Decision Making and Learning in Scientific Emergencies:

The NRC and Three Mile Island

Proposal submitted by:

Prof. Lloyd Etheredge
Center for Advanced Study in
the Behavioral Sciences
202 Junipero Serra Blvd.
Stanford, CA 94305
&
Prof. Philip Tetlock
Dept. of Psychology
University of California, Berkeley
Berkeley, CA 94720

September, 1980

Table of Contents

Introduction

The Nuclear Regulatory Commission assumed several responsibilities during the Three Mile Island (TMI) crisis, including scientific assessment of danger to the public and the decision of whether to recommend general evacuation. The deliberations of Commissioners Hendrie, Kennedy, Bradford and Ahearne and their key staff were preserved on tape: the tapes, and approximately 2,000 pages of transcripts from the tape record, offer an unparalleled, detailed record of group decision processes in a scientific emergency.

This application solicits funds for a three-year, state of the art analysis of NRC decision processes during the TMI crisis. It draws upon theories from social science research traditions that have sought to characterize and explain such processes and tests the explanatory power of these theories rigorously with multiple methods. As necessary, the study will refine existing theories and propose new ones to explain the NRC s behavior.

We propose this study for three reasons. First, the quality of government decision making in nuclear emergencies is a serious problem. The Kemeny Commission was extremely critical (President s Commission, 1974, p. 21) of the NRC. Accidents similar to TMI will probably recur in the United States and other countries. We believe this study, analyzing behavioral processes not systematically addressed by official enquiries, will codify additional lessons from the NRC s experience, and may improve the quality of future decisions and potentially save lives. Second, the state of social science theory and concept operationalization is sufficiently advanced that we can rigorously test the relevant

and major theories in the social science literature. Third, the wealth of data generated by investigations of the TMI crisis, together with Washington interviews and the use of original tapes and documentary records, provide the opportunity to clarify and explain determines of high (or low) quality decision processes with a substantial degree of confidence by employing evidence from many observers and multiple methods.

Practically, the study should provide a useful educational vehicle. TMI is a dramatic story. Using tape excerpts, a final report can recreate the experience of what it was like to be an NRC Commissioner. Via identification, and the imaginative rehearsal of their own responses, students can relive the most important basic lesson of the experience, the nature of the experience itself. Connecting social science analysis and commentary to that experience will allow students to develop their abilities to operate with perspective and wisdom in future emergencies which they, as responsible officials, may be called upon to manage.

Part I: Project Narrative and Research Plan

This section outlines the proposal in two parts. The first outlines the analysis and theories to be tested. The second describes in more detail the methods to be used.

Theory Testing

We believe ten types of processes shaped the NRC s work and affected the quality of the NRC decision process. The theoretical traditions which we will use and which will be the core of the empirical work are outlined in the following subsections:

A. Rational Analysis and Problem Solving

A.1 Macro Analysis of Deviations from Ideals and their Nature

A.2 Learning Processes Within the Crisis

B. Cognitive Processes

B.1 Flow of Decision Processing and Nature of Decision Rules

B.2 Cognitive Dissonance Processes

C. Socioemotional Processes and Inhibitions

C.1 Stress Effects

C.2 Tension Management Modeling

C.3 Effects of Group Norms

D. Power Relationships

D.1 Outside Impact on NRC Decision Processes

D.2 Power Relationships Within the NRC

D.3 The NRC as Political Actor

E. Integration of Causal Components and Reflection

A. Rational Analysis and Problem Solving

The first theoretical tradition analyzes NRC behavior as a case of rational problem solving, the story of Commissioners engaged in a cooperative enterprise to develop a common understanding of the situation they faced and using all of their own resources, those of other agencies, and the best experts in the country, to make wise decisions. Essentially this sub project

will assess the view that, as one of our colleagues put it, They did about as well as anyone could have done under the circumstances.

To structure this analysis we will ask a technical consultant, working with project research assistants, to describe an ideal decision tree and processing algorithm for the most crucial issues the NRC Commissioners faced: 1) Diagnosis of the conditions inside the TMI reactor; 2) Whether to recommend evacuation (and the scope and nature of the evacuation). We will ask our consultant to answer seven questions for each issue (see also Janis and Mann, 1977, for a similar list):

1) What elements should have been in a decision maker s cognitive map of the problem?

2) What information should a decision maker have identified as crucial to a good decision?

3) What, at each point, were the additional information, testing of crucial assumptions, and staff work a decision maker should have sought with high priority?

4) What options did a decision maker have available and what were the probable consequences of each?

5) What degree of confidence should a decision maker have placed in his judgment?

6) What contingency plans should a decision maker have developed in the event he was wrong?

7) For each new piece of information received, what implications

should have been drawn to revise judgments, initiate new analyses and information searches, and develop new contingency plans?

We expect this rendering of a (retrospective) ideal decision procedure will be a matter of substantial agreement among specialists in nuclear engineering and nuclear disaster planning.[1] We will test this assumption by asking colleagues in these two fields to review the work. If they consider major points to be dubious, the budget allows for services of two additional independent consultants to provide a detailed critique.

A. Rational Analysis and Problem-Solving

A.1 Macro-Analysis of Deviations from Ideals and their Nature

The seven categories (above) will be used to describe rigorously the NRC s deliberations and major deviations from the normative model.[2] Given the complete record of both NRC meetings and of staff paper flow to and from the Commissioners, we expect this task to be time consuming but straightforward.

The NRC sometimes did high quality decision analysis in assessing conditions within the reactor: the transcripts show that some Commissioners were obviously familiar with the technical issues, knew the stakes involved, set events in motion

[1] Some preliminary work is reflected in Behn and Vaupel (1979).

[2] Two coders will perform this task independently, and we will discuss and reconcile any differences. The actual methodology will be to merge this process with basic Axelrod cognitive mapping (see Appendix A).

to monitor and refine understanding of many of the points that were crucial, and responded to new evidence that earlier assumptions were unwarranted. But there was major delay in the diagnosis process, at least before it was learned that the reactor core had been uncovered and a hydrogen explosion had occurred within the containment. At this point the Commissioners apparently recognized the situation was a serious crisis rather than a routine emergency scram of a reactor complicated only by mysterious safe level radiation release.

But for issues of health effects and evacuation planning there seem to have been major shortfalls in timely and systematic rational analysis: for example, serious lack of good communications among key actors, inadequate assessment of lead times (and geographic direction) for complete evacuation, delayed analysis of the advisable threshold for evacuating young children and pregnant women., delay in obtaining and supplying large quantities of potassium iodide to Pennsylvania health officials. (Potassium iodide is used to fill up the thyroid, blocking absorption of radioactive iodide, and is a first line defense in radiation emergencies involving isotopes of the kind produced at TMI.)

Beyond a detailed analysis of shortfalls in decision making, we will test three hypotheses with interviews:

1) The NRC began with strong Bayesian priors that the equipment was safe and that the operators were well trained to operate it in an emergency. (This is the understanding proposed, for example, by John Kemeny (1980).)

2) The NRC did not apply timely and systematic analysis to issues with which they or their immediate staff were unfamiliar

(e.g., alternate evacuation scenarios, the nature and scope of contingency planning and cooperation among Executive agencies, press relations).[3]

3) We expect that formal ambiguity about authority, responsibility, and legal standing restricted and bounded NRC information search, analysis, and initiative. We can cite, at this preliminary stage, two examples:

- There are 13 federal agencies whose resources are needed in a serious peacetime radiation emergency. Their coordination can be crucial in diagnosis and planning (e.g., passing radiation data collected by Department of Energy helicopter teams to Public Health Service radiation health specialists) and in evacuation planning (coordinating civilian and military capabilities to assist in moving people, especially those in hospitals). There was, at the time of TMI, an Interagency Radiological Assistance Plan (IRAP) to mobilize these resources rapidly for systematic rational analysis and contingency planning. But no key officials at the White House, HEW, or ERDA knew about IRAP or that DOE was to have become the lead agency (President s Commission Staff Report, Emergency Preparedness, Emergency Response, p. 28). The NRC designated by Carter assistant Jack Watson as the central actor (but without specifying fully their powers or responsibilities) did not initiate analysis of health

[3] We do not plan to construct a detailed ideal decision tree or processing algorithms for federal coordination or press relations because these are not technical or engineering issues and the degree of moderate to severe chaos in both cases, and especially federal coordination, is manifest from the record, and systematically analyzed (President s Commission Staff Report, Emergency Preparedness, Emergency Response, 1979).

effects and federal contingency plans. Such analysis occurred only because HEW Secretary Joseph Califano took independent initiative.

- A second example of how ambiguous responsibilities produced lags and shortfalls, and vague and unsystematic analysis, was the case of evacuation decisions. The NRC felt (in part) that it was Pennsylvania Governor Thornburgh s decision while he and his staff looked to the NRC as the decision making body best qualified to weigh the complex technical information and make a judgement.

A.2 Learning Processes within the Crisis

A major requirement of good rational analysis in novel situations is refinements and transformations, over time, of the cognitive maps which decision makers develop to process incoming information. (Etheredge, 1979, section 2, attached as Appendix B). A useful summary measure of such development is the integrative complexity of the cognitive structures of participants (Schroder, Driver and Streufert, 1967, as refined in Levi and Tetlock, 1980). Our analysis of the learning process will decompose NRC deliberations into four of the principal issues they addressed (diagnosis of TMI reactor conditions, evacuation, press relations, and interagency coordination agendas) and compute measures of the integrative complexity of the NRC s discussions of each issue.

The primary hypothesis (A.2.1) is that learning increased over time, within each issue. But we also want to explain what affects the rate of this learning, and we will test three further ideas:

- A.2.2. Increases in intelligence and sophistication (i.e.,

integrative complexity of analysis) are a function of conflict and disagreement in prior group discussions. This hypothesis will be tested by subjecting transcripts and tapes to Bales (1970) Interaction Process Analysis coding (with some additional refinement see hypothesis 4 in this section). Disagreement rates (assessed by this system) will be used to operationalize the independent variable; we will test alternative mathematical forms of the hypothesis (e.g., change in mean integrative complexity of statements about issue n during t + 1 (a five minute unit) as a function of disagreement rates in issue n discussion during t.)

- A.2.3. The effect of conflict and disagreement on learning rates will be a function of the emotional intensity with which disagreement is expressed. Two specific hypotheses are: a) a professional style hypothesis, disagreements expressed in calm, unemotional or technocratic ways will facilitate learning; b) learning will be affected curvilinearly by the emotional intensity of disagreements; it will proceed most rapidly when there is moderate emotional charge to disagreement and will be slowest when disagreements are unemotional or are passionate.

Emotional charge will be measured by evaluative assertion analysis (Osgood, Saporta, and Nunnally, 1956) of decision makers statements. This technique assesses the frequency with which speakers use value laden terms and the evaluative intensity of these terms.

- A.2.4. Learning is increased by prior self reflective commentary of group members that places their cognitive processes, moods, or personal interactions into perspective.

We will assess this by adding three new categories to the Bales coding procedure that will provide an additional score if the statement: (a) offers perspective or commentary on cognitive processes (b) offers perspective or commentary on group moods or emotional states; (c) offers perspective or commentary on group interactions.

B. Cognitive Processes

A second cluster of research traditions offers an alternative perspective on how the NRC responded to the TMI crisis. Here the focus will be on the specific nature of the decision rules employed by the NRC and on cognitive dissonance reduction processes.

B.1 Flow of Decision Processing and Nature of Decision Rules

An analysis of specific decision processes and rules will be based on separate coding for each of the four decision areas discussed earlier. For each we will reconstruct the actual decision processing rules by recording:

1) the options considered, the consequences of options considered, and the degree to which each option represents a significant departure from current policy;

2) the intensity of preference for options;

3) the times at which various options and consequences are discussed;

4) the values speakers implicitly or explicitly considered to be

ends in themselves;

5) each instance in which an individual acknowledges a trade off among values;

6) each instance in which two or more individuals disagree on the relative significance to be placed on conflicting values.

These data will allow the testing of four hypotheses of theoretical interest:

1) Incremental adjustments (Lindblom, 1959) will be preferred when the sense of crisis is low; as the sense of crisis increases, the preference for incremental responses will decrease (e.g., Wilson, 1966).

2) Early stages of deliberations will involve attempts to reduce the number of options by determining whether they meet a few salient or important criteria (a breadth first strategy Montgomery and Svenson, 1976; Slovic, Fischhoff, and Lichtenstein, 1977). Only when a few options remain will decision makers review options in depth (cf. Payne, 1976).

3) Participants with scientific backgrounds (e.g., Chairman Hendrie, Harold Denton, a key staff member) will be more likely to engage in analyses of probabilities and trade offs than will participants with less scientific expertise.

4) Decision makers will explicitly consider tradeoffs in evaluating the state of the TMI reactor and potential technical solutions, but will shy away from tradeoffs that involve conflicting, seemingly incommensurable, social

values (as in the evacuation decision when the desire to safeguard human life probably conflicted with the desires to avoid unnecessary expense, panic, and damage to public confidence in the nuclear industry) (Calabresi and Bobbitt, 1978).

B.2. Cognitive Dissonance Processes

The TMI crisis placed the NRC in an uncomfortable position since it was the NRC s job to ensure the safety of nuclear plants. Their competence and professional reputations were on the line, both to themselves and in this very dramatic case to the general public. The painful process of rethinking after public commitment may have been defensively resisted (Festinger, 1957; Abelson et al., 1968). If these processes occurred to a substantial degree, and inhibited decision quality, then there are important implications for assigning responsibility for crisis diagnosis and management to decision makers who do not simultaneously need to acknowledge past errors while making current assessments.

Using both interviews and transcripts of group deliberations, we will explore whether dissonance-reduction processes were occurring. We will examine the following issues:

1) Did decision makers try to justify their public commitment to the safety of nuclear power by minimizing the significance of the TMI incident? Did decision makers employ other strategies of dissonance reduction, (e.g., denying responsibility)? Finally, is there evidence of major individual differences in the amount of dissonance experienced or the reduction strategies employed (e.g., as a function of the degree of public commitment to the development of nuclear power)?

2) Did decision makers engage in post decisional bolstering (Festinger, 1964), e.g., by later downplaying or ignoring the existence of potential risks of a chosen option even when they had recognized the existence of tradeoffs prior to committing themselves to a policy?

C. Socioemotional Processes and Inhibitions

A third tradition of analysis focuses on socioemotional processes which aided or inhibited NRC decision making. We will draw upon three clusters of ideas: stress theories, tension management modeling, and group norms as determinants of the quality of critical analysis.

C.1 Stress Effects

Several lines of research including experimental studies (e.g., Schroder, Driver, and Streufert, 1967) and case studies of high level policymaking (see Hermann and Brady, 1972; Holsti and George, 1975, for reviews) suggest that the quality of decision making often deteriorates in crises. This finding is usually explained by noting that crises create threats to central values, and drastically increase both the perceived need to make many rapid decisions and the amount of information that must be quickly processed (Holsti, 1972). In these stressful circumstances, decision makers may adopt simple cognitive heuristics as guides to policy choice, repeat actions taken in prior situations, consider only a few options and emphasize short term over long term consequences of policies.

However the effect of crisis on decision quality is not necessarily deleterious. Crises may in some situations improve the quality of decision making by inducing individuals to rethink

old assumptions, seek new sources of information, abandon restrictive standard operating procedures, and attempt to construct new policy alternatives (Wilson, 1966; Brecher, 1978; Holsti and George, 1975; Janis and Mann, 1977).

How did the NRC s performance during the crisis differ from its non-crisis performance? To address this issue, we will sample NRC discussions from tapes of (about 200) non crisis meetings during the year before the TMI incident and compare these deliberations to those that occurred in crisis conditions.[4] By these comparisons, we can answer two questions:

1) To what extent were key policymakers experiencing stress during the TM events? Drawing on the literature on manifestations of stress (see review by M. Hermann, 1979), we have selected seven indicators to monitor stress levels (see Method Section, part two).

2) How did decision makers individually and collectively respond to the crisis? In examining this question, we will test predictions derived from theoretical models of individual and group responses to crises.

Janis and Mann (1977) have developed a refined theoretical model that distinguishes five patterns of individual coping with stress: unconflicted inertia, unconflicted change, defensive avoidance, hypervigilance, and vigilance. They describe the characteristics of each coping pattern and list factors that

[4] The nature of the pre-crisis sample will need to be determined by review of transcripts on file in Washington. We expect meetings will be divided into several substantive categories, and we will have to consider which provide the most appropriate baseline comparisons.

predispose decision makers to adopt one or another response. We propose to test this model s applicability to the NRCs decision making during the TMI crisis. Major hypotheses are:

1) When decision makers perceived no serious risks associated with the current policy, unconflicted inertia occurred.

2) When decision makers policy and no serious risks perceived serious risks associated with their current associated with an alternative policy, unconflicted change occurred. (As in the first case, decision makers will be strongly committed to their policy preferences and analysis will tend to be half hearted and superficial.)

3) When decision makers perceived serious risks associated with their current policy and were not optimistic that better solutions could be found, defensive avoidance occurred. Manifestations would include procrastination, discussions that go around and around in circles, denial of responsibility (buckpassing), and bolstering (generating as many justifications as possible for the preferred option).

4) When decision makers perceived serious risks associated with their current policy, and the available alternative, and felt that they did not have enough time to find a better solution, hypervigilance occurred. Decision makers will shift their policy preferences, sometimes erratically. Decision making will be unsystematic and poorly organized, although the search for alternative policies will be more active than in the three previous conditions.

5) When decision makers perceived serious risks associated with their current policy, and the available alternatives, but felt that they had adequate time to find a better solution, vigilance will occur. Of the five coping patterns, vigilance most closely corresponds to the normative procedures of rational analysis.

We will use interviews and the transcripts to identify signs of these five coping patterns for each Commissioner. As Janis and Mann (1977) recommend, we will assess subjective belief indicators of each coping pattern (perceptions of time pressure, optimism pessimism concerning the possibility of a better solution, satisfaction dissatisfaction with available options), vacillation in policy options, and indicators of the quality of decision making (number of policy options considered, range of risks and benefits considered, receptivity to new information, development of contingency plans, growing disparity between actual and ideal decision trees - see subproject A.1 and B.1 analyses).

The coping patterns identified for each Commissioner would, however, be an incomplete portrayal of the quality of group decision making without taking into account the effects of group interaction processes.

One theoretical approach to understanding group interactions and decision making under stress is Janis (1972) groupthink analysis. Janis suggests that, under certain circumstances, groups of decision makers will display strong tendencies toward concurrence seeking, valuing the maintenance of group cohesion and solidarity over independent, critical analysis. Although our preliminary reading of the record indicates that a groupthink syndrome did not emerge here, we will include a careful search

for antecedent conditions and symptoms of groupthink in our analysis of transcript and interview data.

Antecedent conditions include: (1) high cohesiveness; (2) insulation of the group from external critics; (3) lack of methodical procedures for search and the appraisal of alternative policies; (4) directive leadership; and (5) high stress with little hope for finding a better solution than the one favored by the leader or other influential group members.

If these antecedent conditions are present, the following symptoms of groupthink should occur: (1) an illusion of invulnerability; (2) collective rationalizations of the dominant policy; (3) a belief in the inherent morality of the group; (4) stereotyping of out groups (e.g., the press, the Pennsylvania state government); (5) direct pressure on dissenters within the group; (6) self censorship of doubts; (7) an illusion of unanimity; (8) the emergence of self appointed mind guards to enforce the group consensus.

At the moment our impression is that groupthink did begin to emerge in the early stages of deliberations only to disappear as more actors and other agencies became involved and the NRC became a more open system (Katz and Kahn,1978). If this is true, one important contribution of this study will be to identify a boundary condition for the occurrence of groupthink, namely that secrecy and group isolation are preconditions for this syndrome to emerge.

Appendix A discusses in more detail the operational indicators we will use to identify group responses to stress.

C.2 Tension Management Modeling

An idea we are interested in testing is that, in a crisis, the presence of people who are cool, self confident and thoughtful calms others, especially when the calmer person is of high status. We will test the proposition that stress levels vary partly as a positive function of the stress level of the previous speaker, with the effect being greater when the previous speaker is Chairman Hendrie.

C.3 Effects of Group Norms

A third set of propositions draw from research suggesting that specific role expectations and norms either facilitate or block critical analysis within organizations (Etheredge, 1979; Argyris and Schon, 1978; Argyris, 1967; Wildavsky, 1978). The project will test two descriptive propositions by content analysis and seek necessary additional evidence through interviews:

(1) NRC staff present at Commission meetings showed significantly lower rates of expressing disagreement than did the Commissioners themselves.

(2) NRC staff present at Commission meetings were significantly less likely to express views about the values at stake in the discussion.

D. Power Relationships

Drawing upon a fourth cluster of relevant theory, the project will analyze the effects of power relationships on internal NRC decision processes and on how the NRC sought to influence elite actors and audiences outside itself.

D.1. Outside Impact on NRC Decision Processes

One clear index of outside impact on the NRC is the capacity to determine the NRC s agenda. The transcripts reveal three types of interruptions or postponements of NRC deliberations: phone calls, outside meetings, and preparation of responses to the press. NRC deliberations were frequently interrupted by phone calls (recorded, via a speaker telephone, and incorporated into the transcripts), and NRC meetings were sometimes postponed to allow Commissioners to attend other meetings. To determine who had the standing to interrupt or postpone NRC meetings in these ways, we will use the transcripts and later testimony that provide, for all main actors, a detailed account of what they did. Another major interruption of NRC meetings were press stories that the NRC felt required an immediate response. Debates about how to word press releases sometimes lasted several hours. We will measure the time spent on wordings of such press statements and the number of occasions when other deliberations were interrupted to draft responses to news reports.

We expect to find that three groups of actors readily interrupted NRC meetings and introduced issues to which the NRC gave high priority: the White House (especially President Carter, Jody Powell, and Jack Watson, who was named midway through the crisis as the White House coordinator of Executive branch responses); Governor Thornburg of Pennsylvania and the national press which, with its deadlines and reports, introduced issues that became immediate concerns.

We know of no major influences on the NRC which are not part of the public record. (the tapes, the paper flow inventory, and statements to investigating bodies). We will, however, question each Commissioner about the phone calls he made or received, and the meetings he had outside of the formal NRC sessions. Conceiv-

ably, substantial pressure and important exchanges occurred behind the scenes.

D.2 Power Relationships Within the NRC

In this step the project will analyze the (partly independent) concern of who in the NRC had influence in its deliberations. The analysis will be at two levels: first, the individual level; second, the level of coalitions.

- D.2.1. Personal Power

The NRC discussed and reached decisions on four major types of substantive issues: (a) what was happening within the TMI reactor; (b) whether to order evacuation; (c) what to say to the press; (d) interagency coordination initiatives. We will treat each issue separately because we expect that the power of individuals differed by issue.

The power of individuals can be assessed in numerous ways (e.g., Barber, 1966). We will use four indices: reputation for power (determined by interviews), agreement rates (both the total number of proposals from an individual which were accepted and the percentage of an individual s proposals accepted), veto power (the total number of proposals opposed by an individual that were ultimately defeated and the percentage of opposition statements tnat were effective), and agenda setting power (the total amount of time spent on issues or considerations introduced by x and the average amount of time spent on a consideration or issue introduced by x).

Hypotheses

Basic hypotheses for investigation are:

1. For technical issues those with technical expertise exercised most influence. (Harold Denton on the NRC staff, for example, appears to have been highly influential in affecting thinking about the state of the reactor.)

2. For non technical concerns the Chairman had more influence than the other four Commissioners and the five Commissioners had more influence with one another than did the staff members present.

3. Among Commissioners, aside from the Chairman, influence was a function of numbers of years of service on the NRC. It should be noted here that the NRC is nominally a collegial body with no special power accorded to the Chairman. It typically acts by majority vote. For reasons which are unclear for the moment, it seems to have favored an implicit rule during TMI that it must reach unanimity before acting. This implicit rule gave substantial power to veto or delay action to any one Commissioner, and much of the power of Commissioner Kennedy in opposition to an evacuation order seems to have come from this sense that unanimity was necessary.[5] Exploring why this unanimity rule came about will have a high priority in interviews. Our working

[5] While many of our research traditions are grounded in the study of small group behavior, we recognize that small group dynamics may not have been the only, or indeed the principal, causal processes. It may be partly an individual story for example, Commissioner Kennedy was a consistent, strong opponent of evacuation, even when others advocated it; it may be that his personal attitudes or decision processes, partly exogenous from the TMI debates, were crucial determinants. And the NRC meetings at times may have functioned simply as an arena where five Commissioners, each with his own network of contacts and constituencies, primarily represented the views and concerns of powerful actors or groups who were not physically present,

hypothesis is that it arose from three concerns: (1) the personal uncertainty of Commissioners in the face of ambiguity which made it seem important to have strong mutual support as an indicator to themselves they were acting rightly; (2) impression management concerns which made it important to act with unanimity to have credibility during the crisis. (At one point the NRC was on the verge of announcing that, by the vote of 3 2, it felt evacuation was unwarranted and then seemed to pull back from this action as a result of consideration of how this divided vote would look to others); (3) the desire to maintain good personal working relationships in the NRC in the long run which made it inadvisable to act in the face of strong opposition from any one member.

There is one additional issue we can study, although perhaps we cannot resolve it. A principal belief of the Kemeny Commission (President s Commission, 1979) was that one strong, formal leader would improve crisis decision making. We can test whether those sessions at which Chairman Hendrie was present (or perhaps better, Harold Denton, who may have functioned as an emergent task leader cf. Bales (1970)) were more productive as indexed by low deviation from ideal decision trees, number of options considered, depth of option analysis, contingency planning, accelerated learning rates, and lower stress levels.

- D.2.2 Coalition Power

The next step in systematic analysis involves attention to the potential power of coalitions: 1) Were there coalitions within the NRC? 2) If so, who held the balance of power?

The first question can be answered by taking each issue considered and tabulating who, in the first five minutes after a

proposal was introduced, tended to agree with one another. The second question can be answered by measuring the amount of time between the announcement of a view by any Commissioner (after the initiator) and the final resolution of a issue. That is, we will ask whether any Commissioner s support served as a swing vote that speeded group acceptance of a position or decided the direction of movement.

Hypotheses

We will test two specific hypotheses: (1) Commissioners Hendrie and Kennedy were more conservative in assessing reactor damage and danger to the public and more opposed to evacuation, whereas Commissioners Gilinsky and Bradford were more inclined to infer serious risk and the need for evacuation: and (2) Commissioner Abearne was often the swing vote so that his announced position often produced movement and signaled the eventual outcome of a deliberation.

(Our impression is that strong coalitions, horse trading and tough bargaining between coalitions were not present, but we will be alert to indications of tacit bargaining e.g., modifying language or taking intermediate positions in order to achieve full consensus).

- D. 3 The NRC as Political Actor

A third analysis in this fourth step will look at NRC behavior in two further respects: first, the formal power of the NRC (and its informal standing) as a determinant of its decision processes; second, the ways the NRC shaped its decisions to influence other elite actors and various audiences.

D.3.1. The Power of the NRC as Shaping its Decision Processes

The formal and informal power of the NRC appears to have had considerable impact on the decision making processes. Primarily, the power was informal, produced by the press and by the abdication of others. Legally, the NRC did not directly run the reactor, did not have the power to order (or prevent) evacuation, and did not have the power to control news reports. It did have greater technical expertise than other actors, it had far more credibility than the reactor operating company or its manufacturer, and it did have national prominence as the highest official body with long term responsibility for the safe construction and operation of nuclear plants. We expect that these factors, especially the news media s attention, were more important than formal power in making the NRC a prominent actor. Conversely, the prominent role of the NRC partly arose because other potential actors stayed out - Governor Thornburgh, for example, apparently did not have the expertise at his disposal to feel he could act confidently. Most important, the White House handled the issue as a low key affair - first because it became involved in an unusual way (through a phone call from Commissioner Gilinsky to an acquaintance on the National Security Council Staff, which led to National Security Advisor Brzezinski becoming an early actor despite his lack of expertise in this area). No one on the White House staff seemed to feel competent to second guess the NRC. Nor did President Carter apparently want to assert control (Martin, 1980).

As we noted in our early discussion of rational analysis, ambiguities about formal power and responsibility likely had a crucial impact. We also expect the NRC did not want a

great deal of power or try to use it, even when they needed to use it to meet fully the demand of good analysis.

- D.3.2. Power Impact Concerns in Decision Making

To say that the NRC did not want to maximize its power is not to say that the NRC was unconcerned with the impact of its decisions. On the contrary, we expect that the NRC cared both to maintain its own credibility and to minimize damage to the long term prospects of nuclear power in the United States.

D.3.2.1. Impression Management

A significant body of literature (e.g., Schlenker, 1980) implies that people decide on actions by considering how other people will react, or more specifically, how it will look in the press and to various other significant audiences. The argument is that people will draw back from decisions that will put them in a bad light and tend to take positions that are acknowledged to be defensible.

Whether the NRC did act from these concerns can be partly discerned from the transcripts. In fact, transcripts are now available because such taping is done routinely and the NRC, noting this early in its deliberations, decided not to stop the recorders on the ground that turning off the recorders would imply a unwillingness to be accountable to the public. There are many references in the transcripts, especially in discussing press releases, to how people will react, the problem of how to retain credibility.

We cannot, however, hope fully to probe this area from transcripts because, by their very nature, true Machiavellian strategies and sensitivities would probably have been implicit

(and rationalized) in the public sessions rather than directly discussed. Self editing of arguments and implicitly calculated self-presentation could simply be second nature to these five Commissioners by now. We will raise the subject in interviews, particularly with Washington reporters who covered the NRC and who may be especially alert to impression management concerns.

D.3.2.2 The Politics of Nuclear Power

The TMI incident and its handling raised doubts not only about the credibility of the NRC, but also about the credibility of the nuclear power industry and the alleged safety of nuclear plants. Almost immediately critics of nuclear power began to talk, loudly, about TMI as absolute proof that nuclear plants are unsafe. It would be obvious to any Commissioner that much more was at stake than just a risk to people around the plant. Arguably, this dramatic visibility could have made those Commissioners favorable to long run nuclear development evacuate at a lower threshold to minimize the risk of any harm to people. But, more likely, a political judgment would have been to low key the crisis, wait it out, not over react, keep a public show of confidence in the safety of the equipment lest the doubts of the NRC itself be a general cue for everyone to desert nuclear power.

By their very nature these concerns might not be ones that would be expressed in public because the specter of an NRC Commissioner trading off risk of harm to people around TMI for political reasons would have been occasion for public outrage (Calabresi and Bobbitt, 1978). This consideration may have been so important that no one needed to discuss it or mention anything about it. All we know at the present is that Newsweek (Mathews, 1979) reported that a White House aide urged an aide to Governor Thornburgh not to evacuate people because of this consideration.

The White House denied the report (as would be expected whether it was true or false.) We plan to pursue this issue in interviews: indeed it may have been a political (White House) decision to low key the affair that sustained the odd NRC channel and delayed coordination and use of IRAP for federal emergency mobilization.

E. Integration

Most systematic public policy case studies have been used to exemplify one to three theoretical models (e.g., Allison, 1971; Steinbruner, 1974; Andersen, 1979); most quantitative hypothesis tests of behavioral decision theories have involved only bivariate models or bivariate relations with one mediating variable (cf. Slovic et al., 1977; Hare, 1976; Janis and Mann, 1977). At this level the previous hypotheses can be tested straightforwardly. However, the hope of this project, in the spirit of Verba (1961), is to do all existing social science can do to make sense of a case in which ten (or more) types of processes, perhaps differing in weights for different individuals, were occurring simultaneously and were interacting.

We cannot say, at this stage, how these various processes are interrelated: it will probably be well into the second year of the study before we have sufficient feel for the data to begin developing models for these connections - and for those group processes which truly are unconnected (March and Olsen, 1976; Sproul et al., 1978). The budget includes funds for such exploratory data analyses and for testing time series and simultaneous equation models in the third year.

We have, at the moment, two guidelines. First, it seems to

us that the main story will be of people, who, initially, do not have standard operating procedures or scripts (we have not included Allison s (1971) and other theories of organizational routines and bureaucratic politics for this reason.) We expect our story will be one of emerging coherence, a process of learning what is going on in the face of stress and ambiguity, and of developing cognitive maps, consensually supported scripts (Schank and Abelson, 1977), sense of perspective, and high quality decision processing that, ideally, should have been there from the beginning. By the end, we think they could have done it over again and done it better. Second, we expect there will be significant individual differences in such learning rates so that disaggregated analysis by individuals is required as well as modeling that takes the group as the unit of analysis.

As we ourselves learn more about the NRC s behavior, we will have available earlier conceptual work on causal processes occurring at different levels within individuals (Smith, 1968; Etheredge, 1976, appendix C of this proposal) and multiple interactions in individual learning processes in organizations (Etheredge, 1979, appendix B of this proposal) which we can draw upon to guide our theorizing about underlying processes. In addition, the Alker group at M.I.T. has been especially concerned with developing formal modeling alternatives and hypothesis testing procedures that are free of the limitations of those linear model correlation analyses that are ahistorical and assume - hopefully wrongly, from our perspective - that data point relations are unaffected by the specific order in which they occur. The Alker group s perspective is especially attractive to us because if, by the end of the crisis, the NRC Commissioners would have behaved differently if they had to do it again, we want to employ formal models that are capable of capturing the evolution of the NRC s approach to the crisis and to test these

models with appropriate statistical assumptions. As the Alker group s work becomes more refined, and their set of new programs are developed and become available, we anticipate fruitful collaboration between our two groups by the 1984-1985 integrative modeling phase.

Part II:
Methods and Work Plan

A. Methods Overview

The depth and scope of this study, a state of the art analysis of NRC decisions (and non decisions) drawing on diverse theoretical literatures, is partly inspired by the abundance of evidence. This study is possible because tens of thousands of hours have already been spent to assemble the basic data: in quality, detail, and scope they are unprecedented. Fleshed out by additional interviews with key actors and observers while memories are still fairly fresh, it offers an opportunity for a full scale test, and both potential refinement and integration, of theories of group decision making processes that is unlikely to reoccur. The scope of evidence is reflected in the following sources of data upon which we will draw:

1. NRC tapes and transcripts from its TMI meetings.

2. Tapes and transcripts from about two hundred non crisis NRC meetings held during the year prior to the TMI crisis. Samples from these will provide explicit base rates for non crisis decision behavior.

3. Self critical appraisals of NRC Commissioners embodied both in their testimony to the Kemeny and Congressional investigations and in five NRC sessions after the crisis devoted to assessing lessons from their experience.

4. The NRC s files of about 2,000 TMI crisis briefing memos, press conference transcripts, etc. Under the Freedom of Information Act every significant piece of paper referring to any aspect of the crisis has been inventoried, described, and copies

are available. Thus we can track all memos received or written by Commissioners during the crisis (NRC, Title List, rev. 1, 1979).

5. Descriptions and causal hypotheses about NRC behavior included in the Kemeny Commission report and its staff reports (e.g., President s Commission, 1979) and by social scientists (e.g., Sills et al., 1982).

6. Appraisals of NRC performance, and causal explanations, provided by key NRC staff members to investigatory bodies.

7. Interviews with NRC Commissioners, staff, former members of the Kemeny Commission and its staff, and with journalists covering NRC deliberations.

8. Technical analysis provided by the NRC staff (NRC, Lessons Learned...), the Kemeny staff (Presidents Commission Staff Reports, 1979) and academic and industry analysts (e.g., Martin 1980; Sills et. al., 1982, pp. 235 243) detailing exactly what was happening inside the TMI reactor. These post mortem analyses, drawing on second by second printed records from the TMI monitor computer, will be a crucial aid to checking, at each point, the realism of the assumptions and inference processes of the NRC. The diversity of theoretical concerns mandate a broad range of methods. In this narrative we provide a summary: Appendix A provides further detail on content analysis methods to be employed.

B. Interviews

The psychological, social, and political processes outlined in the preceding section will be explored by interviews in

Washington during the first year. Principal interviews will be with the Commissioners, their key staff (including special assistants and members of the Secretariat), and news reporters covering the NRC. Supplementary interviews will include the senior investigatory staff of the Kemeny Commission and Governor Thornburgh and other Pennsylvania officials.

C. Document review

Copies of depositions (average 100 150 pages) of key NRC actors to the Kemeny Commission, and their testimony to Congressional inquiries, will be obtained and cross indexed for all references to NRC behavior. The technical literatures will be reviewed separately by our consultant. Copies of all memos and briefing papers to and from Commissioners and of press conference transcripts will be reviewed to identify evidence bearing on the hypotheses.

D. Content Analysis Coding

As a basis for budget estimates we have conducted a trial run to assess the required coding time. Estimates are expressed in ½ R.A. semester equivalents **(=** 260 hours); in the Berkeley sub contract budget these figures are translated to ½ R.A. quarter equivalents (3 quarters 2 semesters 520 hours).

There are nine primary coding tasks:

1. Descriptions of elements and steps of rational analysis and decision making in 7 categories for reactor and evacuation issues (A.1).

2. Integrative complexity coding of statements dealing with reactor, evacuation, press relations, and interagency

coordination issues (A.2).

3. Bales (1970) Interaction Process Analysis, with three additional subcategories.

4. Evaluative assertion analysis coding for each statement. (Osgood, Saporta, and Nunnally, 1956).

5. Classification of decision processing rules (B.1) by five categories (breadth first versus depth first preferences in option processing: compensatory versus non compensatory processing; degree of incremental shifts in preferences; intensity of policy preferences (Brecher, 1975); end values, (Axelrod, 1977)).

6. Seven indicators of stress levels (C.1.): flustered speech, speech rate, unfilled pauses, irritability, excitation level, mood, and self report.

7. Agenda time allocation assessed by issue, by initiator, and by ability to preempt attention (D.1., D.2.).

8.Summary codes of the flow of advocacy, agreement and disagreement by individuals with record of the prevailing decision (or non decision).

9. Excerpting of all statements reflecting impression management (e.g., credibility) concerns.

The first eight tasks require listening to the tapes. One task (task 6 stress coding) requires coding of both the TMI tapes and an (approximately equal) sample of non crisis tapes.

These coding tasks can be grouped and accomplished in a smaller number of passes through the tapes and transcripts. Task 1 will require one pass. Tasks 2 and 5 can be done together. Tasks 3, 4 , and 6 each involve distinctive coding concerns and require separate passes. Tasks 7, 8, and 9 can be done together. With 6 coding passes and about 65 hours of listening per pass, we estimate 390 hours of research assistant listening time will be required. For basic coding we take this figure and double the estimate for task 1 (as increasingly complex cognitive maps will need to be constructed **(=** 455 hours), and we add 20 hours/pass for coder training (455 + 120 = 575). We estimate 35% of this total to do comparison coding of a smaller sample of non crisis tapes (575 + 200 = 775 hours). Finally, we add an additional 1/3 to this total to allow for reliability checks, the likely need to train several part time coders for some tasks, and training required by changes in coder personnel (775 + 260 = 1,035).

Estimating 260 hours for a 50% Research Assistant for a semester, the budget provides for four, 50% Research Assistant semester equivalents for basic coding.

For the 3 years of the project, we will also need a 50% R.A. slot for data base management, assistance with document review and cross indexing and statistical work, and we add a second 50% R.A. slot for the intensive statistical work during **3** semesters and a summer.

The research assistance budget, then, provides for 12 50% R.A.. semester equivalents and 12 months (summer) 50% R.A. work.

Of remaining support staff costs, the budget calls for a full time secretary for 1 semester (to convert the transcripts

into a machine readable data base and transcribe Washington and Harrisburg interviews) and temporary assistance for later manuscript typing.

During the 1982 83 academic year, Etheredge will devote 2/3 time to the project, without cost, while at the Center for Advanced Study in the Behavioral Sciences. During this year, the budget provides for 100% release time for one academic quarter for Tetlock for joint work in developing coding protocols and training the team coders. In subsequent years, the budget provides for 100% time by both Etheredge and Tetlock for 2 months in the summers. Travel provides for joint interviewing in Washington, additional interview work by Etheredge in Harrisburg, and two consultation meetings a year in the second and third years.

The budget provides for a micro computer, serial printer, and word processing and data base management software as a cost effective way to develop and maintain the multiply coded data base and perform basic statistical analysis. Advanced statistical work, exploration of computer graphics to portray and report multi level interactions and artificial intelligence integrative models will call for increased use of mainframes in later stages.

E. Chronological Work Plan

Etheredge and Tetlock will share joint responsibility for developing coding procedures. Tetlock will assume primary responsibility for supervision of coding work and bivariate hypothesis tests. Etheredge will assume primary responsibility for review of government and academic reports, interviews, the construction of integrated coding of the data base, and the conceptual integration work. Both will share equally in the

drafting of publications and the final report.

- Oct.1, 1982 Jan. 15, 1983
Etheredge and Tetlock do preliminary pass of tapes and transcripts to structure and refine coding procedures. Review of basic testimony, reports, and hearings to plan interviews. Full time secretary transfers transcripts to master file.

- Jan. 15, 1983 May 31, 1983
Hiring and training of coders. Coding begins. Technical consultant engaged for ideal decision tree analysis. Release time supports supervision and monitoring of coding with more complex coding supervised by Tetlock with psychology graduate research assistants. Etheredge interviews in Washington (joined by Tetlock for interviews with key actors and for review of non crisis tapes), in Harrisburg, and works at the National Archives.

- June 1, 1983 Aug. 31, 1983
Coding work will be substantially completed with independent reliability checks; complete codes are transferred to master computer file and transcripts are annotated. Interviews and review of documents completed and cross reference file developed in machine readable form for later transmission to ICPR.

Sept. 1, 1983 May 31, 1984
Quantitative hypothesis testing of bivariate hypotheses substantially completed. Drafting of initial publications from this phase.

June 1, 1984 Aug. 31, 1984
Completion of bivariate hypothesis reports, outline developed for integrative multivariate model and work begun. Any necessary supplementary interview work completed.

Sept. 1, 1984 Sept. 30, 1985
Completion of multivariate modeling and hypothesis testing. Drafting, revision, and completing of final report and training package. Full annotation and cleaning of machine-readable file of transcripts and documents index completed for transmission to ICPR archives.

References

Abelson, R. P., Aronson, E., McGuire, W. J., Newcomb, T. M., Rosenberg, M. J., Tannenbam, P. H. (Eds.) Theories of Cognitive Consistency: A Sourcebook. Chicago: Rand McNally, 1968.

Allison, G. T. Essence of Decision: Explaining the Cuban Missile Crisis. Boston: Little, Brown, 1971.

Andersen, D. F. Mathematical models and decision making in bureaucracies: A story told from three points of view. Unpublished doctoral thesis, MIT Sloan School, 1977.

Argyris, C. & Schon, D. Organizational Learning: A Theory of Action Perspective. Reading, Mass.: Addison Wesley, 1978.

Axelrod, R. (Ed.) Structure of Decision. Princeton: Princeton University Press, 1976.

Axelrod, R. Argumentation in foreign policy settings. Journal of Conflict Resolution, 1977, 21 727 755.

Bales, R. F. Personality and Interpersonal Behavior. New York: Holt, Rinehart & Winston, 1970.

Barber, J. D. Power in Committees. Chicago: Rand McNally, 1966.

Behn, R. D. and Vaupel, J. **W**., Fighting theNext War: Or preparing to Analyze Next Crisis. Duke University: Center of Policy Analysis, 1979, mimeo.

Brecher, M. Decisions in Israel s Foreign Policy New Haven: Yale University Press, 1975.

Brecher, M. Studies in Crisis Behavior. New Brunswick, N. J.: Transaction Books, 1978.

Calabresi, G. and Bobbit, H. Tragic Choices. New York: Norton, 1978.

Dollard, J. & Mowrer, 0. H. A method for measuring tension in written documents. Journal of Abnormal and Social Psychology, 1947, 42, 3 32.

Duncan, S. D.& Fiske, D. W. Face to Face Interaction: Research, Methods and Theory. Hillsdale, N. J.: Erlbaum, 1977.

Etheredge, L. S. The Case of the Unreturned Cafeteria Trays. Washington: American Political Science Association, 1976.

Etheredge, L. S. Government learning: An overview. To appear in S. Long (Ed.), Handbook of Political Behavior. New York: Plenum. In press.

Festinger, L. A Theory of Cognitive Dissonance. Evanston, Ill.: Row, Peterson, 1957.

Festinger, L., Conflict, Decision, and Dissonance. Stanford: Stanford University Press, 1964.

Goldman-Eisler, F., The significance of changes in the rate of articulation. Speech, 1961, 4 , 171-174.

Hare, A. Paul. Handbook of Small Group Research. 2nd ed. New

York: Free Press, 1976.

Hermann, C. F. & Brady, L. P. Alternative models of international crisis behavior. In C. P. Herman (Ed.) International Crises: Insight from Behavioral Research. New York: The Free Press, 1972.

Hermann, M. G. Indicators of stress in policymakers during foreign policy crises. Political Psychology, 1979, 1 , 27 46.

Holsti, 0., Time, alternatives and communications: The 1914 and Cuban missile crises. In C. F. Hermann (Ed.), International Crises: Insights from Behavioral Research. NY: The Free Press, 1972.

Holsti, 0. & George, A. L. The effects of stress on the performance of foreign policy makers. In C.P. Cotter (Ed.), Political Science Annual: Individual Decision Making. Indianapolis: Bobbs Merrill, 1975.

Janis, I. L. Victims of Groupthink. Boston: Houghton Mifflin, 1972.

Janis, I. L. & Mann, L. Decision Making. New York: The Free Press, 1977.

Kasl, S. V. & Mahl, G. F. The relationship of disturbances and hesitations taneous speech to anxiety. Journal of Personality and Social Psychology, 1965.

Kemeny, J. Saving American democracy: The lessons of Three Mile Island. Technology Review, 1980, June/July, 65 75.

Lasswell, H. The structure and function of communications in

society. In L. Bryson (Ed.), Communication of Ideas. New York: Harper, 1978.

Levi, A. & Tetlock, P. E. A cognitive analysis of Japan s 1941 decision for war. Journal of Conflict Resolution, 1980, 24 195 211.

Lindblom, C. E. The science of muddling through. Public Administration Review, 1959, 19, 79 88.

Maclay, H. & Osgood, C. E. Hesitation phenomena in spontaneous English speech. Word, 1959, 15, pp. 19 44.

March, J. G. & Olsen, J. P. Ambiguity and Choice in Organizations. Berson, Norway: Universitetforlaget, 1976.

Martin, D. Three Mile Island: Prologue or Epilogue. Cambridge, Mass.: Ballinger, 1980.

Mathews, T. et al. Cooling off the crisis. Newsweek, April 16, 1979.

Montgomery, H. & Svenson, 0. On decision rules and information processing strategies among multiattribute alternatives. Scandinavian Journal of Psychology,1976, 17, 283-291.

NRC, Title List - Documents Pertaining to Three Mile Island Nuclear Reactor, rev. 1. Washington Nuclear Regulatory Commission, 1979.

Osgood, C. E. & Saporta, S. & Nunnally, J. C. Evaluative assertion analysis. 1956, Litera, 1956, 3, 47 102.

Osgood, C.E. Walker, E. Motivation and language behavior: A content analysis of suicide notes. Journal of Abnormal and Social Psychology,1959, 59, 58 67.

Payne, J. W. Task complexity and contingent processing in decision making: An information search and protocol analysis. Organizational Behavior and Human Performance, 1976, 16, 366 367.

Perrow, C. The President s Commission and the Normal Accident. In Sills et al. (Eds.), pp. 173 184.

President s Commission on the Accident at Three Mile Island. The Need for Change: The legacy of TMI. Washington & U. S. Government Printing Office, 1979.

President s Commission Staff Report, Emergency Preparedness, Emergency Response. Washington: U.S. Government Printing Office, 1979.

Schank, R. C. and Abelson, R. R. Scripts, Plans, Goals and Understanding. Hillsdale, N. J.: Erlbaum, 1977.

Schlenker, B. R. Impression Management: The Self concept, Social Identity and Interpersonal Relations. Belmont, Ca: Brooks/Cole, 1980.

Schroder, H. M., Driver, M. J. & Streufert, S. Human Information Processing. New York: Holt, Rinehart & Winston, 1967.

Sills, D., Wolf, C., and Shelanski, V. (Eds.) Accident at Three Mile Island: Human Dimensions. Boulder, CO:: Westview Press, 1982.

Slovic, P., Fischhoff, B. & Lichtenstein, S. Behavioral decision theory. Annual Review of Psychology, 1977, 33, 1-39.

Smith, M. B. A map for the analysis of personality and politics. Journal of Social Issues, 1968, 24, 15 28.

Sproull, Weiner S., and Wolf, D. Organizing an Anarchy. Chicago: University of Chicago Press, 1974.

Steinbruner, J. D. The Cybernetic Theory of Decision. Princeton: Princeton University Press, 1974.

Suedfeld, P., Tetlock, P. E., & Ramirez, C. War, peace and integrative complexity: U.N. speeches on the Middle East problem, 1947 1976.Journal of Conflict Resolution, 1977, 21, 427 441.

Tetlock, P. E. Identifying victims of groupthink from public statements of decisionmakers. Journal of Personality and Social Psychology, 1979, 37, 1314 1324.

Tetlock, P. E. Integrative complexity as a variable in political decision making. Paper presented to the annual meeting of the International Studies Association, 1980.

Verba, S. Small Groups and Political Behavior. Princeton: Princeton University Press, 1961.

Wildavsky, A. The self evaluating organization. In J. M. Shafritz & A. C. Hyde (Eds.) Classics of Public Administration. Oak Park, Ill.: Moore Publishing Company, 1978, 412 427.

Wilson, J. Q. Innovation in organization: Notes toward a theory. In J. D. Thompson (Ed.) Approaches to Organizational Design.

Pittsburgh: University of Pennsylvania Press, 1967.

Appendix A

Extended Description of Systematic Content Analysis Methods

To address the wide variety of issues and hypotheses discussed previously, we plan to use a wide variety of coding systems.[1]

We organize our description of them around the following topics: (1) techniques designed to capture and represent the policy issue encoding and decision processes of the NRC; (2) techniques designed to capture socioemotional processes occurring during the deliberations.

1. Assessing Perceptions of Issues and Options

Here the focus is on what decision makers perceived to be happening in the world around them, what they perceived to be the policy options open to them, and what they perceived to be the probable consequences of these options. We will rely heavily on cognitive mapping to address these issues.

1.1 Cognitive Mapping Cognitive mapping (Axelrod, 1976, 1977; Levi & Tetlock, 1980) is a technique for representing the causal assertions contained in a decision maker s arguments. Cognitive maps consist of two basic elements: concept variables, represented by letters, and causal relationships, represented by arrows that connect concepts to each other. A concept variable is coded as exerting a causal influence on another variable when a change in the former variable is stated to result in a change (positive or negative) in the latter variable. For instance, the

[1] Bibliographic references are incorporated in the bibliography of the project narrative.

statement Failure to evacuate persons within 5 miles of TMI reduces our ability to save lives in a sudden emergency would be coded:

A---- B

where A refers to the policy of failing to evacuate and B refers to our ability to save lives in a sudden emergency . Concept variables that are implicitly or explicitly stated to be relevant to important values are coded as value assertions in which the connecting arrow leads from the concept variable to another variable designated utility . For instance, the above example would be treated as having an implicit value assertion linking our ability to respond in a sudden emergency to utility . (See Axelrod, 1976, for more detailed discussion of specific coding rules and how to handle more ambiguous cases.)

We will adapt and refine Axelrod s procedures in several ways. In our coding, we will distinguish several types of concept variables - policy option variables (e.g., don t evacuate anyone, evacuate only pregnant women and preschool children, evacuate everyone within 5, 10, or 20 miles of the reactor, policy consequence variables (e.g., panic, loss of life, loss of public confidence, economic dislocation, costs) and state-of-the-world variables (e.g., what has happened in the TMI reactor, how much radiation has leaked out and may leak out in the future). We will also use a special coding convention for representing interactive causation (Levi & Tetlock, 1980). Interactive causation occurs whenever two or more variables in combination are said to produce an effect. In such cases, the appropriate unit of analysis is no longer the isolated causal variable; it is a network of variables. For instance, a speaker might observe that if events D, E, and F occur in the TMI

reactor, then there will be a high probability of G (say, a core melt-down). This would be coded:

D ------- G

E

F

In subproject A.l (project narrative) we will construct cognitive maps for each uninterrupted statement made by the key actors during the pre-crisis periods. If Harold Denton made 15 such statements in the relevant time periods, we will develop 15 corresponding maps. There are several reasons why, here and for later subprojects, it is desirable to develop separate maps at this level: (1) to identify shifts in decision makers perceptions as a result of stress, new information, and learning; (2) to identify who agrees with whom at what time; (3) to identify who proposed which policy options, when, and for what expressed reasons.

Working from this extremely detailed data base, we will construct overall cognitive maps for each key decision maker (i.e., a map that summarizes the decision maker s overall view of the situation as reflected in his statements during a certain time period). It should then be possible: (1) to assess systematic individual differences in causal perceptions and to correlate these differences with background characteristics (scientists vs. nonscientists, degree of commitment to nuclear industry); (2) to assess the degree to which decision makers cognitive maps resemble the ideal or normative decision tree

discussed in Section A (i.e., who, in retrospect, was most accurate, when, and on what issues).

We will also construct collective cognitive maps that summarize patterns of causal beliefs shared by subgroups of decision makers at various periods of time. In this way, it should be possible: (1) to identify the degree of intragroup consensus on what was happening at particular times; (2) to identify patterns of agreement and disagreement among decision makers (e.g., did subgroups or coalitions emerge, when and on what issue?).

It should be noted that merging cognitive maps (within individuals or across individuals) is a difficult procedure that requires considerable patience and trained coders. Since decision makers rarely use exactly the same terms to refer to concepts or ideas, it is necessary for coders to judge the degree to which various words and phrases are sufficiently synonymous to be classified as references to the same concept. Past research indicates, however, that such coding decisions can be made reliably (Axelrod, 1976, 1977; Levi & Tetlock, 1980).

1 .2. Measuring the Cognitive Structure of the Decision Process

A variety of structural indices can be derived from cognitive maps (Axelrod, 1976; Levi & Tetlock, 1980). These include: (1) differentiation of policy options (how many and how wide a variety of policy options were considered?); (2) the differentiation of policy consequences (how many and how wide a variety of consequences per option were considered?); (3) differentiation of values (how many and how wide a variety of values were considered?); (4) the differentiation of perceptions of states-of-the-world (how many and how wide a variety of causal variables were perceived as influencing events?); (5)

perceptions of interactive causation; (6) presence of mutually supporting causal arguments (in which one causal variable is perceived to affect another variable through two or more independent paths); (7) presence of cycles (in which three or more concept variables are stated to affect each other in a feedback loop); (8) tolerance for cognitive inconsistency and value trade-offs (subproject B.2) indicated by the willingness of decision makers to acknowledge that policy options have both positive and negative effects on utility. We will tabulate these indicators for each cognitive map constructed.

We will also apply the integrative complexity coding system to the transcript data. This system has been used in previous studies of decision making in crises and has demonstrated reliability and construct validity (Levi and Tetlock, 1980; Suedfeld and Tetlock, 1977; Tetlock, 1979, 1980). The coding rules - which permit scores ranging from 1 to 7 - define complexity in terms of differentiation and integration (see Schroder et al ., 1967, for detailed description of the rules). Differentiation refers to the number of characteristics or dimensions of a problem that are recognized; integration refers to the development of complex connections among these characteristics. The complexity of integration depends on whether characteristics are perceived in isolation from each other (low integration), in simple interactions (moderate integration), or according to multiple, complex patterns (high integration). Scores of 1 reflect low differentiation and low integration. Scores of 3 reflect medium to high differentiation and low integration. Scores of 5 reflect medium to high differentiation and medium integration. Scores of 7 reflect high differentiation and integration. Scores of 2, 4, and 6 represent transition points between these levels. Statements (that meet minimum requirements for being scorable - Levi and Tetlock, 1980) will be

scored for integrative complexity.

Past work indicates encouragingly strong relationships among measures of cognitive structure derived from maps and integrative complexity scores (Levi and Tetlock, 1980). The current research will: (1) further explore the relationships between the two measurement approaches; (2) use the integrative complexity scores to test hypotheses concerning determinants of learning, the effects of professional background and coping responses to stress.

2. Assessing Socioemotional Processes

To test the hypotheses noted in Section C (project narrative) requires techniques designed to capture the direction and intensity of decision makers emotional responses to policy issues, to the situation that they confronted, and to each other.

2.1 Indicators of Stress

To what degree were key policymakers experiencing stress during the TMI incident? Since negative affect is often hypothesized to be a major reaction to the threats to central values present in crises (M. Hermann, 1979), one approach to this question is to develop verbal and nonverbal indicators of negative affect. Drawing upon this large literature (see M. Hermann s, 1979, review), we will collect the following measures of negative affect from tape recordings of NRC deliberations:

(a) increased use of filler phrases in speech such as ah, you know, etc. (Maclay & Osgood, 1959);

(b) increased repetitiousness in words, phrases or sentences (higher type-token ratios - Osgood & Walker, 1959);

(c) increased number of changes or corrections in mid-sentence (Kasl and Mahl, 1965);

(d) increased rate of speech (Goldmen-Eisler, 1961);

(e) increased number of statements of personal discomfort and tension (Dollard & Mowrer, 1967);

(f) increased disorganization of normal rules of conversational turn-taking as reflected in more frequent interruptions of speech and simultaneous speaking (Duncan & Fiske, 1977).

Although we expect these measures to correlate with one another (as well as with participant s retrospective ratings of stressfulness of time periods), we will assess the psychometric properties of these measures to determine whether to use them separately or in one or more indices.

2.2 Appraisals of Situation Relevant to Coping Responses

As noted earlier, the Janis and Mann (1977) conflict model of decision making distinguished five patterns of coping with stress: unconflicted inertia, unconflicted change, defensive avoidance, hypervigilance and vigilance. To assess which patterns characterize individual responses to the TMI incident, the following measures will be collected to identify hypothesized determinants and manifestations of each pattern:

(a) Subjective Belief Indicators: Evaluative assertion analysis (Osgood, Saporta, & Nunnally, 1956) will be employed to assess decision makers perceptions of available policy options. In particular, did decision makers perceive serious risks associated with their current policy (no evacuation) and/or with alternative policies? Were decision makers optimistic that a better solution

could be found? Evaluative assertion analysis involves four basic stages (each of which requires two coders). The first stage is the identification of perceived policy options from transcripts of the group deliberations. The second stage involves translating all statements with references to policy options into a common attitude object/verb/descriptive term format. For instance, the statement Evacuation will lead to panic and disaster would be translated to read:

Attitude object X / leads to / panic
Attitude object X / leads to/ disaster

(Codes in later stages can thus be blinded to the nature of the attitude object.) The third stage involves rating the intensity and direction of the verbs and descriptive terms on a scale ranging from +3 to -3. A verb receives a negative score to the degree that it dissociates the subject from the predicate (would never lead to would receive a score of -3) and a positive score to the degree it associates the subject and the predicate (always leads to would receive a score of +3). A descriptive term receives a negative or positive score to the degree it represents a negatively evaluated attribute (e .g., disaster, panic) or positively evaluated attribute (e.g.. safety, rationality) within the language community of the speaker (Osgood et al ., 1956). Previous research indicates that high levels of interrater agreement are possible at all stages of the coding process (Osgood et al ., 1956; Tetlock, 1979).

(b) Perceptions of time pressure: Coders will be instructed to identify all references in the group deliberations to time. Coders will rate these references of a 1-7 scale, where 1 indicates a feeling that there is a great deal of time to make

decisions and 7 indicates that there is extremely little time to make decisions. The neutral point (4) will indicate no particular concern one way or the other with time.

(c) Vacillation in decision making. Coders will be instructed to identify all references to policy options that indicate whether the speaker is certain or uncertain in his advocacy of a particular policy. Using a methodology similar to Brecher s (1975) advocacy analysis, coders will rate on a 1-7 scale the degree to which decision makers endorse or oppose particular policy options. Previous research indicates that such assessments can be made reliably and, moreover, have predictive utility (Brecher, 1978).

(d) Quality of decision making. Janis and Mann define quality of decision making by reference to how thoroughly people carry out key cognitive tasks such as surveying the available policy options, analyzing the probable consequences of options, recognizing the range of relevant values implicated in the decision, searching for new information, revising beliefs in response to new evidence and developing contingency plans in the event things go wrong.

With one exception, we can readily construct these indicators of quality of decision making from the cognitive maps. The exception concerns the degree to which policy makers carefully and systematically searched for new information. We will assess information search in two ways: (1) having coders note whenever decision makers express the need for additional information; (2) having coders note whenever decision makers think critically and self-reflectively on how to structure procedures for the acquisition of additional information.

2.3 Indicators of Small Group Responses to Stress

As noted earlier, the research literature suggests that group decision making changes in a number of ways in crises (Holsti & George, 1975; Janis, 1972). Content analysis procedures will be used to identify a variety of possible shifts in small group processes.

(a) Size of decision making group: A record will be kept of the number of individuals actively involved in the decision making process.

(b) Frequency and intensity of interaction: A record will be kept of the number of times decision makers conferred, the length of the meetings.

(c) Emergence of directive leadership: Interaction process analysis (Bales, 1970) will be used to assess whether discussion became increasingly dominated by one or a few individuals.

(d) In-group cohesiveness: Interaction process analysis will be employed to assess whether group members increasingly directed positive attitudes toward in-group members.

(e) Out-group stereotyping: Evaluative assertion analysis (described earlier) will be used to assess whether members of the decision making group became more hostile toward out-groups (e.g., the press, state of Pennsylvania) as the crisis progressed.

(f) Discouraging deviance: Interaction process analysis will be used to assess whether group members became increasingly hostile toward individuals who expressed deviant attitudes.

2.4 Patterns of Interpersonal Behavior

The interaction process analysis (IPA) system distinguishes 12 categories of interpersonal acts: seems friendly, dramatizes, agrees, gives suggestion, gives opinion, gives information, asks for information, asks for opinion, asks for suggestion, disagrees, shows tension and seems unfriendly (Bales, 1970).

We will follow Bales (1970) suggested procedure for determining the role identities of speakers. Each role will be given a direction indicator for each category of interpersonal behavior that occurred with greater or less than the normal range of frequency (the normal range is based on data collected from 21 studies of a variety of interactions - Bales & Hare, 1965; Bales, 1970, pp. 96-97). For instance, assume that the normal range for seems friendly is 15% to 21%. Speakers with less than 15% in this category will be given the direction indicator negative socioemotional, whereas those with more than 21% will be given the direction indicator positive socioemotional ; speakers in the medium range receive no direction indicator.

There are three basic value directions in interaction process analysis: positive-negative (friendly versus unfriendly), up down (dominance-submission) and forward-backward (task orientation versus socioemotional orientation). Each dimension is defined by the incidence of specific classes of behavior, such as giving an opinion, disagreeing, and so forth. To obtain a speaker s score for each value dimension, the number of indicators in each direction must be counted and the difference between opposite directions taken. For example, if a speaker received two dominance and four submission indicators, the speaker s score on the dominance-submission dimension would be -2.

It should be noted that Bales (1970, pp. 96-97) used separate sets of statistical norms to determine direction for acts initiated by the speaker and acts received from other group members. Thus, each speaker could receive three IPA dimension values based on acts initiated and another three based on acts received from others - six in all . Although Bales recommended combining acts initiated and received into a single index for each dimension, we will - for the present - maintain separate scores to distinguish the contributions of speakers and others behavior to raters judgments.

As indicated earlier in the project narrative we will add three additional codes to the Bales system to test whether the self-reflective theory of learning applies within the crisis.