any given time period may run quite high. For instance, the Federal Highway Administration reported in January 1978 that one U.S. highway bridge in five (a total of over 100,000 bridges) is deficient and dangerous. Every two days a bridge sags, buckles or collapses.

Accidents were estimated by the NRC to add approximately .0054 latent cancer fatalities and .0005 early fatalities per year of shipment at the 1975 levels to the "normal transport" totals, as compared with approximately 160 early fatalities per year from lightning strikes (NRC, 1977a: xxi). These deaths from transportation accidents involving radiation exposure were thought to come primarily from industrial and fuel cycle shipments rather than pharmaceutical uses, because of the larger quantities or more toxic materials. In addition, NRC's figures (1977a: Table V-3) indicate that more than half of truck accidents would probably be only "Type 1" severity. But this Type 1 level includes crashes with fires of up to 15 minutes duration. Furthermore, the NRC figures also indicate that some 80% of Type 1 accidents would probably occur in high-density urban areas. Finally, the remaining 45% of all truck accidents would presumably be of even greater severity.

3.2 Low-Level Radiopharmaceutical Trucking Accident: Scenario #3

The actual contents of a particular truck may make very little difference in relation to the collective behavior processes that might spring up around an accident, especially if an ensuing fire obscures the situation and prevents determination of the load contents and the condition of the packaging, even by the relevant "experts," who in all probability would not be on hand at the time. The contents do of course become more and more relevant as time passes, and thus it will first be assumed that the truck is carrying a Mo-99 generator (average of TI=2 and 4.3 Ci per package) because that is the most frequent radiopharmaceutical load (approximately 130,000 such packages per year; NRC, 1977a: V-63). However, the truck could just as well be carrying Co-60 (7,000 packages per year, averaging TI=6.5 and 500 Ci of radioactivity).

Rapid and accurate assessment of actual radiological release problems in connection with even the smallest and seemingly most trivial delays in truck shipments, such as a flat tire, engine trouble, brake failure, minor accident, etc., but this assessment on a timely basis would be very unlikely in most incidents. Since radiation is generally known to be invisible as well as dangerous, bystanders and members of any crowd that would gather around an accident scene are very likely to enter into the interactive processes of rumor, milling, collective definition of the situation, and possibly panic flight behavior, unless the personnel who are in charge of the situation and in a position to measure and comprehend any objective danger to nearby persons can swiftly and authoritatively put reasonable fears to rest. Collective behavior processes frequently start up so as to fill the perceived void in information and orientation to conduct. The following sections give brief overviews of these elementary collective behavior processes.

3.2.1 Rumor

Ralph Turner has best framed the communicative nature of collective behavior and the central place in it held by rumor, the characteristic form of communication in situations that are both threatening and ambiguous

Collective behavior, it has been suggested, is not the random, disorganized activity of a gathering of individuals free of the influence of social control. Collective behavior occurs when the established organization ceases to afford direction and supply channels for action. The occurrences of events that are inadequately defined in the culture of the group or for which no traditional organization exists confronts the group and the individuals in it with an ambiguous critical situation. In such a critical situation new norms may emerge to give direction to the collective behavior that follows. These norms make the coordination of the individuals' actions possible by supplying a shared definition of the situation.

. . .

One of the crucial characteristics of a critical situation is that information and directives for action cannot be validated through (the) normal channels of communication. The formal channels may be closed by mechanical failure, may be over-loaded, or may have their usual sources of information severly restricted. In some situations, people may find official communications so hard to believe or to assimilate that they refuse to rely on them. . . . Official channels may seem to be closed even though they are still functioning. . . . A critical situation may create a demand for explanations that are simply not available in the culture because they have never been needed before.

> Under such circumstances communication takes on characteristics different from those of normal times. More reliance is placed on informal and unconventional channels.
>
> . . .
>
> The type of communication described above is what is usually called rumor. Rumor is the characteristic mode of communication in collective behavior. It is the process through which emergent norms develop to give direction to the activities of the collectivity. This implies a conception of rumor as a collective problem-solving procedure. (Turner & Killian, 1972:30,32)

Thus rumor is not necessarily a problem; it is an attempt at solution of the fundamental problem of ambiguity in seemingly threat ening situations. Rumor is therefore very likely to occur in abundance in the face of undefined but possibly dangerous situations that are probable in any accident involving radioactive materials, whether or not there is objectively any release of radiation.

When coupled with the fundamental sociological truism that circumstances believed to be real become so in their consequences, rumor provides the crucial link between individually perceived ambiguous cues in threatening situations and collectively developed definitions of the situation that may include normatively constraining directives to action. Rumor takes on an added dimension of importance because of its complex interconnections with mass communications. As indicated in the Turner passage above, rumor draws upon mass communicated "news" for raw material. In addition, rumor feeds back into mass communication about rumors, and rumor connects opinion seekers and mass communication channels by means of opinion leaders, who interpret and "retail" the mass-communicated story on events in their areas of interest and expertise (Peterson & Gist, 1951; Larsen & Hill, 1954; Katz, 1957; DeFleur & Larsen, 1958; Greengerg, 1963; Coleman & Katz, 1966).

Finally, among the most interesting and important of the typical contents of rumor is a socially-constructed version of who is to blame for the problem, threat or perceived blockage of relief in the collective behavior situation (Veltfort & Lee, 1943; Bucher, 1957; Drabeck & Quarantelli, 1967; Hall & Hewitt, 1970; and Tuchman, 1973). In the case of radiopharmaceuticals, it is very difficult to blame doctors and medical institutions for trying to cure cancer with isotopes. Other scenarios would probably provide plenty of corporate moguls and/or powerful government officials as potential "power-mad villians" and "money-hungry bad guys." These depictions then could form the basis for possible protest demonstrations and other forms of adversary processes. Recent examples of press and rumor themes of greed in relation to trucking of hazardous materials can be found in the ammonia truck wreck and explosion on 11 May 1976 at the intersection of Highway 59 and Loop 610 in Houston (which killed six people, required evacuation of a commercial area, and closed down the 400,000 car-per-day intersection); the crash of a bromine gas truck in Knoxville, Kentucky, in summer 1977 that required evacuation of a large part of the town, and the refusal of Texas pollution officials to permit the trucking of Velsicol Co.'s Phosvel waste into the state to be disposed of in Bayport.

In the case of a crash-and-burn accident involving pharmaceutical isotopes, those persons near the site of the accident would most certainly gather close at first, partly out of curiousity and partly out of desire to aid the driver or loader. As a substantial number of people gather around the damaged and perhaps burning truck, another social process is likely to begin that is connected to rumoring, but has some special properties of its own: milling.

3.2.2 Milling

Especially in outdoor circumstances where it is hard to get a complete overall view from any one location, crowd members are likely to engage in a kind of erratic circling pattern as they move about to "get a better look" at the surprising and possibly dangerous physical circumstances (in this case a wrecked truck). Turner again has put the process with clarity and social understanding:

> Milling may take place over a still larger area, particularly where automobiles and telephones are part of a city. Typically, many people who hear the sound, see smoke rising, or hear the scream of sirens will rush toward that location to see what has happened. Their movement attracts the attention of others, who ask questions and often join in the movement. Some peple pick up their telephones to call friends, the police, or newspaper offices, to ask questions or to repeat their own versions of what has happened. In what often seems an incredibly short time, interest may be aroused and reports spread far beyond the immediate vicinity of the unexpected incident. Such convergence behavior constitutes a form of milling. (Turner & Killian, 1972:38).

This milling process and its extension to telephoning and "sending somebody to get help" are especially important in the case of a truck accident that may involve radiation release. The agencies that should be alerted (in addition to the usual calls to police and fire departments) are generally not familiar to the general public, and thus may not be alerted at all or far too late to either (1) reduce public fears and extended rumor-spreading about posssible threat to health and life if there is no substantial release, or (2) take appropriate action to call for sufficient evacuation to protect life and health to the maximum extent possible on a timely basis, while whatever re-shielding and decontamination actions necessary are being carried out. For example, if the truck accident under consideration took place on the grounds of Houston's Texas Medical Center near M.D. Anderson Cancer Clinic, and if the truck were clearly placarded as:

RADIOACTIVE
PHARMACEUTICAL ISOTOPES
FOR ANDERSON CLINIC, Phone:______

there is a fairly good chance that initial milling and rumor processes would generate the idea of alerting (1) the Medical Center's own police, who presumably could and would radio to county or state radiological monitoring teams and the relevant city/county/state police officials, and (2) the M.D. Anderson nuclear medicine section personnel who could most quickly and accurately determine wheth r there were a release and what the implications (if any) would be for the surrounding population.

This suggested attempt to placard radioactive shipments with information as to their actual contents and specific information as to action officials at their next destination is not trivial, because it could prevent the rumor and milling processes from spreading disturbing versions of likely outcomes when a more moderate one is accurate and effective. The rumor processes will spread truth just as rapidly and effectively as horror-story exaggeration, but only if the straight word is presented at the scene in a timely and authoritative manner that does not seem to be "covering up" a situation that is really much more dangerous than officials are claiming. In particular, officials on the scene should not avoid announcing every important step in their precautionary measures on the grounds that such information would cause panic. Accurate and timely information about realistic and effective steps being taken to minimize potential danger is the best antidote to panic; unchecked rumor built up in the milling process to fill an information/direction void is what feeds panic.

3.2.3 Panic

One possible response to perception of severe threat is the intensely individualistic flight behavior in complete disregard of the welfare of others that has come to be termed panic, but it is very rare and occurs only under very specific conditions.

> Panic occurs when, in the presence of severe threat, the collective definition indicates that escape is possible but that the means of escape are limited. The situation becomes essentially individualistic and competitive; a number of people are each trying to gain an objective whose

attainment is problematic for each of them. The situation may become a competitive one not because of its objective features but because of the crowd members' definition of it. This happens when they overlook escape routes or think that a route that is actually blocked is still open.

. . .

This analysis suggests that the failure of communication is the condition that lends ambiguity and lack of direction to the urgent situation. (Turner & Killian, 1972:83, 84)

Thus panics do occur, perhaps most recently in the case of the Beverly Hills Nightclub fire in Fort Mitchell, Kentucky, in which 164 persons were killed as about 1,360 people tried to escape from an entertainment room designed to seat 536, through inadequate exit passages, some of which led to locked doors; (Houston Post, 19 September 1977). However, they can be prevented or at least greatly reduced by prior planning, explanation, rehearsal in emergency exit procedures, and proper physical arrangements designed to facilitate rapid and safe exit from settings in which danger might occur. Panic is very unlikely in relation to radioactive transport accidents, unless something occurs such as a truck-crash in a tunnel or other enclosed space. Panic is more likely if largescale evacuation of flight from an entire city-sector occurs, because escape routes may be perceived as blocked or inadequate to handle the large numbers of people. (See the study of public response to Orson Welles' War of the Worlds simulated newscasts suggesting the necessity of mass exodus [Cantril, et al.:1940].

Other studies of panic include Meerloo [1950] and Quarantelli [1953] regarding natural disasters, Kelley, et al., [1965], for an experimental situation, and Rosengran, et al., [1975] in relation to a simulated newscast regarding a nuclear power station disaster.)

3.2.4 Resignation

Another individual response to a perceived severe threat is a kind of immobilizing apathy or resignation to the inevitability of the impending danger. This resignation is quite different from panic and from mass delusions that tend to produce active but "irrational" behavior such as weird psychosomatic symtoms (Johnson, 1945; Meerloo, 1949; Diggory, 1956; Kerchoff, Back & Miller, 1965; Kerchoff & Back, 1968; Kerchoff, 1970). One of these "delusion studies" did relate specifically to radioactivity, in the case of rapidly spreading belief that atomic fallout had damaged car windshields all over Seattle (Medalia & Larsen, 1958). Resignation is relatively rarely encountered or studied directly (see Forman, 1963, for one of the few examples), but somewhat similar public reactions such as mass grief after death of a beloved public figure have been examined (see, for example, Sheatsley & Feldman, 1964, on the public responses to the assassination of President Kennedy). More generally, there is a substantial literature on problems of individual perception and collective expression under conditions of high risk and uncertainty that might very well exist after a severe accident involving radioactive material (Bettelheim, 1943; Janis, 1954; Basowitz, et al., 1955; Kilpatrick, 1957; Janis, 1963;

Pervin, 1963; Lazarus, 1966; Goland & Burton, 1969; McGrath, 1970; Weick, 1970). In particular, looting is very unlikely in such accident cases, because most people would want to get away from the scene rather than stay to steal (Dynes & Quarentelli, 1968).

3.2.5 Agency Response to Moderate Accidents and Their Collective Behavior

Even though it was asserted above that the collective behavior responses to a minor or moderate truck accident would probably be rather moderate, there is no guarantee that the relevant officials will respond to the accident in an effective manner within any reasonable length of time. Thus in order to minimize any objective environmental impact from actual radiation release, and, of equal importance, to minimize misinterpretation by a fearful, untrained, and generally skittish public, responsible officials must arrive with relevant and well-communicated information as well as with monitoring/decontamination equipment. Officials should actively take advantage of the milling/rumoring process by feeding it valid and timely information in a direct and effective manner, rather than treating the gathering crowd as a nuisance and irrelevant hindrance to necessary recovering and clean-up services. Nothing could be more sure to generate larger problems than the appearance of official cover-up of both danger and of ineptitude on the part of those who must take reconstitutive action.

A study by Garfinkel and Bryan (1974) evaluating agency reactions within North Carolina's "Radioactive Emergency Response System" in a pre-announced test simulating the crash of a small truck carrying a 200 millicurie Cs^{137} source showed that serious problems of communication occurred at almost every step in the response system, even after officials had been warned of the impending test. This system test is one of the few that have been even partially evaluated by independent observers, and is very instructive for anyone who thinks existence of a procedure on paper means that it will be put into operation effectively during an emergency.

At 9:45 in the morning of 2 August 1974, members of the North Carolina Radiation Protection Branch (Department of Human Resources) and other state emergency preparedness officials placed a panel truck placarded on all four sides with "RADIOACTIVE" signs off into a drainage ditch across the street from the Midway Elementary School in the small town of Spivey's Corner, about 100 yards south of U.S. Highway 13. They placed the 200 millicurie Cs^{137} source in a bush about 100 feet south of the truck.

> This accident situation conforms to a Severity Level IV accident as defined in the Operations Manual; that is, an accident involving breach of package containment and spread of contamination to the ground in the immediate area.
>
> The entire day-long operation was carried out in severe, intermittent thunderstorms. In a real accident situation, it is conceivable that runoff could have carried radioactive material into a nearby stream had there been one. This would have constituted a Severity Level VI accident, i.e., watercourse contamination. As the methodology was designed to test a Severity Level IV accident, the possibility of a Severity Level VI accident was not taken into consideration during the test. (Garfinkel and Bryan, 1974:4).

Thus the actual situation was more severe than it had originally been set up to simulate; the results therefore appear even more dismal than the authors seem to appreciate.

Since the test was held during the summer, there were presumably no school children around to witness the truck leaving the road and losing its cargo. In fact, the test did not allow for any form of on-site "civilian" behavior at all, because the test team started the process rolling themselves by telephoning from Spivey's Corner to the Highway Patrol. In a real situation, many hours might have been lost before anyone happened to see the truck and figure out that someone should be called (presuming that the driver was either dead or too badly injured to walk the 100 yards to the pay phone). Even under the test's ideal communication conditions, the first Highway Patrol car did not arrive until 10:06 a.m., with two more HP cars arriving at 10:20. This vehicular response was considered adequately effective (p.13), but the ensuing radio and telephone communications attempting to call out a radiological team got thoroughly scrambled. Some interagency procedures were in the process of revision, and the first HP officers on the scene apparently did not know how to go about reporting to someone that this was not an ordinary traffic accident, but included "radiological involvement." The test team actually handed the officer a sheet of instructions (extremely unlikely in a real accident case) telling him to alert Patrol the telecommunicator of his local Troop B, who would in turn alert the Highway Patrol telecommunicator in Raleigh (approximately one hour's drive away) and the Highway Division Engineer. The Raleigh HP telecommunicator should then have alerted the Radiation Protection Branch and the Division of Civil Preparedness. As is often the case in bureaucratic communications, even under completely routine conditions, these messages went to the wrong offices at the wrong levels:

> At this point, it appears that a misunderstanding occurred. Rather than notifying the Division Engineer in Wilmington, the Troop B telecommunicator notified the District Office in Clinton (Highway Districts are subdivisions of Highway Divisions). During pre-test preparation, Division Engineers had been informed of their role in this type of operation via memorandum from Gerald Fleming. District personnel, however, had not been informed since they would take action only on orders of the Division Engineer. The result of misrouting this information was that the District Engineer possessed information but had no authority to act on it and the Division Engineer, possessing authority to act, and no knowledge that the test was in progress. (p.13)
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> . . .
>
> This mistake did not become evident until Dayne Brown, (one of the testers), acting for the RPET (the radiological team that should have been alerted), radioed the Troop B telecommunicator and requested that he relay a request for equipment to the Division Engineer (11:45 a.m.). At this time, the telecommunicator did attempt to contact the Division Engineer and not the District Engineer as he had done previously. However, because he was still unaware

that the test was in progress, the Division Engineer and Assistant Division Engineer had both gone to lunch and were unavailable. The telecommunicator relayed this information to the site at 12:05 p.m. At 1:00 p.m., he informed those at the site that the Division Engineer had received the request for equipment.

In addition to the delay in arrival of equipment caused by the original misrouting of information, the Highway Division Radiological Monitoring Team, which should have been dispatched to the site by the Division Engineer, was never activated.

Following receipt of Mr. Brown's message, the Division Engineer ordered earth moving and tanker equipment and steel drums dispatched from the District Office in Clinton, approximately 10 miles from the accident site. While in the process of clearing the test area, at 2:25 p.m., two vehicles carrying steel drums arrived at the site. (Footnote: Actually, the two vehicles drove past the site without seeing it. This was due in part to incomplete information which did not indicate that the accident was approximately 100 yards off U.S. 13. In a real accident situation, however, a Patrol vehicle would have been readily visible at the intersection of U.S. 13 and S.R. 1476 so that the site would not have been overlooked in spite of the incomplete information.)

2. Highway Patrol

Although Highway Patrol communications activities did not meet expectations, on-site response was extremely effective. The first car arrived within 16 minutes of notification; the two additional cars operating in Sampson County were both on site by 10:20 a.m. In addition, an officer from the License and Theft Division arrived on the scene at 10:50 a.m.

3. Radiation Protection Emergency Team

The RPET received notification of the accident at 10:40 a.m. and a team arrived on site at 12:40 p.m. The two hour time lag was longer than expected. Some of this can be attributed to the incomplete information which caused the field team difficulty in locating the accident. At 12:32 they called into the Raleigh office to confirm the location of the accident and shortly thereafter (12:40 p.m.) arrived on-site. In addition, RPET members were instructed to drive normally from Raleigh to the site using their own vehicle. In an actual emergency, the Highway Patrol would transport the RPET at high speed, greatly reducing the arrival time.

Once on site, RPET personnel took the name, address, and phone number of involved persons and proceeded to quickly locate the 200 millicurie Cs^{137} source.

4. Division of Civil Preparedness

Since this test was designed for a Severity Level IV accident, DCP response was not required beyond noting the alert at the State office level initiated by the Raleigh Highway Patrol telecommunicator. However, the State office did request Mr. Charles Markus, Sampson County Director of Civil Preparedness, to proceed to the site which he did, arriving at 12:30 p.m. In addition, two observers from the State Civil Preparedness Office arrived on site at 1:15 p.m.

It had been expected that DCP would dispatch its own Radiological Monitoring Team to the site but this did not occur. DCP, therefore, had no actual role to be evaluated in this test other than their ability to respond to a telephone alert. This ability was well demonstrated. (Garfinkel and Bryan, 1974:14-15).

Thus 4 hours and 45 minutes after its totally artificial start, even with immediate telephone alert to the local Highway Patrol, this pathetic comedy of bureaucratic communication errors whimpered out, not with any effective action that would actually be helpful in protecting people or property from what would have been a rather severe accident, but with one more sadly hilarious foul-up:

2:25 p.m. - two trucks with barrels drove past the site on U.S. 13. Did not see site. District Office messenger was sent to overtake them.

2:30 p.m. - all vehicles clear site. Test ended. (p.8)

What evidence is there that a test in any other location would go any more smoothly? What about a real accident, in a real environment, under real time pressures, with real radiation escaping from a breached container? The time typically involved in repairing damaged containment and decontamination procedures (even after the social processes of discovering the accident, alerting the complex bureaucratic apparatus, and getting effective physical help to the site) make serious radiation hazard to urban populations very likely after almost any accident that has release, no matter how trivial the circumstances may seem.

A real accident reported in Critical Mass (August 76) illustrates the time lag even after clean-up gets under way (15 hours just to recap a crate and secure its lid). Ironically, it occured to the same Mr. Dayne H. Brown mentioned in the accident simulation test presented above. This time Mr. Brown had a real breached crate to deal with: he commented, "Frankly, there were no precautions taken to allow it to ride safely."

3.3 Transportation Accident Involving High-Activity Materials, Spent Fuel, or High-Level Wastes: Scenario #4

All of the collective behavior processes discussed in connection with transportation accidents involving radiopharmaceuticals or industrial materials, and also the bureaucratic foul-ups illustrated in the North Carolina radioactive emergency response test, would in all likelihood be present in magnified form in the case of an accident befalling a high-activity shipment, whether or not there was any significant radiation release. Since these shipments tend to be the subject of intense political and ideological controversy within interested publics, it can be expected that the elementary rumor/milling springing up around any given accident would be set in the context of significant politicization in which the companies making the shipments are much more likely to be perceived as profit-hungry exploiters rather than as medical humanitarians. Furthermore, any orders given by medical center officials to assembled crowds around a radiopharmaceutical accident in the neighborhood of a prestigous medical/scientific institution such as M.D. Anderson hospital would probably be much better received and much more willingly acted upon (even if burdensome and difficult, such as evacuation of the nearby Ben Taub Hospital maternity ward) than would similar kinds of "unofficial" instructions by executives of atomic industries, utility companies, shipping firms, etc.

Again, it should not be thought that serious truck accidents do not happen. On 7 Feb 1978, two trucks carrying radioactive uranium hexaflouride were involved in an accident with two other trucks and a passenger car, six miles outside of Morrisburg, Ontario. The news reports did not mention the contents of the other two trucks, but did say that one of the cylinders of enriched uranium bounced out onto the road, where it could have been struck by other vehicles. As yet there have been no reports on any social impact.

The U.S. Environmental Protection Agency (1974:43,49) estimated that in 1975 there would be approximately 360 shipments of spent fuel from nuclear reactors all around the country to reprocessing facilities in such locations as West Valley, New York; Barnwell, South Carolina; and Morris, Illinois. These shipments would average 960 miles, for a total of 330,000 shipment miles per year. The total radioactivity to be carried was estimated to be 3,820 MCi, from a total mass of 850 metric tons. The estimates projected for the year 2000 were much higher: 7,513 shipments averaging 640 miles each for a total of 4,800,000 shipment miles, carrying a total of 56,210 MCi of radioactivity from 17,580 metric tons of spent fuel. In short, the amounts of material, average specific activities and numbers of miles traveled are already very large, and are predicted to increase by more than a factor of 15 in only twenty-five years. Some 85% of these shipments are currently estimated to go by rail, but the rest go by "legal weight" truck (5%), overweight truck (5%), or a combination of barge and truck (5%) (U.S. EPA, 1974:40). The rail shipment scanario will be deferred until the next section of this chapter, but fortunately there has been a recent detailed treatment of some physical aspects of a severe truck accident, a treatment that can form the basis of our hypothesized scenario for collective behavior patterns and agency responses.

In 1974, the Public Interest Research Group In Michigan (PIRGIM) published a report by Marion Anderson entitled Fallout On the Freeway: The Hazards of Transporting Radioactive Wastes in Michigan. PIRGIM is one of the campus-based research-and-advocacy organizations set up under the auspices of Ralph Nader's Center for the Study of Responsive Law, and the report is very directly critical of the then-current policies and procedures that controlled shipment of spent fuel and other radioactive materials. While some of the report's objections may have been countered by recent improvements in cask design, it is quite probable that many of the indicated problems in cask inspection, driver training, monitoring, and general road-handling of the trucks and their contents are still with us.

One particularly important aspect of the Anderson report is its specification of cesium as one of the major components of the material in the spent fuel casks, an element that is a solid under normal conditions but which vaporizes at the high-seeming temperature of 1253 degrees Farenheit. The problem about this temperature is that any cracks that might occur in the spent fuel cask as a result of a transport accident would allow the cooling water to escape as steam and allow the inside temperature to rise above 1253, thus letting the cesium vaporize and escape throught the same cracks. The cesium vapor could spread downwind, and then be deposited on people, crops, the ground, and into any available water supply, so that it would rapidly enter the food chain of animals that are later used for food by humans. Whether or not the latent cancer fatality estimates in the Anderson report are of plausible magnitude, even if they were reduced by 90% the result would be catastrophic. When we also take into consideration the possibility of the other high-level wastes contained in a truck shipment going into a river if a head-on collision at over 50 miles an hour for each vehicle occurred on a bridge, the impacts on the public could be very severe indeed. Within the framework of a truck accident, we will now turn to probable crowd processes, agency responses and development of incipient social protest movements devoted to the transportation aspect within the general issue of nuclear power.

3.3.1 Crowd Processes

Suppose that the above-mentioned truck accident on a river bridge did in fact occur. Suppose further that the head-on collision was with another truck, carrying any one of the following substances that (according to the Anderson report, p.19) burn at temperatures a minimum of 2000 degrees higher than that required to melt some portion of a spent-fuel cask, even if there were no crack caused by the impact of the collision itself: acetone, acrylonitrile, benzene, butadiene, n-butane, ethylene oxide, isooctane, propane, and toluene. Any one of these chemicals set afire in a single truck accident would be problem enough for highway department and police personnel, as has been shown in recent truck crashes involving bromine, ammonia and heating fuel. Recent truck crashes have also been characterized by explosions, fires, multi-car follow-on accidents, and seepage into sewer lines (Southeast Houston, August 77).

This kind of an accident would not only involve those immediately on the scene (surviving drivers of the trucks and of any cars that may have plowed into the wreckage, passengers in all the vehicles, pedestrians using the bridge, and residents of houses near the ends of the bridge, etc.), but the noise, fire, and smoke undoubtedly bring large numbers of people running toward the accident and thus into possibly very great danger from radiological contamination. In addition, the first reports by CB radio, police calls and mass media will draw others. This convergence behavior (Fritz & Mathewson, 1957) is very common in both surprise natural disasters (tornadoes, dam breaks, explosions, large fires, etc.) and in large-scale traffic accidents, and Fritz & Mathewson have suggested a typology of five kinds of convergers who together make up the initial crowds that gather around the scene of the mishap, but who have very different motivations for being there: (1) people who own property in the immediately affected area, who come to assess the extent of the damage to their homes or businesses and to locate their loved ones and others that they know in the immediate neighborhood; (2) those who live or work in the neighborhoods surrounding the directly affected one, and come to see whether family or property may have been affected, (3) those who want to be of help even though they do not even know anyone in the affected area, (4) those who are merely curious and wish only to sightsee, and (5) those who come to exploit, through looting, souvenir hunting, stealing of relief supplies, and through posing as "Insurance adjustors" etc. Turner has added a sixth type, those who use the unstructured situation following a surprise disaster to assume temporary leadership roles in the rescue and reconstruction efforts, and who as "powerseekers" feel a rush of instantaneous fame and "moral rightness" justifying their apparently humanitarian efforts (Turner & Killian, 1972:28).

Many articles and books have dealt with psychological responses to disasters (Leighton, 1951; Hamilton, Taylor & Rice, 1955; Wolfenstein, 1957; Bates, et al., 1963; Latane & Wheeler, 1966; Sterling, Drabeck, and Key, 1977), and there is a good deal of work on the effects of multiple roles (especially family roles) on individual performance under disaster conditions (Killian, 1952; Fritz & Marks, 1954; Wallace, 1956; Moore, 1956; Office of Civil Defense Mobilization, 1958; Quarantelli, 1960; Disaster Research Group, 1961; Fritz and Williams, 1967; Turner, 1967; Drabeck & Boggs, 1968; Kates, et al., 1973; Drabeck, et al., 1975; Drabeck & Key, 1976; Erickson, et al., 1976; Webber, 1976). The major conclusions from these studies are actually rather optimistic about the capacities of individuals and family groups to avoid panic, hysteria and apathetic resignation so that they can get on with the work of reconstruction (cf. Quarantelli & Dynes, 1972; and Taylor, 1977).

Much less is known about the ways in which the major community institutional sectors and large-scale organizations respond to warnings of impending disaster or to instructions from official emergency authorities once the disaster has struck. A good deal of work on specific disaster situations has been published (e.g., Clifford, 1956; Form and Loomis, 1956; Danzig, Thayer & Galanter, 1958; Form & Nosow, 1958; Fritz, 1961; Barker & Chapman, 1962; Dynes & Quarantelli, 1968; Taylor, Zurcher & Key, 1970; Grosser, 1971; Waxman, 1973; Erickson, 1976; and Manning, 1976), but Allen Barton's excellent integrative study Social Organization Under Stress: A Sociological Review of Disaster Studies (1963) remains the pre-eminent example of the attempt to understand the way in which formal organizations tend to respond to emergency situations and relate to the rest of the community in helping overcome the ravages of disaster, hindering the operation by inter-organizational disputes, or becoming irrelevant through chaos and inaction.

Barton's analytic frameworks can be directly applied to the situation stemming from the truck crash outlined above. His table "Disaster problems by period and social unit" (1963:16) arrays the relevant levels of social units (individuals, small groups, formal organizations, a community systems, and state/region/national systems) in a matrix specifying the most relevant time periods (pre-disaster, immediate response, organized response, and long-term response) of action. Our example scenario would not have a "pre-disaster" phase except in the general senses of any possible community or organizational general emergency preparedness training and establishment of the general symbolic climate regarding the wisdom and social meanings of radioactive materials transport (discussed in Section I above).

Once the first arrivals on the scene get to the survivors, we move from the initial "individual response to warnings or cues" phase to small-group (crowd, in this instance) opinion-forming interaction phase. Now we see the beginnings of the complex interconnections between (1) the immediate crowd processes that develop around the scene of the accident and (2) the mobilization of what Barton calls the "mass assault" of "unofficial" helpers, and (3) the official emergency aid, control and reconstruction efforts.

Thus the first arrivals on the scene and the survivors of the accident would probably mill about for a time, trying to define just what had happened, what dangers seemed to be at hand, what dangers might be coming in the immediate future (gas tanks exploding, other cars crashing into the wreckage, injured persons bleeding to death, etc.) and trying to contact emergency help and police aid. CB's would be used if available, but such "Mayday calls" would probably serve to complicate the situation even more by drawing even more persons into the range of any released radiation or airborn radiological contamination. Telephone calls to police and ambulance services would alert these "official" agencies if they could be reached, or some cars that were still in running shape may be used to go for aid. Whatever the means of alerting the official agencies, no person on the scene may have noticed or understood the RADIOACTIVE signs on the spent fuel truck, or the sign may have been obliterated in the fire. The driver and any helpers on the truck may be able to communicate the nature of the cargo, but it is quite likely that they would be either dead or injured very seriously.

Suppose that the police do arrive on the scene after some 15-30 minutes, and that they are told by someone in the gathered crowd that RADIOACTIVE signs are visible now that the flames have died down. What would the police do? Messages from the police to the radiological teams might serve to mobilize the resources and expertise of these teams (granted that there are no bureaucratic foul-ups of the kind observed in the Spivey's Corner test described above), but the same message might very well be overheard by members of the gathered crowd. Rumors would then fly at an enormous rate, and the police might find themselves having to deal with a panic flight off the bridge by people who may then rush out into the surrounding community carrying the terrifying message that radioactive material and invisible radiation were spreading out from the bridge site. If portions of the wreckage of the cargo were observed to have fallen into the river, the rumor would doubtless spread very rapidly that the town's drinking water was radiologically contaminated (whether or not this is technically possible). Immense traffic tie-ups would develop as some "convergers" tried to reach the accident site just as "escapees" were trying very hard to get away from it, thus blocking the arrival of medical ambulances, wrecker trucks, and additional police units that would have been called when the first police units realized that their problem had a special dimension beyond the usual traffic accident.

Telephone switchboards would probably overload as relatives and friends of those persons living in the immediate vicinity of the bridge tried to gain assurance that all was well.

What would the police do when the radiological team querried them over the phone about the nature of the cargo and the probable extent of damage to the containment systems? In the case of the bromine gas release, the police ordered immediate evacuation of a small town lying directly down wind, but they themselves stayed well away from the visible gas cloud. What would the police do in the face of the fact that they themselves might be receiving very large doses of radiation or be breathing cesium vapor in such quantities that death or at least very severe radiation sickness was almost a certainty? Would they stay on the scene to direct the rescue and warning operations, or would they try to flee as rapidly as the civilians in order to maximize their personal safety and that of their families? Killian (1952) studies these and similar questions, and Barton has integrated some empirical data on them (1963:92ff), but none has dealt with radiation hazard as a direct and present danger to action officials on the scene. Especially given the low state of knowledge and preparedness among officials at all levels of the "emergency" response system, it would be foolhardy to predict that all would go smoothly.

Once activated, what would be the response by the various levels of state or local radiological teams, hospital facilities, civil defense organizations, etc? Barton has attempted to relate systematically the operations of the "mass assault" of people attempting to help (or in this case to escape) as either facilitating or impeding the efforts of the formal emergency systems (1963: 73-77). The conclusion must be drawn that radiation emergencies (particularly if the authorities become convinced that there really is substantial radiological hazard to the community) go far beyond even the worst of the previously experienced disasters in the sense that the threat is terribly frightening, invisible and so not permitting a feeling of safety no matter what precautions have been taken, and often so long-lasting that no "return-to-normalcy" can be justified easily.

3.3.2 Evacuation

If evacuation is ordered of a large area around the bridge site, of the downwind corridor, or of the entire community served by a drinking water supply, a whole new level of very difficult problems would be encountered. All the usual evacuation problems would occur (Fritz, Rayner, and Guskin, 1958; Drabeck, 1969), and America simply has no evacuation plans or large-scale preparedness systems that could produce rapid and safe evacuations of high density urban areas in a radiological emergency. Barton's analysis of this problem makes the components visible (1963: 120-121,157-158), but leads to little optimism as to the probability of effective functioning in a large-scale radiological emergency, nor does examination of the underlying literature (French, 1944; Bakke, 1959; Gouldner, 1959; Kahn, et al., 1964; Swanson, 1964; Thompson, 1967; Heyns, 1968; Hundley, 1968; Dynes, 1970; Haas & Drabeck, 1970; Dynes, Quarantelli & Kreps, 1972, Mileti, Drabeck & Haas, 1975; Sutton, 1976; Turner, 1976; Stallings & Freeling, 1977). To give a flavor of the special evacuation problem, one community's planned evacuation site was found to be directly in the prevailing wind path of any airborne radioactive cloud (Critical Mass, August 1976).

In short, the combination of the assemblage processes bringing persons toward the accident (McPhail & Miller, 1973), the crowd processes outlined above, possible panic flight, and evacuation processes (if they should be ordered) would probably overload all community systems and cause great hardship for all concerned.

4. Diversion of Radioactive Material by Terrorists

4.1 Sociological Approaches to Comprehension of Terrorism

There were few analyses of terrorism in the early literature on collective behavior (for example, Hardman, 1933; Thornton, 1964), perhaps because political terrorism seemed somehow "foreign" ("Bomb-throwing Bolsheviks," etc.) even though the United States has certainly seen enough of it in the cases of presidential assassination and the kinds of CIA/Watergate types of adventures, glorified in the TV series "Mission Impossible." Almost anyone of the action scenarios would, if conducted against targets in this country, be considered as terrorist adventures. One recent sociological analysis has provided a typology of terrorism in urban settings; Phillip Karber (1971) uses the following conceptual distinctions:

> 'The Propaganda of the Deed'--Undoubtedly terrorism is very often confused with revolution due to the radical left's justifying ideology and theoretical dependence upon the writings of the deceased Brazilian revolutionary, Carlos Marighella. Marighella's Minimanual of the Urban Guerrilla calls for revolutionaries to leave the fields and come fight in the cities; he defines terrorism as 'armed propaganda,' the symbolic use of violence as a means of communication. (f.n.: Marighella apparently borrowed the concept of "the propaganda of the deed" from Peter Kropotkin who coined it in the nineteenth century; see Hardman, 1933:557.) Bank robberies, ambushes, desertions, the rescue of prisoners, hijackings, executions, sabotage and bombings are all instrumental in and of themselves; however, these 'actions carried

out with specific and determined objectives, inevitably become propaganda material for the mass communication system.' (Marighella, 1971; see also Scanlan's Editors, 1971).

The symbolic concept of terrorism provides two crucial distinctions--between terrorism and revolution and between terrorism and other forms of violence. If the objective of violence is the acquisition of useful objects (money, weapons, etc.) or the denial of such resources from the enemy, this action is robbery, assassination, sabotage, etc.; 'if, on the other hand, the objective is symbolic expression, we are dealing with terror.' (Thornton, 1964:78). This highlights the distinction between terrorism and revolution, for symbolic violence can be used not only to propagandize the overthrow of a system but also as a means of interest articulation to effect the system's output.

When the 'establishment' is unwilling to listen to non-violent protest, terrorism permits the frustrated communicator, as stated by one terrorist, 'to maximize significance and minimize getting caught.' (See Trinquier, 1964:17.)

. . .

The symbolic functions of terrorism--as a symbolic act, terrorism can be analyzed much like other mediums of communication, consisting of four basis components: transmitter (terrorist), intended recipient (target), message (bombing, ambush) and feedback (reaction of target).

> The terrorist's message of violence necessitates a victim, whether personal or institutional, but the target or intended recipient of the communication may not be the victim.
>
> . .
>
> Every attempt at communication is intended to have an impact external to the transmitter. The utility of the terrorist's violent message can be divided between two poles: instrumental influence in which the terrorist's message has an immediate effect on the behavior of others against their will or out of fear, and affective influence in which the message has a long-range effect on the behavior of others due to their identification with or respect for the transmitter.
>
> The message of terrorism also varies with the degree of discriminatin between the symbolic victim and society. The more indiscriminate and random the terrorist act, the more general the target group and diffuse the message. Thus, to communicate a specific message to a particular target, the terrorist must be highly selective in his choice of the symbolic victim.
>
> (Karber, 1971:527-529; emphases added)

4.2 Typology of Terrorism

Karber then sets out the following typology of terrorism, which will here be related to the possibilities regarding diversion and terrorist use of a truck shipment of plutonium. We have seen that

President Carter is most opposed to the breeder reactor and to plutonium re-cycle programs because of just such a diversion of plutonium, and thus the various scenarios outlined within Karber's typology should be of immediate political as well as radiological interest.

Here is Karber's Functional Typology of Terrorism: (p. 529)

	INSTRUMENTAL	AFFECTIVE
DISCRIMINATE	Coercive Bargaining	Advertisement and Recruitment
INDISCRIMINATE	Social Paralysis	Social Conscience

4.2.1 Advertisement and recruitment are general purposes often achieved through focused attacks on symbolic targets, combined with mass media coverage telling the message of previously unnoticed injustices. The recent occupation of a passenger train and a schoolhouse by the South Mollucan minority within Holland gained world-wide attention for their grievances; a similar scenario directly relevant to our purposes might involve capture of a barge carrying a large amount of low-level radioactive wastes down the Missouri or Mississippi rivers. Terrorists would have only to threaten to scuttle the barge or blow it up; whether or not there would actually be serious radioactive hazards to drinking water, industrial processes, fish and wildlife, etc; is relatively unimportant in comparison to the great public fear and concern that would be engendered.

As in many of the recent attempts to deal with terrorists who have occupied or hijacked some vehicle, negotiations and press coverage for the barge-jackers would probably be counterproductive. The successful rescue of 86 hostages from a hijacked Lufthansa jet that had been diverted to Somalia by Arabic-speaking terrorists showed what can be done by trained "anti-skyjacking commandoes" using special equipment and essentially unlimited travel facilities. The problem still lies with the moral question of the right to risk the lives of the hostages when going in shooting to get the terrorists. So far this "surprise and shoot" tactic has worked well in a large number of cases this summer, but the next one could result in the deaths of a great many innocent people. Paying the desired ransom of course does not guarantee that the hostages will be released safely, and probably does increase the chances of more "borderline terrorists" actually getting organized to make their own attempt at fame and riches. Apparently the German commando team was formed after the success of the Israeli raid on the Entebbe Uganda, airport last year, and now U.S. has revealed the existence of its own counter-terror force (reports in the Houston Post on 19 and 20 Oct 77). Perhaps use of this kind of lightening surprise attack while apparently negotiating is the best over-all strategy, but the moral dilemmas of the hostages and of possible destruction remain insoluble.

4.2.2 Social conscience forms of urban terrorism are primarily symbolic attacks on the society's way of "doing business." Perhaps represented best by the current state of affairs in West Germany, this form of terrorism involves the holding for ransom of prominent citizens (in the current case, a very prominent industrial. In addition to money, the terrorists have sought to bring world attention to what they view as the "materialistic rottenness" of West German life (see the New York Times of 25 September 1977). Apparently some upper-middle-class youth have been attempting to live out their visions of romantic struggle, and thus triumph over the materialistic banalities of contemporary urban life.

With specific relation to the German case, lest it be thought that democractic societies will not give up their freedoms when threatened severely, consider the details of the proposed anti-terrorist legislation before the West German Parliament (from the CSM of 5 October 77). Breaking the privacy of the mails and telephone, increasing the use of the identity papers for travelers, and expanding the powers of the Federal Criminal Office are all included in the present bill. Another bill introduced by conservatives in the previous week would have prevented many forms of legal self-defense, made slander of the state as a crime, made disobeying any form of administrative directive a crime, authorized preventive detention, and many other such repressive measures.

The recent rapid increase in world-wide terrorism (especially involving aircraft) has already led to a very stringent proposal by officials of the Energy Research and Development Administration to the Federal Aviation Administration that the airspace over and around ERDA-owned facilities in Amarillo, Texas, Golden, Colorado and Oak Ridge, Tennessee should be restricted to aircraft, up to 12,000 feet and with a radius of 20 miles around each site. This plan would have severely disrupted civilian air travel in six states.

4.2.3 Social Paralysis

In this case, terrorists engage in essentially random attacks on government facilities and vehicles (in this case high-level waste or fuel transports), with the general idea of demoralizing and disorienting the populace so that no area is felt to be safe, and so that the government is perceived as weak and powerless to stop the attacks. Very much this kind of situation now prevails in Dublin and other parts of Ireland, where random bombings of pubs and markets are anxiety-producing for all concerned, especially since there are frequently several groups of terrorists operating at the same time. Sporadic grenade attacks on any of the forms of radioactive transport would very effectively create anxiety, doubt and general disorientation, and the only solution might be to offer huge rewards (and new identities) for informers.

Bombings using conventional explosives directed against specific targets have already become a very great problem in this country; Karber summarizes some fairly recent data collected by U.S. News and World Report in 1971:

> If the target refuses to ransom the victim, the terrorist must either prove his willingness to carry out the threat or forfeit his bargaining credibility.
>
> Bombings, for instance, increase the bargaining power of threats. In 1970, federal government structures were the victims in 36 bombings or bomb attempts, with damage estimated at $650,000. However, 592 bomb threats, usually

made by a 10-cent phone call, forced 226 evacuations of federal buildings, costing the government an estimated 3.8 million dollars in time lost by employees. (Karber, 1971:529).

What if even one of the nearly 600 bomb threats had claimed impending use of a plutonium-based nuclear explosive? Government search and seizure activities might well be both rapid and thorough, but they would also be very expensive and likely to violate the basic civil rights and liberties of many innocent persons.

4.2.4 Coercive Bargaining

The terrorist attempts to get the adversary to agree to his demands based on the communicated threat to inflict pain on the victim. Kidnapping and hijacking are the major forms of this type of terrorism, and the wave of recent diversions of commercial passenger jets to neutral or hospitable countries illustrates the international scale of these operations, in which hundreds of innocent passengers and a multi-million dolar plane are held at ransom, often for demanded sums of money in the millions of dollars and for release of prisoners who may or may not be involved in wider political/revolutionary activity.

If commercial planes were to carry shipments of plutonium again, the possibilities for diversion and threat to sell to non-nuclear powers (or even just sale to the highest bidder in secret negotiations) are immense, especially considering the lax security precautions in the airports of most countries. Even in the U.S., airport metal detectors and so forth are only designed to spot hidden guns. As was shown by the diversion of a jet to Atlanta on 21 October 77, there is at present no defense against even a single gunman who is determined to shoot his way onto an airplane just before takeoff. The Association of Airline Pilots has announced that its members would go on long-term international strike unless Senator Abraham Ribbicoff's proposed bill is passed cutting off U.S. aid to any country that has ineffective airport security or that harbors airplane hijackers. Perhaps this form of anti-terrorist effort will help, but the situation looks bleak.

4.3 Terrorist Diversion of Uranium or Plutonium

One expressed purpose of the DOE program of radioactive waste and spent fuel collection is to reduce the chance that terrorist groups within the various reprocessing/recycling nations might divert sufficient quantities of either enriched uranium or (much more likely) plutonium to produce enough of a bomb to be an effective threat for either monetary gain, political bargaining, or even to use as a military weapon. Such a scenario is not merely the product of the overactive imagination of journalists or anti-nuclear ideologists.

4.3.1 Uranium Trucks

On 24 October 77, NBC's Today Show carried a report to the effect that some 200 to 400 pounds of enriched uranium had been smuggled out of the Nuclear Materials & Equipment Company (NUMEC) plant in Apollo, Pennsylvania, during the mid-1960's. According to the report prepared by Howard Kohn and Barbara Newman for Rolling Stone (15 November 1977) and given orally on the Today program, the president of NUMEC, Mr. Zollman Shapiro, assisted in smuggling the uranium to Israel. In addition, Kohn and Newman report that Israeli c mandoes hijacked at least two truck-loads of uranium (in England and France, and perhaps in other mediterranean countries), but that these hijackings may have been staged in cooperation with some officials of the countries involved. Adding to this complex scenario, Kohn and Newman reported that the smuggling of some 200 tons of low-grade uranium into Israel with cooperation of German officials was done in return for some $3.7 million and some uranium-enrichment technology that Israel possessed and Germany wanted. To complete the initial round of this intricate story, the Israelis apparently developed the uranium-enrichment technology because it wanted to make bombs from the relatively low-grade uranium that it had smuggled from the mediterranean countries. The alleged results of the whole series of interchanges are that (assertedly) Israel now has some number of atomic bombs (reported by Kohn and Newman as 15, but already rumored on the evening NBC news to be as high as 150), Germany has uranium-enrichment technology worked out in Israel, several trucks have been hijacked (reported as being done by small commando squads using tear gas to subdue the drivers and guards), and several U.S. officials have called for investigations of the whole affair, including possible CIA, FBI, State Department, and Presidential knowledge along the way. On 29 Jan. 1978, the CIA acknowledged a 1974 intelligence estimate that credited Israel with possession of nuclear weapons, made possible partly by use of clandestine means, an intelligence estimate that had been released by mistake. Once again, such a failed attempt to keep knowledge about nuclear information and activity hidden from public view can only add to public cynicism and mistrust of government. In addition, media coverage of the truck-hijacking scenario cannot help but reinforce the idea that diverting uranium shipments is not really very hard.

4.3.2 Plutonium Truck--Of greater likelihood regarding radioactive regarding radioactive materials transport in urban areas is the diversion of a truckload of plutonium, especially if the fast-breeder reactor and plutonium re-cycle are authorized. NUREG-0170 asserts that there will be only about 30 shipments per year in 1977 and 1978 of U-233, enriched U-235 or plutonium, the only materials now requiring physical protection against theft and sabotage, and claims that the armored trucks with special communications gear and five guards could resist guerrilla attack: "On the basis of intelligence and other relevant information available to the NRC there are no known groups in this country having the combination of motivation, skill, and resources required to carry out an assault against a protected shipment or facility." (U.S. NRC, 1977a: VII-12). This may sound reassuring, but it is wise to recall the assertion that small squads of Israeli commandoes were able to use simple teargas grenades to flush out the guards and drivers from protected uranium trucks (see the Kohn & Newman report above). Armor plate is of no use against chemical attack, and teargas is readily available in this country.

While U.S. public debate regarding the wisdom of moving to extensive use of plutonium as fuel for power-generating reactors has hardly begun, France is expanding its La Hague reprocessing facility to extract plutonium from spent fuel being shipped from all over the world. Our current president seems vigorously opposed to the idea (and vetoed the Clinch River Breeder Reactor in Nov 77), but the "Standard Shipments Model" contained in Appendix A of NUREG-0170 (1977a) assumes that in fact such plutonium use will begin by 1980, and that both research and weapons-related plutonium shipments will continue at their 1975 levels:

> Pu-239 shipments were estimated to be unchanged from their 1975 values, since these involve principally research reactors and weapons production facilities. However, a new type of plutonium shipment, 'recycle Pu', was added to account for recycling of plutonium recovered from spent fuel and the fabrication of mixed oxide (MOX) fuel by 1980. For an estimated 20,535 kg per year transported in 1985, 41 packages per year will be shipped in integrated container vehicles (ICV) in 504 kg quantities. (p. A-25)

It should be remembered that only 4 kilograms of plutonium are necessary for making a 1-kiloton bomb (equal in explosive power to 1,000 tons of TNT), and so each "ICV" would be carrying enough plutonium to make 126 such bombs.

4.3.3 Plutonium Transportation Scenario Involving Inside Workers

One further scenario involves in-plant or transportation workers in the possible diversion of plutonium somewhere along the production/reprocessing cycle, and does not have to be invented because it comes to us in the form of the recently-validated report concerning the Kerr-McGee plutonium factory outside of Oklahoma City.

Perhaps the earliest public report on conditions and activities at the Kerr-McGee plant was printed in the April 1975 issue of Critical Mass. This account was corroborated in the article "Karen Silkwood was right in plutonium scandal," by Howard Kohn in the October 20, 1977 issue of Rolling Stone. The initial report concerned primarily the death of Karen Silkwood, a laboratory technician employed at the Kerr-McGee plant, who had been killed in a car crash on 14 November 74. The story took on larger proportions because of references to unsafe working conditions, needless exposure to radiation, incorrect record-keeping regarding the plutonium being processed in the plant, and the company's generally poor response to the questions of health and safety being raised by members of the Oil, Chemical and Atomic Workers Union. Particularly suspicious were details about radioactive contamination of Ms. Silkwood's person, her apartment, and even the food in her refrigerator. The details of the car crash were murky (leaving very big questions as to whether she had been carrying a folder of "evidence" regarding company practices, and whether the crash was accidental or intentionally caused), and the general picture was a fascinating one but without corroboration.

The most recent report (there have been two others in Rolling Stone) gave much more detail on plant handling and transportation practices, and carried the strong suggestion that Ms. Silkwood had discovered a plutonium-smuggling ring operating inside the plant. The second report claims to be based on interviews with two former department heads at the plant, and gives much more detail that can now be checked for accuracy. Even if doubt remains forever about the causes of Ms. Silkwood's death, the accounts by former department heads Smith and Cooper of the plant's plutonium handling, transportation, and disposal practices make for unfortunately real horror-story reading. Add the possibility of substantial plutonium smuggling and the Silkwood case becomes very intriguing. A few key examples from the second report:

> Leaking pipes and defective equipment regularly contaminated workers with plutonium, a deadly radioactive substance that can cause cancer. Instead of stopping production, Kerr-McGee ordered its employees to continue working and did not repair the leaks until slack production periods.
>
> At the same time, the two men claim, Kerr-McGee routinely shipped plutonium waste in unsafe leaking containers that sometimes spilled on the plant grounds and may have been responsible for contaminating an area in Kentucky where the waste was buried.
>
> An even more alarming problem is the possibility that plutonium was diverted from the plant. On two occasions, Smith says, Kerr-McGee did not recover plutonium that the company had originally reported missing to the AEC. As many as fifty pounds, enough for four nuclear bombs, could be lost if Smith is correct.
> (Kohn, 1977: 51-52)

As if these charges were not enough, the later sections of the second report provide some fascinating scenarios that give a very dark perspective on what might happen at a number of sites around the country if plutonium recycle and reprocess become accepted practices:

Kerr-McGee's handling of plutonium outside the plant was equally haphazard, and this created a danger that could still affect thousands of people as far as three states away. The problem arose in the disposal of hundreds of barrels of left-over liquid plutonium. Kerr-McGee converted the liquid to a solid by mixing twelve gallons of an acid with thirty-three gallons of plutonium waste and then shipped the mixture about 500 miles away to the Maxey Flats Disposal Site near Morehead Kentucky.

Because of the particular low-cost processing the mixture sometimes became unstable. 'It'd start going back to a liquid and then it looked like a big ice cube floating in a barrel,' Smith says. When that happened, the acid in the solution began to eat away at the black iron barrels. Truck drivers had to race to Kentucky and unload the drums before holes spouted. Sometimes they didn't make it.

'They had a hell of a problem,' Cooper says. 'It sometimes leaked out of the barrels before the trucks pulled out of the plant.' Once, the radioactive liquid burned through the floorboards of a semi-trailer and the whole truck had to be destroyed. 'They took the wheels off and hauled the semi out and buried it,' Smith says. On at least three other occasions the waste material leaked from the drums onto the plant grounds and the soil had to be excavated and removed. Some plutonium, Smith says, was never retrieved. (p. 54)

. . .

Smith also disputes Kerr-McGee's claim that twenty-two pounds of plutonium were left in the plant's system when it shut down permanently in 1975. That time, he says, he supervised the flushing of the pipes with boiling-hot nitric acid. 'We could have flushed for another month,' he explains, 'and we couldn't have gotten another three ounces out of the sonofabitch. There's no way twenty-two pounds could still be in there.' (p. 56)

This particular plant is now closed, but there is never any shortage of honest mismanagement, dishonest greed, or political intrigue. When terrorism is added to this program for eventual disaster, the probabilities and the seriousness of the consequences go up dramatically.

4.4 Adoption of Plutonium Recycle as a Policy Question

Even the rather pro-nuclear Report of the Nuclear Energy Policy Study Group (Keeny, et al., 1977), sponsored by the Ford Foundation (no enemy of commercial development of technology) came to the conclusion that escalation to the plutonium economy would be both dangerous and unnecessary:

Some of the elements of a U.S. nonproliferation strategy that are broader than nuclear power are: a foreign policy in support of international security, peace, and stability; security commitments to reduce the perceived need for nuclear weapons; use of influence to discourage apparent preparatory moves for a nuclear capability; arms limitation agreements (e.g., a comprehensive test ban) to build additional barriers to proliferation; deemphasis of nuclear weapons in military policy, particularly doctrines that present nuclear weapons as acceptable and necessary armaments for limited application or political pressure; and cooperation in international development of the full range of energy resources.

. . .

There are also actions and policies that relate directly to nuclear power and the nuclear fuel cycle that would help to control nuclear proliferation in important ways. The nonproliferation system will inevitably be flawed and unstable if plutonium and highly enriched uranium, materials suitable for nuclear weapons, and the facilities to produce them become increasingly widespread. The time required for achieving a nuclear weapons capability would be greatly reduced and the temptation to make an irreversible decision to fabricate, and even use, nuclear weapons might be difficult to resist in a crisis. Facilities for plutonium separation and enrichment of uranium are thus particularly sensitive. (p. 23)

Decisions about civilian nuclear policy have an important bearing on the terrorist problem. If plutonium is not recycled, the opportunities for plutonium theft in civilian industry are essentially eliminated. Similarly, if the high temperature gas-cooled reactor is not commercialized, the amount of highly enriched uranium in commerce will be very small. Technologies which introduce weapons-grade materials into commerce are clearly undesirable from a security viewpoint. (p. 302).

. . .

The United States faces a number of early decisions having an important bearing on the future of nuclear power and on the worldwide risks in the nuclear fuel cycle. These decisions, which are closely interrelated, must be considered in the context of the economic, energy supply, social costs, and international security issues discussed above. From this broader perspective we have examined the pending decisions: whether to proceed with plutonium reprocessing and recycle; how to conduct a breeder program most appropriate to long-term energy needs; how to manage and dispose of nuclear waste; when and how to expand enrichment capacity; and how to develop a nuclear export policy which minimizes threats to international peace and stability.

. . .

The significant common thread in these decisions is the question of whether plutonium should be introduced into the nuclear fuel cycle. We have concluded that there is no compelling reason at this time to introduce plutonium or to anticipate its introduction in this century. Plutonium could do little to improve nuclear fuel economics or assurance here or abroad. This conclusion rests on our analysis of uranium supply, the economics of the plutonium recycle in current reactors, and the prospective of breeder reactors. In the longer term, beginning in the next century there is at least a possibility that the world can bypass substantial reliance on plutonium. If this is not the case, the time bought by delay may permit political and technical developments that will reduce the nuclear proliferation risks involved in the introduction of plutonium. (p. 29, emphasis added).

4.5 Impacts of Increased Security on Civil Rights and Civil Liberties

Numbers of bombing and bomb threat incidents vary from year to year, but no modern society can tolerate high levels without "cracking down" in a wide range of ways on "potential dissidents" and "known troublemakers." In fact, a very strong argument can be made that the effects on civil rights and civil liberties (especially the rights to privacy, freedom from unreasonable search and seisure, and freedom of assembly) that would flow from adoption of plutonium recycle would be even more damaging to the nation than would even the most severe threat of terrorist use of a plutonium bomb or plutonium as an environmental poison. Russell Ayres has developed the underlying reasoning in a recent issue of the Harvard Civil Rights - Civil Liberties Law Review (1975):

> To prevent dangerous quantities of plutonium from falling into the hands of criminals and terrorists and to insure the safe and speedy recovery of plutonium if it is stolen would require fundamental alteration of the legal framework established to protect individual rights. Virtually everyone in society would be called on to make sacrifices of personal liberty in order to assure effective safeguards. Both within and without the nuclear industry, individuals would be confronted with governmental demands that they curtail their expectations of privacy and their exercise of associational and expressive rights for the greater good of public safety.
>
> A basic objection to theft-preventive safeguards is that they would require individuals to distort their assessment of their own role in society. For example, civilian employees of the nuclear power industry who would have to comply with stringent new security regulations might come to believe that they were more like soldiers than civilians in light of the background checks that they would have to undergo to secure employment and in light of the limitations on their off-the-job activities that they would have to observe to

retain employment. Similarly, people outside the nuclear power industry would wonder whether they were the subjects of covert government surveillance. The result would be a chill on first amendment rights and an increase in the general level of suspicion in society.

Post-theft recovery measures would create a situation approaching civil war, with the government arrayed against the pepetrators of the nuclear threat and with innocent citizens caught in the middle. Although emergency measures like widespread ransacking of homes and buildings, detention of resisters and offenders by the military, and restrictions on assembly and movement would hopefully be temporary, they are nonetheless drastic departures from the rule of law as it has come to be understood by the people of this country.

Throughout this comment, reference has been made to the unprecedented difficulties posed by plutonium in the context of legislative and judicial decisionmaking. This challenge to the legal system's competence to adjust social interests in public safety with individual interests in civil liberties may be the most significant social cost of plutonium. It is instructive to consider that, while the Anglo-American legal system is approximately ten centuries old and the United States is about two centuries old, the hazardous lifetime of plutonium is hundreds of centuries. With the passage of time and the increase in the quantity of plutonium in existence will come pressure to eliminate the traditional checks the courts and legislatures place on the activities of the executive and to develop a powerful central authority better able to enforce strict safeguards. Alongside the prospects for diminished individual liberties in a plutonium economy must be placed the possible substitution of an authoritarian 'nuclear priesthood' for the traditinal institutions of law enforcement.

It is thus viturally impossible to construct a compelling affirmative case for plutonium recycling in the face of the civil liberties objections to it. Although in the present era one would not lightly urge rejection of a promising source of energy, it is instructive to consider Dr. Weinberg's characterization of the choice involved:

> We nuclear people have made a Faustian bargain with society. On the one hand we offer ... an inexhaustable source of energy. ... But the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to. (1972:33)

It is surely within reason to demand that all other sources of energy be proven unworkable or unacceptable and to demand significant long term reduction in the consumption of energy before implementing an energy program with such dire effects on law and liberty. (Ayres, 1975:441-443)

John Barton (1975) has covered much of the same legal ground as has Ayres, but from the perspective of trying to help the NRC in formulating policy and decisions regarding plutonium use and control. He deals with a wide range of issues regarding employee background checks, searches, the effects of sabotage, theft of special nuclear material, and a terrorist making a threat to detonate a nuclear device. Martial law, seizure of property to be destroyed, traffic control, the constitutionality of "shoot to kill" orders, area searches, perimeter searches, detention of suspected "dissidents", surveillance of all concerned, wiretapping, use of informers, use of torture in interrogations, and a wide range of technologically based search and protection tactics are discussed. Even though starting from a pro-NRC base point, Barton is drawn to quite negative conclusions regarding the civil rights effects of adopting plutonium recycle. For exampl

> Evaluation of the Surveillance Issues. The possibility of continuing surveillance is probably the most severe civil liberties effect of a plutonium recycle decision. The surveillance would act at all times; it would not be restricted to emergency situations. It could have significant chilling effects on First Amendment discussion, particularly in the nuclear area.
>
> At the same time, the government is already engaged in a substantial amount of domestic surveillance. It is not clear that plutonium recycle would increase the amount of surveillance--the surveillance groups are said not to distinguish between high-explosive terrorists and chemical warfare terrorists, for example.

> Nevertheless, plutonium recycle would provide a new justification for surveillance; according to some, the only rational justification. Nuclear safeguards requirements would be prominent among the arguments used by the surveillance agencies at budget time. Thus, plutonium recycle could be central in helping maintain what might otherwise be a diminishing level of surveillance.
>
> Because of this effect and because of the possibility that the surveillance agencies might overreact to the nuclear terrorist threat, it is clear that NRC must consider the civil liberties costs of this surveillance in its decision on plutonium recycle. (Barton, 1975: 35-36)

Another of Barton's contributions concerns the independent thrust toward de-humanization of our society that may come from increased emphasis placed on technological approaches to surveillance and security:

> Finally, there is some civil liberties risk associated with the fact that nuclear safeguards might bring new technologies--such as incapacitating gases or computer inventory sytems. One may fear that some of these technologies will be widely marketed and become part of normal public and private crime-prevention technology. The expanding application of such security systems as elaborate locks and centralized computer-surveilled alarms

argues that this possibility is not at all hypothetical. Although it is hard to define the civil liberties implication in precise constitutional terms, one senses a civil-liberties related frustration in living in a society heavily shielded by crime-prevention technology as contrasted with one where a relatively large share of human relationships are regulated through consent and respect. (1975:40).

It is almost certain that security and surveillance policies, practices and technologies developed to protect plutonium transportation links and reactor sites from nuclear terrorists would spread to wider sectors of our society, and would have a deadening effect on the social and political life of our nation. Barton puts this issue sharply:

> Surveillance could be very dangerous for First Amendment freedoms and the number of threats for which surveillance could be argued to be helpful is very great. It is therefore wisest not to accept the logic that a large domestic risk--even that of nuclear terrorism--justifies domestic surveillance. NRC could conceivably conclude that plutonium recycle is undesirable without domestic surveillance. (1975:36)

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16. ABSTRACT (200 words or less)

The symbolic interactionist/collective behavior approach within sociology in applied to the transport of radioactive materials through urban environs, indicating that social impacts of such transport would extend far beyond objectively measurable radiological impacts of normal (incident free) transport, accidents during transport (with or without radiation release) or diversion by terrorists.

This approach is used to delineate the major cultural frames of reference that interested publics and special groups might use in interpreting events surrounding radioactive material transport, and to specify probable social impacts of seven scenarios. These impacts include: (1) uncertainty, fear and mistrust, (2) processes, (3) initial agency responses, (4) subsequent collective behavior responses, and (5) a wide range of more general impacts on U.S. culture and special structure.

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