NRC LESSONS LEARNED FROM THREE MILE ISLAND: A TIME FOR ACTION AND NEW DIRECTIONS IN SAFETY POLICY FOR NUCLEAR POWER PLANTS*

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Investigation of the Accident at Three Mile Island

The accident that occurred over a year ago at the Three Mile Island nuclear power plant was traumatic -- especially for the people living in the region of the facility near Harrisburg, Pennsylvania -- as well as for utilities; nuclear plant suppliers; and governmental authorities at the local, State and Federal levels. The accident at TMI received extensive media coverage and also produced fear and anxiety among a wide segment of the public, especially people living near other nuclear power plants. Indeed, it is now apparent that NRC's safety policies should be formulated so as to deal not only with safety and economic tradeoffs, as recommended by the Kemeny Commission (Ref. 1), but also to deal constructively with what Robert DuPont has characterized as "nuclear phobi " (Ref. 2). In this light, this paper describes NRC's status on lessons learned from the accident at TMI and our continuing search for new directions in the formulation of safety policies for the siting, design, and operation of nuclear power reactors.

Since the accident at Three Mile Island on March 28, 1979, there have been an abundance of studies and investigations of the causes of the accident and recommendations for corrective actions. Among those who have investigated the accident are committees of both houses of the Congress, the President's Commission on the Accident at Three Mile Island, the NRC Special Inquiry Group, the NRC Advisory Committee on Reactor Safeguards, the Lessons-Learned Task Force and the Bulletins and Orders Task Force of the NRC Office of Nuclear Reactor Regulation, and the Special Review Group of the NRC Office of Inspection and Enforcement (Refs. 3-14). Others who have studied the accident include a number of State groups, individual utilities and new industry organizations, such as the Atomic Industrial Forum Policy Committee on Follow-up to the Three Mile Island Accident, the Nuclear Safety Analysis Center operated for the electric utility industry by the Electric Power Research Institute, and the Institute for Nuclear Power Operations (Refs. 15 and 16).

The Conception of an Action Plan

Although there is a never-ending need to study and learn more about nuclear safety and risk assessment, it is fair to say that the immediate priorities related to the accident at TMI have shifted from a learning to an action phase. Indeed, in view of the troubled world outlook for energy supply, the President on December 7, 1979 expressed a sense of urgency for the NRC to end the nuclear licensing pause following the TMI accident within a six-month

period. The NRC had already initiated the development of an Action Plan to address the urgency of performing its regulatory and licensing functions on a timely basis, commensurate with the urgent need for deciding and implementing improved safety measures.

In developing an action plan to accomplish these objectives, the obvious starting point was the recommendations from the various external and internal investigative studies. In the aggregate, the recommendations from these official studies numbered over a thousand. Although the various groups, for the most part, reached similar conclusions, they organized and stated their recommendations in different ways in accordance with their particular perspectives. In order to pull all of these recommendations together in one place and develop specific plans for prioritizing and acting on them, the Nuclear Regulatory Commission called late last year for the development of an action plan to respond to the lessons learned from the accident at Three Mile Island. This TMI Action Plan is now more than five months old and the final draft is soon to be published (Ref. 17). The plan contains approximately 175 discrete actions organized into five chapters, each covering a broad subject area: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Regulatory Practices and Procedures; and NRC Policy, Organization and Management.

The Action Plan serves to consolidate and definitize the many general recommendations from the official investigations into a set of discrete, scheduled tasks that specify changes (or studies of possible future changes) in regulatory

requirements and the organization and procedures of NRC. The actions in the Plan also have been systematically prioritized and have now been assigned to appropriate organizational elements of NRC. The various offices have estimated the resources and schedules for NRC and the industry to accomplish each of the actions. All of this information is provided in the final version of the Action Plan.

The Action Plan is a roadmap for both short and longer range actions. It catalogs, as well, the many decisions and actions already taken by the NRC in the year since the accident. For example, the NRC took a number of immediate steps to improve the safety of operating nuclear power plants in the first few days and weeks after the accident. These steps were described in a series of bulletins and orders to the licensees of operating plants that provided up-to-the-minute interpretations of the sequence of events leading up to the TMI accident and required specific changes at all operating plants to guard against repetitions of such events. A few months later, approximately thirty short-term requirements were issued by the NRC on the basis of lessons learned from the accident. These are now being implemented in two stages, between January 1, 1980 and January 1, 1981, by all operating plant licensees. All of the immediate and short-term actions were documented in the Action Plan so that they could be coordinated and accounted for during the development of the longer term requirements that are also reflected in the plan.

In developing the TMI Action Plan, the recommendations of the various investigations and studies were assessed and either adopted, modified, or rejected. These assessments and decisions were made under the direction of a Steering Group, which served to integrate and coordinate the development of the Action Plan by the NRC staff. The Commission, the Executive Director for Operations, and the directors of the program offices within NRC reviewed and commented on the various drafts of the plan, and their decisions and directions were followed in refining subsequent drafts. The regulated industry has also undertaken intensive study of the plan in order to provide its assessment of the priorities and resources for implementation of the actions which affect licensees.

The decisions on whether to include specific action items in the plan were based primarily on whether they were necessary to respond to the recommendations of the principal investigations of the accident. This was consistent with the NRC decision made in November 1979 to implement changes so as to conform with the recommendations of the President's Commission and with subsequent findings by the NRC and its staff that the principal investigations reached consistent conclusions. However, decisions on the priority and resources to be afforded the various actions in the plan have been based primarily on assessments of their relative risk reduction potential, i.e., their contribution to overall safety. Throughout the decision-making process, there has been general agreement as to basic causes of the accident and universal opinion that improvements are necessary in order to restore the confidence of government regulators, reactor owners, and the public that

operating plants are acceptably safe. It is recognized, of course, that acceptable levels of safety cannot be viewed as static concepts. Not only is this because of changing social values (Ref. 18), but also because of new options made available by advances in science and technology and other world developments affecting the energy supply outlook either favorably or unfavorably.

In addition to the above, there is also a wide consensus among experts as to which technological and human factors in reactor safety need improvement. This consensus stems from the aforementioned general agreement among the various investigations as to the causes of the accident. This includes failures that occurred before and during the event, both in the equipment and in the organizations that designed, operated and regulated the plant. For the most part, any differences of opinion that did exist among the investigating groups were over the degree of improvement required and the specific choice of methods and timing of their implementation.

We have now reached a point where we are doing something about all the major weakness identified by the accident. But, there is a need for longer term response, and it is reflected in the TMI Action Plan. Certain elements of the plan have been scheduled for the future, so as to provide for:

I. A realistic amount of time for licensed utilities to perform the engineering design, fabrication, installation and testing of technological modifications once they are decided to be necessary.

2. Additional studies by the government, the industry, and the public that are necessary, in some instances, to establish the desirability of specific changes that have been suggested for siting, design, or operation of reactors.

3. Effective public input as a means of exploring the diversity of societal impacts of candidate safety measures having controversial aspects or wide scientific disagreement. This includes the need to ensure against hasty decisions on behalf of certain safety measures which, in the absence of careful study and review, might have yielded an actual reduction in overall system safety instead of the hoped for gains.

An Overview of the TMI Action Plan

The development of the TMI Action Plan has provided a useful, if controversial, vehicle for debating and deciding on the methods and timing of the needed safety improvements, consistent with a variety of resource restraints. In the following paragraphs, the principal elements of the plan are summarized.

All of the investigations seem to agree that, although the accident stemmed from many sources, the most significant deficiencies were in the general area that some of us have come to call operational safety. Operational safety includes the number, organization, qualifications, training and support of both the operating staff and the management of the plant. The general conclusion is that these human elements in reactor safety have been underemphasized

in the past compared with the attention given to the hardware or equipment aspects of reactor safety.

The actions in the plan directed toward improving operational safety have two objectives. The first is to improve the operation of nuclear plants so as to reduce the frequency of initiating events that could lead to accidents with significant adverse effects on the health and safety of workers or the general public. The second objective is to improve the ability of the operating staff to recognize promptly any abnormal events and to take corrective actions.

Lower incidence of initiating events that cause accidents is being addressed through improvements in the selection and training of reactor operators and other plant staff and improvements in utility management techniques and capabilities. Lower incidence and better control of initiating events are also addressed by specific improvements being required in the content and level of training courses, the use of plant simulators, the content of casualty procedures, the design of the controls and instrument displays in the control room and the addition on every shift of technical advisors with engineering qualifications and other special training. Improvements in the evaluation by licensees and NRC of operating experience and the auditing of day-to-day plant operations are also to be instituted to provide continual feedback of new lessons and to develop a comprehensive body of knowledge and experience upon which to found future improvements in the capability to prevent accidents.

Although operational safety merits primary emphasis in our future work, means of improving current plant design are also necessary and the Action Plan

includes several of them. Even though there were no debilitating equipment failures during the initial sequence of events, other than the relief valve that stuck open, the TMI accident reemphasized the importance of system reliability. Therefore, the Action Plan contains requirements for the assessment of the reliability of some of the engineered safety features (e.g., auxiliary feedwater, emergency core cooling, containment isolation, and decay-heat removal) and an overall assessment of accident probabilities and consequences using integrated reliability analyses. These analyses are directed toward identifying and correcting specific weaknesses in the design features of currently operating plants as well as plants still under construction.

The Action Plan also contains studies of the desirability of additional design requirements and safety systems to reduce the risk from accidents involving significant melting or degradation of the reactor core even worse than that at TMI. Besides studies of possible future requirements for core melt, the plan contains short-term actions to make interim improvements in the capability of nuclear power plants to mitigate the consequences of accidents in which the core is severely damaged. These interim improvements include reducing the possible leakage paths for the highly radioactive material that would accompany such an accident.

Other actions to aid in the management and control of severe* accidents are included in the plan, such as improved shielding to aid access to highly

*Severe accidents are those which involve full or partial melting of the reactor core or that cause extensive damage to the fuel elements.

radioactive fluid systems, better means of sampling the reactor coolant and containment atmosphere, increased range of instruments so that accident conditions can be monitored, and better training of operators on the capability and use of the currently installed equipment during severe accidents. Finally, in this area of severe accidents, the action plan includes a rulemaking action involving the possible need for additional hydrogen control features as appropriate for various types of containment structures, and mitigation features for other effects of accidents involving core damage.

An action in the plan that is related to design for severe accidents and that applies to future plants is the reexamination of NRC policy on remote siting of nuclear power plants. The idea is to place greater reliance on distance between population centers and reactor sites as a means of reducing safety and health consequences to the general public in the event of a core melt that leads to offsite releases of radioactivity. In this regard and well before the TMI accident, the Nuclear Regulatory Commission in August 1978 directed the staff to develop a general policy statement regarding these and other aspects of nuclear power reactor siting. A Siting Policy Task Force was organized and its report, published in August 1979, contained a number of recommendations to accomplish the following goals (Ref. 19):

1. To strengthen siting as a factor in defense in depth by establishing requirements for site approval that are independent of plant design consideration. The present policy of permitting plant design features to compensate for unfavorable site characteristics has resulted in improved designs but has tended to deemphasize site isolation.

2. To take into consideration in siting the risk associated with accidents beyond the design basis (Class 9) by establishing population density and distribution criteria. Plant design improvements have reduced the probability and consequences of design basis accidents, but there remains the residual risk from accidents not considered in the design basis. Although this risk cannot be completely reduced to zero, it can be significantly reduced by selective siting.

3. To require that sites selected will minimize the risk for energy generation. The selected sites should be among the best available in the region where new generating capacity is needed. Siting requirements should be stringent enough to limit the residual risk of reactor operation but not so stringent as to eliminate the nuclear option from large regions of the country. This is because energy generation from any source has its associated risk, with risks from some energy sources being greater than that of the nuclear option.

In addition to the weaknesses identified in operational safety, system design, and reactor siting, the reports of investigations of TMI have generally agreed that the state of planning and preparedness for emergencies at nuclear power plants was inadequate. This inadequacy resulted from the low priority assigned to emergency planning by NRC and its licensees, a poor definition of the NRC role in emergencies, and insufficient coordination among licensees, NRC, and other Federal, State and local agencies. A major action that occurred in this area since the accident was the President's centralization of emergency

planning and response in a single Federal agency - the Federal Emergency Management Agency (FEMA).

Emergency response improvements that fall to NRC are contained in the Action Plan. They include better emergency centers and upgraded organization of onsite utility personnel for emergencies, improvement of the emergency plans for offsite action by the utility and by State and local governments, and improvement in the emergency response capability of NRC. The accident also increased our awareness of the importance of informing the public before and during emergencies, and actions are provided in the plan to improve the understanding of the news media and the public as to how nuclear plants operate. This would include key safety features; how radiation affects health; and what additional protective actions will be provided during emergencies.

The investigations of the accident at TMI-2 have criticized the worker radiation protection programs at nuclear power plants, particularly under accident conditions. The plan includes improvements in radiation-protection plans, health-physics operations, inplant radiation monitoring, and the habitability of control rooms, all intended to keep the exposures to workers during both normal operations and accidents as low as reasonably achievable. The Action Plan also lays out programs for improvements in the protection of the public from radiation, including increased monitoring of radioactive effluents from plants, better inplant radioanalytical measurements, more rapid estimation of offsite doses, and more secure control of the release of radioactivity.

Investigative studies of the accident have also shown the need for improvements in the practices and procedures for regulation of nuclear power plants. The areas of improvement within NRC include a clearer definition of the overall safety policy and goals, including backfit policy; improvement in the agency's rulemaking practices; reorganization of the functions and interactions of the Commission and the staff; improved administrative procedures; and counteractions to some of the financial disincentives to safety that have apparently existed in the past.

The Action Plan and the Resumption of Reactor Licensing: The End of a Pause

For almost a year following the TMI accident there were no new licenses, authorizations or permits issued by NRC. The licensing pause was necessary for NRC to be able to concentrate its efforts on assuring the safety of operating reactors and to control the situation at TMI-2 as well as to undertake extensive work in identifying and resolving the broad safety issues raised by the accident. Until recently, these efforts absorbed a large portion of the available staff resources , and little work could be accomplished on licensing reviews until it was complete.

Thus, the pause in licensing was designed to provide time and resources for the assessment of the TMI accident to be substantially completed and for improvements in both the operation and regulation of nuclear power plants to be set in motion. The pause assured that the staff would not be distracted or delayed from making a comprehensive assessment of the accident and applying

the lessons learned to operating plants. In addition, the pause addressed the concern that the risk from new plants not be added to the risk of presently operating plants until after the full implications of the accident had been addressed.

As outlined above, the NRC staff has developed and issued a number of new requirements, many of which are already implemented in operating plants and verified by NRC, which have provided immediate and substantial improvement in the safety of operating reactors. The Commission has also reviewed and given preliminary approval to a list of TMI-related requirements recommended by the staff as prerequisite to issuance of full power operating licenses for future plants. In the context of the Action Plan we have also defined what further, longer term studies and research are required.

Until the Action Plan has been approved, the conditions for ending the licensing pause and granting the first full power license since TMI will not have been met. However, the NRC has recognized an obligation to act on license applications with reasonable dispatch since delays in licensing of fully constructed nuclear plants can involve large economic costs to utilities and, ultimately, consumers of electric power. There is an opportunity to reduce these costs without compromising the aims of the licensing pause, and without incurring any significant public risk, through the issuance of restricted licenses that permit newly completed plants to load fuel and perform zero and low power testing. By completing these necessary preliminary steps, licensees can reduce the time which would otherwise be necessary before the plant could

begin generating substantial amounts of electricity. Near the end of this summer, the first new plant should finish this low power testing phase.

A number of the improvements derived from TMI studies are required to be implemented on new plants prior to loading fuel. These requirements provide additional assurance that the risk to the public will be extremely small during the low power testing. They include improvements in the number, training, and qualifications of the reactor operating staff; augmented management and technical support of the operating staff; better emergency preparedness and improvement of some equipment. Procedural controls on the duties and responsibilities of various operating personnel during both normal and accident situations are required to be reassessed and clearly specified. The management and technical support organization and staff are being given much closer scrutiny than in the past to assure that they are adequate. An improved safety audit function and an improved operating experience evaluation function are also to be provided by the licensees at each new plant.

The emergency preparedness of the plant staff is to be improved by better organization with more closely specified functions, and by the addition of special facilities for the groups designated to perform these functions. The emergency plans of the utility and State and local authorities are reviewed and, with FEMA's advice, approved by the NRC before loading fuel. In addition, drills of the emergency plans are conducted and observed by the NRC.

There is only a small possibility of serious error during the authorized testing at low power and any errors at these power levels are not likely to result in serious consequences. Additionally, test procedures are to be reviewed by the supplier of the reactor to provide further assurance that operational errors are not committed. The NRC will have a resident inspector at each plant before fuel is loaded to audit the testing program. Each new plant will have dedicated telephone lines to the NRC for rapid communication in the event of an accident. Dedicated telephone lines have already been installed for presently operating plants.

Consistent with these special prerequisites, the Commission has already acted on the merits of three applications for fuel loading and zero- and low-power testing of power reactors for which construction had been completed. The Commission has decided to license the Sequoyah, North Anna 2 and Salem 2 nuclear plants to load fuel and conduct tests up to 5 percent power.

In sum, a number of very important steps toward regulatory recovery from the TMI accident have been accomplished. First, a number of major investigations of the TMI accident have been completed and their conclusions and recommendations assessed. Second, and most important, the safety of operating plants has been significantly improved. Third, NRC has been through several iterations and refinements of a comprehensive Action Plan for responding to the recommendations of the investigations. That plan is nearing final approval. Fourth, a set of requirements within the Action Plan has been developed for those operating license applicants whose construction is complete and who are

otherwise ready to be licensed except for the TMI-related concerns. Having accomplished these steps, the NRC has made real progress towards getting its house in order, and the stage is now set for ending the licensing pause and granting full power operating licenses.

Some Remaining Issues and the Need for Further Articulation of Safety Policies and Objectives

It is readily apparent that regulatory uncertainty will not end when licensing has resumed. There is more to be done at both the technical level and at the policy level. The technical projects that follow from TMI are described and arranged in the Action Plan, and, although their final outcome cannot be predicted with complete certainty, the areas of interest and concern have been set forth for review by all interested persons. However, this is not the case with reactor safety policy and backfit policy. Their future study and development are not well described in the plan and therein lies a considerable measure of uncertainty.

The majority of the uncertainty for the future of nuclear reactor safety seems to stem from the fact that NRC regulates in an environment that is largely governed by perceptions and subjective judgments rather than the more objective considerations of engineering, science, and law. For example, the fundamental proposition of NRC's role in accidents is subject to substantially different interpretations according to whether it is considered in the general statutory

framework prior to the TMI accident, or as it occurred in fact during the accident, or as it is variously perceived and desired by others. Similarly, although the NRC staff deals daily in concepts of safety and risk from a predominantly scientific and analytical perspective, the public, the Congress, and the media generally react to their perception of risk independently of whether that perception comports with reality. We lack a national consensus, a Congressional mandate, or even a popular understanding of national nuclear safety objectives. We even lack agreement on the correct approach to making safety judgments. There is an acute need for policy on what is an acceptable safety goal and supporting safety standards for reactor regulation.

In the past, many of us have suggested that our basic overall objective was to control the safety of nuclear power plants to achieve a level of risk that was less than the risk of any realistic alternative method of producing electricity. General agreement today on this overall objective would provide a sizeable reduction in the present uncertainty. Similarly, it would help considerably if agreement could be reached that the accident prevention measures already implemented and others soon to be in place return us to the level of safety we thought we had attained prior to TMI (for which I think there is now a strong argument). With these accomplishments we could then proceed at a more deliberate pace to study and debate whether there is a need for further significant risk reduction, especially through measures to mitigate the severity of consequences of potential core melt accidents. By mitigation measures, I mean those distinct from the reduction of the probability of accidents to which initial measures since TMI, and indeed the overall regulatory program, have

largely been directed. In the meantime, we are already pushing rapidly ahead to decide whether some operating plants require special emergency preparations or design features for core melt accidents.

Lacking any such articulation of safety objectives, the incentive is strong for NRC engineers and scientists to continue to develop and issue piecemeal, prescriptive licensing requirements that slowly accumulate on the complex patchwork of past regulatory practice. This patchwork has become important to safety, and there is no strong indication that plants cannot be safely operated in conformance with the somewhat abstract pattern of requirements. However, there can also be no question that 20 years of this form of regulation have taught the regulated industry that the only certainties in the regulatory process are those of uncertainty and delay. The patchwork system of regulation and attendent uncertanties and costs of delay are equally unsatisfactory to the people it was designed to protect.

Whatever national reactor safety goal and supporting safety standards are eventually decided upon, it is clear that we have an opportunity to set some new and constructive precedents with the development and implementation of the TMI Action Plan. For example, it contains an implementation policy for future requirements that will eventually be developed in accord with its long-term studies. During the past year, our policy on the short-term, urgent actions related to TMI has been one of prompt implementation, at the expense of possible delay in the startup of new units or special shutdowns for some operating

plants. These prompt and costly actions were judged to be necessary for public health and safety. Having continued to examine and reexamine these urgent requirements in the broad context of the Action Plan, and having decided that only a small number of requirements needed to be added to the list for new plants, it follows that the remaining changes need not be implemented in the same urgent manner. Thus, we should be able to adopt a more deliberate implementation policy as we continue to pursue changes that are desirable for long-term improvements in safety or maintenance of improvements already gained in the short-term. There is an additional reason to be more deliberate in our future changes - that is, the need to avoid counterproductive actions because of finite resources or, worse yet, changes that may prove to be unsafe because they were inadequately studied. The patchwork of requirements can become so complex in its details that it is not always clear that some changes actually improve safety.

Accordingly, it has been proposed that an implementation policy for future regulatory changes in keeping with the lessons learned from the TMI accident would have four principal ingredients:

1. Develop and implement additional TMI-related requirements in a priority order that gives consideration both to risk reduction and to resource requirements (i.e., a priority system that gives greater weight to actions with a high potential for risk reduction and low resource requirements).

2. Obtain public comment on the substance and scheduling of implementation of the most significant new requirements prior to their issuance. In most cases, the opportunity for such review would be the formal public comment period for a Regulatory Guide, a Standard Review Plan revision, or a regulation.

3. Apply future requirements developed in accordance with the Action Plan uniformily to operating plants and to plants under construction, with due consideration of design or other differences among plants. Require that implementation be complete by a specified date on all plants in operation or going into operation after that date. Allow case-by-case exceptions to the deadlines for good cause.

4. In order to minimize the cost of the future requirements to be derived from the Action Plan, and absent new information to the contrary, set implementation deadlines so as to avoid downtime on operating plants and delay in startup of plants under construction beyond that necessary to accomplish the change in an orderly manner.

An implementation policy of this kind, in conjunction with wide dissemination of the Action Plan and NRC management adherence to resource priorities, should reduce uncertainties of significance to the public and the industry regarding the regulatory effects of TMI. That would be a step in the right direction, but it would still fall short of what our long-range target ought to be -- the definition of an acceptable set of national reactor safety goals and standards including a stable and generally applicable backfit policy.

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FEDERAL-STATE COOPERATION IN NUCLEAR POWER PLANT LICENSING: Federal Initiatives to Improve Federal-State Cooperation—Part III

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ABSTRACT. The Calvert Cliffs decision of the U.S. Circuit Court (July 23, 1971) established a requirement for an expanded Environmental Impact Statement (EIS) involving an independent evaluation and balancing of environmental factors against benefits by the U.S. Atomic Energy Commission and its successor agency, the Nuclear Regulatory Commission (NRC). Since then, the AEC/NRC has prepared well over a hundred EISs representing extensive review experience in dealing with highly varied environmental issues of a region-specific and site-specific nature as well as a number of hearing issues of generic importance. In recent years, a growing number of States are increasing their involvement in environmental review and decision making affecting the licensing of nuclear power plants. The diversity of siting and permitting laws as well as administrative policies and procedures by the various States are potential sources of inefficiency in Federal-State cooperation. There are also problems of wasteful duplication and potentialities for delay and confusion in the licensing of nuclear power plants unless significant improvements are made in Federal-State cooperation. This paper, originally presented at the Third Annual Meeting of the National Association of Environmental Professionals in February 1978, is presented in three parts for sequential publication. Part I, *Federal-State Cooperation in Nuclear Power Plant Licensing*, discusses: (i) environmental issues in licensing and the related roles of the NRC, the utility applicant as well as other State and Federal agencies; (ii) the basis of interest for increasing State involvement in licensing activities; and (iii) the basis of interest in a continued Federal role. Part II, *Diversity of State Practices in Nuclear Power Plant Licensing*, provides a review of contrasting State roles and practices in the licensing process from selected cases, giving special attention to key environmental issues such as need for facility and site selection. Part III, *Federal Initiatives to Improve Federal-State Cooperation in Nuclear Power Plant Licensing*, describes a number of initiatives by the NRC to improve licensing cooperation including special programs to involve State officials in NRC workshops, formal agreements with States regarding licensing procedures, contractual and inhouse research studies on safety and environmental review methodologies of possible interest to States, improved coordination with other Federal agencies, and generic rulemaking and other efforts to increase licensing efficiency.

NRC INITIATIVES TO IMPROVE FEDERAL-STATE COOPERATION IN THE LICENSING PROCESS—ACTIVITIES OF THE OFFICE OF STATE PROGRAMS

The Office of State Programs (OSP) of the Nuclear Regulatory Commission has engaged in numerous activities directed toward improving Federal-State cooperation in the licensing of nuclear power plants and dealing with related fuel cycle issues. Many of these activities have drawn upon the technical expertise of other NRC divisions as well as the OSP staff in its lead role. One primary objective of these activities is to facilitate an exchange of information on methodologies, procedures, guides, standards and factual

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data on safety and environmental issues associated with nuclear power plant licensing and other areas of NRC responsibility in which the States have an interest or shared responsibility.

Useful forums for the exchange of such information have been arranged by the OSP through workshops and conferences. Two Federal-State conferences were sponsored by the OSP on Power Plant Siting in which experts and administrators from various State and Federal agencies were brought together for an exchange of information, ideas and concepts. Proceedings of these conferences have been issued to reach a wider audience (NRC, 1975a and NRC, 1976a).

A number of special study efforts were initiated by the OSP following the directive of the Nuclear Regulatory Commission in September 1976 to examine the matter of regulatory activity in environmental decision making regarding nuclear power plants and to suggest steps that could be implemented to improve this aspect of the licensing process. The following reports relate to this OSP program:

- Improving Regulatory Effectiveness in Federal/State Siting Actions, NUREG-0195.
- Success Factor Evaluation Panel, NUREG-0196.
- State Regulatory Activity Involved in Need for Power, NUREG-0197.
- State Perspectives on Energy Facility Siting, NUREG-0198.
- Environmental Planning and the Siting of Nuclear Facilities: The Integration of Water, Air, Coastal, and Comprehensive Planning into the Nuclear Siting Process, NUREG-0199.
- Federal/State Regulatory Permitting Actions in Selected Nuclear Power Station Licensing Cases, NUREG-0200.
- Water Supplies and the Nuclear Licensing Process, NUREG-0201.
- Nuclear Power Plant Licensing: A New England Perspective, NUREG-0202.
- State and Local Planning Procedures Dealing with Social and Economic Impacts from Nuclear Power Plants, NUREG-0203.
- Alternative Financing Methods, NUREG-0204.
- Need for Power: Determinants in the State Decision-Making Processes, NUREG/CR-0022.

The manner by which these studies were prepared reflects in itself a notable spirit of Federal-State cooperation in improving regulatory effectiveness in Federal-State nuclear power plant licensing actions. Two examples are meaningful in this regard. The plan of execution in the preparation of the Preliminary Staff Report on *Improving Regulatory Effectiveness in Federal/State Siting Actions* involved the following procedures (NRC, 1977a):

(1) Early arrangements to work with the staff and committees of the National Governor's Conference including two workshops under their auspices (Atlanta and Chicago) to develop an exchange of views on the study's objectives and potential proposals.
(2) Exchange of views through direct contacts and correspondence with the Governors and various regulatory offices.
(3) A review of the purpose and scope of the program by representatives of other Federal agencies at two meetings organized by the Council on Environmental Quality.
(4) The organization within NRC of a Study Task Force to relate NRC experience to study objectives and receive comments on possible alternatives.
(5) The organization of two important panels of national experts to focus on two specific areas: (a) need for power or facility, and (b) the definition of criteria for effectiveness in regulatory activity.
(6) Contracts with five individuals and groups to assist in study areas where additional professional support was needed on special subjects such as funding regulatory activity, legal review of statutes involving planning and matters of regional organization.

Regarding the study report on *Water Supplies and the Nuclear Licensing Process*, the procedural steps were far simpler with limited involvement of the NRC staff (WRC, 1977). The report was prepared for transmittal to the NRC under contract with the U.S. Water Resources Council, which in turn assigned the study effort to the Interstate Conference on Water Problems (ICWP). The ICWP Executive Committee serves as the Standing State Advisory Committee to the U.S. Water Resources Council and manages the activities of the ICWP. The ICWP is a national association of State, intrastate and interstate officials and legislators whose purpose is to facilitate cooperation, consultation and exchange of information on the conservation, use, development and administration of water and related land resources, legal aspects, and Federal-State relationships in the field of water and related resources and to promote a harmonization of State and intrastate views on these matters. Although 24 States and two interstate agencies participated in developing the report through attendance at formal meetings and review of drafts, no endorsement by any State or Federal agency of the report's findings and conclusions was sought or is claimed. To provide a spectrum of variations in State and interstate procedures for licensing or control of water uses by energy facilities, nine appendices were provided in the report by the following States: Georgia, North Carolina, Wyoming, Montana, Washington, Minnesota, Penn-

sylvania, South Carolina, and the Delaware River Basin Commission (WRC, 1977).

The NRC Office of State Programs has also initiated a number of studies and workshops with State agency participation involving a variety of safety-related issues. A number of States are involved in legal actions or have expressed serious concerns over the lack of facilities for the permanent and safe disposal of high level nuclear wastes. The U.S. Energy Research and Development Administration (ERDA), now the Department of Energy, has been authorized by the Congress to develop repositories for commercial high level wastes. Its schedule calls for an operational facility by 1985. The U.S. Nuclear Regulatory Commission has licensing and regulatory authority over the repositories, including the authority to set siting criteria which the repositories will be required to meet.

The NRC Waste Management Program and the Office of State Programs held three regional workshops to solicit ideas from State executives and legislators on the siting and licensing procedures for high level waste repositories and to solicit comments on the NRC preliminary site suitability criteria. The workshops were attended by 170 invited State executives and legislators from 46 States. In addition, there were over 80 observers from diverse backgrounds including the general public, government, industry, professional consultants and university faculty. Discussion group reports and the analysis and recommendations of the workshops have been published (NRC, 1977b, 1978a).

Another important problem involving Federal-State coordination is that of emergency response and evacuation planning. In March 1977, the NRC Office of State Programs had issued a report on "Standards and Procedures for Concurrence in State and Local Government Radiological Emergency Response Plans" (NRC, 1977c). In January 1979, the OSP issued a handbook entitled: "Radiological Emergency Response Planning: Handbook for Federal Assistance to State and Local Government" (NRC, 1979a).

Following the onset of the accident at the Three-Mile Island (TMI) Nuclear Plant on March 28, 1979, public and governmental concern became heightened over the adequacy of emergency response and evacuation planning and governmental coordination of related activities. In October 1979, NRC's Office of State Programs issued a staff report, "Beyond Defense-in-Depth: Cost and Funding of State and Local Government Radiological Emergency Response Plans and Preparedness in Support of Commercial Nuclear Power Stations" (Salomon, 1979). This report describes as "inadequate, sporadic, uncertain and frustrating" the current hodgepodge funding approach to State and local government radiological emergency response plans. The report proposes a funding scheme to be administered by the NRC and public comment was invited in the *Federal Register* (Vol. 44, No. 218, Nov. 8, 1979).

Still another safety-related issue involving Federal-State cooperation is that of nuclear power plant decommissioning policy. In March 1978 a report was published on a "Plan for Reevaluation of NRC Policy on Decommissioning of Nuclear Facilities" (NRC, 1978b). The Office of State Programs and the Office of Standards Development sponsored three regional workshops during September 18-30, 1978 in order to receive comment from State representatives and published the Conference Proceedings (NRC, 1978c). Following the publication of Revision 1 to NRC's March 1978 plan, two regional State workshops to be held in September 1979 were announced in the *Federal Register* (Vol. 44, No. 150, Aug. 2, 1979). The purpose of the workshops was to discuss the modified plan and the progress made during the past year. This included additional technical information consisting of an expanded report on the decommissioning of pressurized water reactors and reports on the decommissioning of boiling water reactors and low level waste burial facilities. Comments were sought on preliminary staff reports on financial assurance and residual activity limits.

NRC-STATE AGREEMENTS ON LICENSING PROCEDURES OR COOPERATIVE REVIEW EFFORTS

There are numerous examples of cooperative NRC-State efforts regarding safety and environmental aspects of nuclear power plant licensing and related activities in the mining, milling, transport and storage of nuclear fuels and wastes or emergency evacuation planning in the event of accidental radioactive releases. The NRC has entered into formal agreements with certain qualifying States regarding procedures for safety and environmental protection in the mining and milling of uranium. Moreover, prior to the formation of the NRC, the States of South Carolina and Louisiana, for example, entered into contractual agreements with the AEC and the Department of Transportation to provide studies of existing flows of radioactive materials in their respective States and to provide recommendations to make desirable improvements in the transport and storage of nuclear materials (SCDHEC, 1975 and LDC, 1975).

A different kind of example of NRC-State cooperation designed to improve the effectiveness of nuclear power plant licensing is the agreement recently consummated between the Virginia State Water Control Board and the NRC on requirements pursuant to the Federal Water Pollution Control Act Amendments of 1972 (FWPCA) (NRC, 1977d). Specifically, the cooperative efforts will extend to requirements for the

control and consideration of impacts on water quality and aquatic biota associated with the licensing and regulation, including early site approval, of nuclear power plants located within the Commonwealth in accordance with principles embodied in the Second Memorandum of Understanding between the U.S. Nuclear Regulatory Commission and the Environmental Protection Agency. A brief summary of the points of the NRC-Virginia agreement include:

(1) Cooperation in the compilation of environmental information needed for early evaluations on water quality and aquatic biota in meeting the joint information needs of NRC licensing and the State issuance of water quality certifications pursuant to Section 402 of the FWPCA and the State Water Control Law, including, where applicable, Section 316(a) and Section 316(b) considerations.
(2) An early meeting of Virginia and NRC prior to or during the environmental licensing review process to discuss potential water quality and aquatic impacts.
(3) As early as practicable, to make investigation and evaluation of these matters to issue a timely permit pursuant to the State Water Control Law and Section 402 of the FWPCA as well as Section 401.
(4) Maintain close communications throughout the licensing review process including a status meeting to assess any significant new considerations that may develop.
(5) Conduct combined or concurrent hearings, where feasible, on the Board's Section 402 permits and NRC's construction permits, or other actions.
(6) Explore means by which joint or cooperative preparation of parts of Environmental Impact Statements for nuclear power plants could be accomplished with NRC assistance to the Board in the form of appropriate information and technical support.

Three other States have entered into similar agreements with the NRC to coordinate review activities related to the water quality requirements of the FWPCA Amendments of 1972: Indiana, Nebraska and South Carolina.

Another area in which it is desirable that NRC and affected States work in closer cooperation is the issue of "need for power"—or more appropriately, "need for baseload facility," since generating cost advantages and improved fuel mix in the applicant's system may, in some instances, provide sufficient reasons for adding baseload capacity even in the face of reduced rates of growth in electricity demands. The "need" issue, of course, is relevant to NEPA requirements since one alternative to the proposed construction of a baseload plant is not to build it at all, or at a later time than proposed. Despite the frequency and controversy of the "need" issue at NRC environmental hearings over the past four years, if past experience is a reliable guide, it would appear unlikely that NRC's evaluation of need will differ from the applicant's determination by more than several years, and the Atomic Safety and Licensing Boards of NRC, which make initial decisions on these matters (subject to appeal), have found that forecast differences of need by several years would be insufficient grounds for denial of a construction permit. Moreover, no such initial decision has yet been reversed.

Malcolm Ernst, NRC's Assistant Director of Environmental Technology, makes the following observations, outlining certain procedures and principles for increased informational and analytical inputs by States in evaluating the "need" issue (Ernst, 1977):

> The NRC believes that cooperative efforts with States in this area would be useful, in that this could reduce the amount of duplicative review done by State and Federal governments. As a result, the NRC is in various stages of discussion with a number of States to see what kind of cooperative agreements can usefully be worked out.
>
> The principle behind these efforts is that, while the NRC cannot abdicate its NEPA responsibilities by delegating them to the States or by relying upon State analyses, the NRC can utilize State data and analyses in the NRC's decisional process. Several types of cooperative efforts are possible:
>
> (1) Establish common data needs.
> (2) Establish common analytical methodology.
> (3) Utilize State data and analyses as an adjunct to NRC's analyses.
> (4) Utilize State data, analyses and expertise directly in NRC's EIS and hearing process.
>
> All of the above stop short of accepting a State decision regarding "need" as being dispositive in the NRC decisional process. Even in the fourth case, the NRC would be familiar with the States methodology and would be prepared to testify that the NRC's methodology is similar and would likely have yielded a similar answer. However, in the fourth case, the NRC reviewer would *not* testify regarding the specific analysis performed by the State—that would be the responsibility of the State's representative.

Of special interest in view of the variable and unsettled nature of forecasting methodologies as described above for different State experiences are certain procedural features and critera which have been proposed for NRC-State agreement. It is suggested that portions of environmental impact statements and associated environmental evaluations on need-for-baseload facility additions would involve analysis of:

- Need-for-power, including likely positive or negative errors in forecasting electricity demand.
- Net economic benefits through retiring or placing

on reserve status existing units with high operating cost.
- Advantages of system fuel diversification.
- Cost-benefit comparisons of starting construction of a nuclear power plant earlier than actually needed compared to later than actually needed due to forecasting error.

Such evaluations and input to NRC's environmental impact statements will be prepared under guidelines and criteria mutually acceptable to a cooperating State and NRC in order to assure that the needs of both are met, and will be subject to review and modification by NRC as necessary to meet its full NEPA responsibilities. Specific guidelines have been proposed (Denton, 1977a)

The need for adding baseload (nuclear) generating capacity to an applicant's system can be justified in the public interest if the following criteria applied in combination (or possibly singly) are persuasive:

(a) A need-for-power analysis that determines the adequacy of baseload generating capacity which would encompass (i) all proposed additions or deletions of generating facilities for several years beyond the planned inservice date of the proposed plant; (ii) forecasts of electrical energy demand for the general service area of the utility as well as the interconnected power pool which may serve as a market for export sales of baseload energy as well as a source of baseload energy purchases; and (iii) the contribution of baseload capacity to total capacity needs for meeting reliability or reserve margin requirements in view of changing trend relationships between baseload, intermediate and peaking needs as reflected in system load duration curves or production simulation models.

(b) An analysis of the net economic benefits of proposed or potential actions for placing higher cost units on reserve or in retirement, especially those units whose high operating costs have resulted from a sharp escalation of fuel prices.

(c) A judgmental evaluation of public interests of national and regional importance stemming from an improved mix of fuel for the applicant's system so as to reduce vulnerability to unexpected interruptions of a given fuel type (such as imported oil) or risk of a dramatic rise in prices for any fuel of substantial use in the applicant's system.

(d) No specific forecasting technique (econometric or judgmental) will be required, but the methodology selected shall fall within the range of acceptable professional practices.

(e) No forecasting methodology will be deemed acceptable unless it includes a reasoned consideration of the following causal factors which potentially might have a significant impact on future electricity demand growth in the service area or power pool region (to be evaluated whether the impact is deemed significant or not):

(i) growth in regional population, number of households or residential customers, commercial and industrial activity (especially large firms that are heavy users of electricity);

(ii) a sensitivity analysis of the impact of high and low assumptions of rising real prices of electricity, but not necessarily a specific form of rate restructuring;

(iii) the collective impact of voluntary and government-induced nonprice conservation measures that are reasonably foreseeable to occur within the forecast period of relevance to the immediate investment decision;

(iv) regional saturation and baseload implications in the use of electricity in both summer and winter space-conditioning and for other appliances using substantial electricity;

(v) the relationship of fuel substitution in the region such as the use of heat pumps or solar energy in space heating and cooling, the growth of all-electric systems in new building construction, industrial conversion from gas to electric furnaces, etc., including the stimulus of alternative scenario assumptions on relative price movements and fuel interruption uncertainties for the key fuel options;

(vi) a discussion of the outlook for technological advances improving the efficiencies of electrical consumption or in developing new uses for electricity of importance to the regional analysis within the forecast period of relevance.

(f) Forecasts of electrical demand should be provided separately for the major customer classes: residential, industrial and commercial.

(g) In ascertaining need for power, the unreliabilities inherent in forecasting methodologies would not require a precise year of need, or scheduled inservice data, but rather a "window of launch" of perhaps several years would suffice corresponding to a range of high and low forecasts of demand growth for baseload capacity additions with feasible interconnection. An analysis of the likely positive or negative errors in forecasting that could reasonably be expected for the region served by the applicant's system, as well as the likely asymmetry of cost penalties of starting construction of a nuclear plant earlier than actu-

ally needed compared to later than actually needed, should be developed as the basis for determining an appropriate window of launch.

(h) Further detailed guidance on form and content is provided in NRC's Draft Environmental Standard Review Plan. Any substantive revisions of this draft will be subject to discussion by the parties of this Agreement with the objective of resolving any differences of viewpoints regarding input requirements to NRC environmental statements in need for baseload facility analysis.

The flexibility permitted in the previous guidelines regarding the specific *form* of forecasting methodology (as distinguished from substantive elements to be included in whatever methodology is selected) is an important feature that would make practicable its application to a number of State forecasting procedures. For example, discussions held between the technical staffs of the State of New York and the NRC on forecasting methodologies and review procedures as related to need-for-facility analysis revealed a high degree of parallelisms which would indicate a need for relatively modest changes in the above proposed guidelines and criteria in order to reach agreement on specific wording.

Several States (New York, Indiana and Washington) have entered into agreements with the NRC regarding principles of cooperation in the regulation of nuclear activities covering a broad range of review and hearing activities. An example is the "Memorandum of Agreement between the State of Washington and the U.S. Nuclear Regulatory Commission," dated September 6, 1978, which provides for the following Principles of Cooperation:

1. Toward these goals, the State and NRC agree to explore together the development of detailed subagreements in areas of mutual concern, including, but not necessarily limited to, environmental reviews (or portions thereof) of nuclear facilities subject to licensing by NRC or certification by the State Energy Facility Site Evaluation Council (EFSEC); siting considerations; conduct and structure, format of hearings; confirmatory radiological environmental monitoring around operating nuclear facilities; decommissioning of nuclear facilities; emergency preparedness planning; response to radiological incidents; and radioactive material transportation monitoring.
2. Subagreements under this Memorandum may provide for activities to be performed by the NRC or the State under mutually acceptable guidelines and criteria which assure that the needs of both are met.
3. For activities performed by the NRC or the State at the request of NRC or the State under specific subagreements to this Memorandum, the agency making the request will explore means by which compensation may be made available to the other agency or by which the costs may be shared.
4. NRC agrees to explore with the State the possibility of sharing of proprietary information in NRC's possession with the State.
5. Each agency will explore means by which its training programs may be made available to the other.
6. Nothing in this Memorandum is intended to restrict or extend the statutory authority of either NRC or the State or to affect or vary the terms of the present agreement between the State and NRC under section 274b of the Atomic Energy Act of 1954, as amended.
7. The principal NRC contact under this Memorandum shall be the Director of the Office of State Programs. The principal State contact shall be the Chairman of the Energy Facility Site Evaluation Council (EFSEC). Subagreements will name appropriate individuals, agencies or offices as contacts.
8. This Memorandum shall take effect immediately upon signing by the State and the Nuclear Regulatory Commission, and may be terminated upon 30 days written notice by either party.

A pioneering agreement was signed on April 6, 1979 by the NRC and New York State (NRC, 1979b). This agreement between the New York Departments of Public Service (DPS) and Environmental Conservation (DEC) and the United States Nuclear Regulatory Commission (NRC) sets forth mutually acceptable levels of cooperation between the State of New York and NRC related to providing NRC with specific technical support of the DPS staff in preparation of designated sections of the NRC's Draft Environmental Statement (DES) and Final Environmental Statement (FES) for New Haven Nuclear Station, Unit Nos. 1 and 2.

It is the intent of this agreement that the technical staff of the DPS will provide services involving analysis, evaluation and written material in preselected subject areas, utilizing the NRC's Environmental Standard Review Plans. This cooperative endeavor is intended to reduce duplication, provide for more effective use of resources and permit a more orderly and efficient hearing.

The eighteen-point agreement is both comprehensive and detailed. The staff of the DPS will provide to the NRC information for inclusion in the DES and FES which shall primarily consist of technical review assistance in the subject areas of need for power, hydrology, land use, demography, ecology (aquatic and terrestrial), socio-economics, plant and transmission facility description (to include non-radiological waste systems), non-radiological monitoring programs, impacts from construction and operation, environmental noise, alternative plant and transmission systems.

The staffs of NRC and the State of New York developed a "Protocol for the Conduct of Joint Hearings before the United States Nuclear Regulatory Commission and the New York State Board on Electrical Generating Siting and the Environment: New Haven 1 and 2" which was proposed for consid-

eration by both parties on April 27, 1979 (Flynn et al., 1979). One of the key provisions of the protocol involves the conduct of the evidentiary hearing. It was proposed that the evidentiary hearing shall proceed on a contention issue basis—either a designated contention (NRC) or a contested issue (Article VIII). After an adequate period for full discovery of the applicants' *direct case* on a contention issue, proper parties shall file their *direct cases on that contention issue*. Thus, both parties (NY State and NRC) would establish staff positions on alternatives and related issues *before* the start of the evidentiary hearing. At previous hearings on proposed nuclear power plants in New York State, there was a divergency of practice in this regard since the NRC Staff took conclusive positions before the start of hearings whereas the staffs of the involved New York departments did not take affirmative positions on issues throughout the conduct of the hearings.

However, another divergency of analytic procedure remains unresolved. Whereas Article VIII requires that the proposed site and at least one alternative site be examined with equal detail regarding beneficial and adverse environmental impacts, the practice of the NRC is to examine only the proposed site at a high level of detail with analysis of alternative sites made on the basis of reconnaissance level information (NRC, 1978d).

Although a detailed schedule was agreed upon for the cooperative-staff reviews and joint hearing conduct regarding the New Haven 1 and 2 Nuclear Station, further staff activity has been suspended pending the outcome of an appeal to the New York State Siting Board.

GENERIC STUDIES, METHODOLOGICAL PROCEDURES, AND CONFIRMATORY RESEARCH EFFORTS OF THE NRC

If the NRC licensing review process would be strengthened and wasteful duplication of effort would be avoided by increased information and analytical inputs in selected areas from the technical staffs of various States, it would also appear that information and analyses produced by the NRC staff and their research contractors would be of potential benefit to a number of States in the exercise of their licensing reviews and permitting functions regarding proposed nuclear plants and sites. Such a two-way flow of information has already been practiced to some degree through individual or agency contacts and formally organized workshops.

However, much of this exchange of information has been opportunistic or based on happenstance of contacts rather than the result of systematic efforts or formalized agreements for the exchange of information. One of the problems is that converting such coordinative efforts from a largely passive or reactive mode to a more active or initiating mode involves the allocation of increased financial and manpower resources within NRC and other governmental agencies. This, of course, would require resolution through budgetary procedures or possibly an administrative reallocation of priorities involving resource assignments.

Tables 1-3 show various research studies (completed, in progress, or planned) initiated by the NRC Cost-Benefit Analysis Branch and the Environmental Specialists Branch. All of these studies are of generic significance to the improvement of environmental reviews in the nuclear power plant licensing process even though some are oriented to specific cases. Since many socioeconomic, water quality and ecological impacts are site-specific and plant design-specific (especially cooling system alternatives), a spectrum of confirmatory case-related studies covering a variety of situations and circumstances will be needed to provide a comprehensive set of empirical data on impacts actually realized that will serve to improve the quality and defensibility of estimates or forecasts of these kinds of impacts in an adversarial type of hearing. It should be noted that, in confirmatory impact assessments, it is no less important to ascertain which impacts on the human environment were *insignificant* as it is to determine the magnitude of significant impacts. This is so because the potentiality for public controversy covers a wide spectrum of impacts, many of which are subsequently determined to have been insignificant for specific sites or which can be reduced to acceptable levels through mitigative measures (Cleary, 1977; Spangler, 1978). States which are engaged in their own Environmental Impact Statement preparation or licensing review functions would undoubtedly find many of these confirmatory studies helpful to their own analyses as well as decision making on further delineation of programs and policies to deal with environmental matters, including legislative actions. For those States with an interest in gaining more insight regarding NRC's safety reviews associated with the licensing process, there have been a sizeable number of generic safety studies as listed in the (NUREG) Accession Lists for U.S. Nuclear Regulatory Commission Publications. Several such studies of widespread interest are:

- *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants* (known as the Rasmussen/MIT Study), WASH-1400 (NUREG-75/014), U.S. Nuclear Regulatory Commission, October 1975.
- *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives*, Draft, NUREG-0332, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September, 1977.

TABLE 1
Confirmatory and Generic
Research Program Related to Socioeconomic Impact Assessment

I. *Completed Contract Studies:*

"Development of Methodologies and Analytical Procedures to Quantify the Impact of Nuclear Power Plant Construction and Operation on Local Communities" (Turkey Point)

"Assessment of the Impact of Nuclear Power Plant Construction and Operation on Small Regions" (Robinson)

"A Post Licensing Case Study of Community Effects at Two Operating Nuclear Power Plants" (Pilgrim and Millstone) (ORNL NUREG TM-22)

"Socioeconomic Impacts: Nuclear Power Station Siting" (A Literature Review) (NUREG-0150)

"Effects of Nuclear Power Plants on Community Growth and Residential Property Values" (NUREG/CR-0454)

"A Post Licensing Case Study of Community Effects at Two Operating Nuclear Power Plants (Hatch & Brunswick) (NUREG/CR-0916)

"Post Licensing Community Impact from Trojan Nuclear Power Plant" (NUREG/CR-0973)

"Impact of Offshore Nuclear Generating Stations on Recreational Behavior at Adjacent Coastal Sites" (NUREG-0394)

"Study of the Visual Change Within a Region Due to Alternative Closed Cycle Cooling Systems and Associated Socioeconomic Impacts" (NUREG/CR-0975, 0977, 0986, 0989; there are three additional vols. which have not yet been assigned numbers)

"Three Mile Island Telephone Survey" NUREG/CR-1093)

II. *Studies in Progress:*

"Nuclear Power Station Construction: Labor Force Migration and Residential Choice"

"Small Region Forecasts of Population and Economic Activity"—Technical Assistance From U.S. Department of Commerce

"Construction Labor Force Estimates"—Technical Assistance From U.S. Department of Labor

"Twelve Post Licensing Studies of the Socioeconomic Impacts of Nuclear Power Plant Siting"

"Socioeconomic Consequences of TMI Accident"

"Effect of TMI on Real Estate Markets"

"The Social and Economic Effects of the Accident at Three Mile Island—Findings to Date" (NUREG/CR-1215.)

III. *Planned Studies:*

"Land Use and Demographic Changes in the Vicinity of Nuclear Power Plants"

Source: Cost-Benefit Analysis Branch, Division of Site Safety and Environmental Analysis, Nuclear Reactor Regulation, NRC.

TABLE 2
Confirmatory and Generic Research Program Related to
Technology Assessment

I. *Completed Contract Studies:*

"Commercial Electric Power Cost Studies" (An 8-volume study on the generic capital cost and total generating cost for coal and nuclear-power plants) (NUREG-0241 through -0248)

"Sensitivity of Generation Cost with Changes in Electricity Growth Rates and Issuance of Construction Permits for Nuclear Power Plants" (NUREG-0634)

"The Environmental Effects of Using Coal for Generating Electricity" (NUREG-0252)

II. *Studies in Progress:*

"Improvement of ORNL CONCEPT Computer Code and Updated Data Inputs for the Estimation of Plant Capital Costs and Operation and Maintenance Costs"

"Community, Regional, Health, and Environmental Impacts of the Coal Fuel Cycle"

III. *Planned Studies:*

"Update of Generic Investment Cost Study for Nuclear and Coal Generating Plants"

Source: Cost-Benefit Analysis Branch, Division of Site Safety and Environmental Analysis, Nuclear Reactor Regulation, NRC.

TABLE 3
Confirmatory and Generic Research Program Related to
Environmental Assessments

I. *Completed Contract Studies:*

"The Use of Reconnaissance Level Information for Environmental Assessment" (NUREG/CR-0990)

"Comparison of Simulation Models Used in Assessing the Affects of Power-Plant-Induced Mortality on Fish Populations" (NUREG/CR-0474)

"Fish Protection at Steam-Electric Power Plants: Alternative Screening Devices" (Published by Oak Ridge National Laboratory, Report No. ORNL TM-6472)

"The Application of Fisheries Management Techniques to Assessing Impacts: Task I Report" (NUREG/CR-0572)

"Management of Transmission Line Rights of Way For Fish and Wildlife" (An interagency report being published by the Fish and Wildlife Service U.S. Department of Interior)

"The Application of Aerial Photography Using Infrared Imagery for Environmental Monitoring of Operating Nuclear Plants" (A report being printed by the U.S. Government Printing Office)

II. *Studies in Progress:*

"Biocide Discharges from Nuclear Power Plants into Receiving Waters"

"Simulation Models to Determine Impacts of Nuclear Power Facilities on Fisheries"

"Effects of Power Plant Operation on Marine Borers"

"Significance of Threadfin Shad Impingement at Nuclear Power Plants in Southeastern Reservoirs"

"The Use of Energy Flow Analysis in Land Use Impacts of Alternative Cooling Systems for Nuclear Power Plants"

"Methods to Assess Impacts on Hudson River Striped Bass Populations"

"Methods to Assess Impacts on Hudson River White Perch Populations"

"Source of Condenser Entrainment Mortality on Aquatic Organisms"

"Kinetics of Chlorine—Ammonia Interaction in Sea Water"

"The Products, Pathways, Effects and Fates of Chlorination By-products"

III. *Planned Studies:*

"Chemical Effluents in Surface Waters from Nuclear Power Plants"

"Value of Population Replacement and Habitat Enhancement to Compensate for Nuclear Power Plant Impacts on Fisheries"

"Environmental Impact Assessment Methods and Mitigation Measures to Reduce Risk to Aquatic and Terrestrial Biota"

"Applicability of Plankton Studies in Power Plant Monitoring Programs"

"Applicability of Aerial Photographic Techniques for Site Assessment Relative to Terrestrial Ecology"

"Environmental Monitoring Data Review"

Source: Environmental Specialists Branch, Division of Site Safety and Environmental Analysis, Nuclear Reactor Regulation, NRC.

- *Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0116, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, March 1977.
- *The Nuclear Regulatory Commission Low-Level Radioactive Waste Management Program*, NUREG-0240, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, September 1977.
- *Joint ERDA-NRC Task Force on Safeguards (U)*, Final Report (Unclassified Version), U.S. Nuclear Regulatory Commission and U.S. Energy Research and Development Administration, July 1976.
- *A Study of the Nuclear Regulatory Commission Quality Assurance Program*, NUREG-0321, prepared by Sandia Laboratories for the U.S. Nuclear Regulatory Commission, August 1977.
- *Transport of Radioactive Material in the U.S.: A Detailed Summary of "Survey of Radioactive Material Shipment in the United States"*, NUREG-0073, prepared by the Battelle Northwest Laboratory for the Office of Standards Development, U.S. Nuclear Regulatory Commission, May 1976.
- *Occupational Radiation Exposure at Light Water Cooled Power Reactors: 1969–1975*, T. D. Murphy, *et al.*, NUREG-0109, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, August 1976.
- *Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission*, H. W. Lewis, Chairman, NUREG/CR-0400, September 1978.
- "NRC Statement on Risk Assessment and the Reactor Safety Study Report (WASH-1400) in Light of the Risk Assessment Review Group Report," a statement issued by the U.S. Nuclear Regulatory Commission on January 18, 1979.
- *Final Liquid Pathway Generic Study Report*, NUREG-0440, a comparative study of radiological impacts on man and biota of a postulated core-melt (Class 9) accident for floating nuclear plants versus land based plants, U.S. Nuclear Regulatory Commission, February 1978.
- *Radiological Effluent Technical Specifications*, NUREG-0472 for PWRs and NUREG-0473 for BWRs, U.S. Nuclear Regulatory Commission, July 1979.
- *Activities, Effects, and Impacts of the Coal Fuel Cycle for a 1,000-MWe Electric Power Generating Plant*, a report prepared by Teknekron, Inc. for the U.S. Nuclear Regulatory Commission, October 1979.

A study of special significance for those States interested in siting policy with particular focus on safety-related issues is the *Report of the Siting Policy Task Force* (NUREG-0625, August 1979). Nine policy change recommendations were made by the Siting Policy Task Force to achieve the following goals (p. iii):

(1) To strengthen siting as a factor in defense in depth by establishing requirements for site approval that are independent of plant design consideration. The present policy of permitting plant design features to compensate for unfavorable site characteristics has resulted in improved designs but has tended to deemphasize site isolation.

(2) To take into consideration in siting the risk associated with accidents beyond the design basis (Class 9) by establishing population density and distribution criteria. Plant design improvements have reduced the probability and consequences of design basis accidents, but there remains the residual risk from accidents not considered in the design basis. Although this risk cannot be completely reduced to zero, it can be significantly reduced by selective siting.

(3) To require that sites selected will minimize the risk from energy generation. The selected sites should be among the best available in the region where new generating capacity is needed. Siting requirements should be stringent enough to limit the residual risk of reactor operation but not so stringent as to eliminate the nuclear option from large regions of the country. This is because energy generation from any source has its associated risk, with risks from some energy sources being greater than that of the nuclear option.

As a result of the accident at the Three Mile Island Nuclear Power Station, the President's appointed Commission has made a number of recommendations to improve safety and emergency evacuation planning (Kemeny, 1979). A preliminary analysis and views of

the Nuclear Regulatory Commission regarding these and other recommendations was released on November 9, 1979 (NRC, 1979c). A number of other NRC studies related to the safety aspects of the Three Mile Island (TMI) accident are:

- *TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations*, NUREG-0578, July 1979.
- *Title List: Publicly Available Documents, Three Mile Island Unit 2*, NUREG-0568, Rev. 1, Cumulated to June 30, 1979.
- *Investigation into the March 28, 1979 Three Mile Island Accident by Office of Inspection and Enforcement*, NUREG-0600, August 1979.
- *Evaluation of Long-Term Post-Accident Core Cooling of Three Mile Island Unit 2*, NUREG-0557, May 1979.
- *Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station*, NUREG-0558, May 1979.
- *Three Mile Island Telephone Survey: Preliminary Report on Procedures and Findings*, NUREG/CR-1093, prepared by Mountain West Research, Inc. for the U.S. Nuclear Regulatory Commission, October 1979.

NRC INHOUSE EFFORTS TO IMPROVE THE LICENSING PROCESS

Those States which have expanded or are contemplating an expanded role in the nuclear licensing review process may find useful information in a number of studies or published materials that are designed to improve the effectiveness of NRC's licensing process or that provide a more in depth investigation of controversial issues than are normally provided in routine case reviews. The latter would include special staff treatment and more thorough development of methodologies regarding issues of unusual difficulty or complexity in certain Environmental Impact Statements or supplemental hearing testimonies. An example of a useful testimony is that prepared by Dr. Sidney Feld, Regional Environmental Economist in NRC's Cost-Benefit Analysis Branch, regarding intervenor Contention I-19 in reference to the proposed Wolf Creek Nuclear Generating Station (Feld, 1976):

> The applicants' projections of demand, and thus the assessment of the need for the proposed WCGS, are inadequate and overstated because they fail to take into account price elasticity of demand for electricity. The real price of electricity per kilowatt hour will increase, and will result in a decrease in demand from that predicted by the applicants.

In his supplemental testimony, Dr. Feld provides an illuminating review of the diversity of expert opinion and some of the serious methodological difficulties in forecasting future electricity price elasticities which is a frequent and troublesome issue in need for power analysis in nuclear power licensing actions. Many other hearing testimonies would also provide valuable insight on methodological procedures of generic importance.

Regarding Environmental Impact Statements, there are also a large number of examples (not yet catalogued) that would lend useful insight for the treatment of special environmental and socioeconomic issues. One such example is the EIS for the Indian Point Unit No. 2 nuclear plant, which examined at greater than customary depth the internal and external (or indirect social) costs associated with various cooling system alternatives in compliance with the ASLB's decision to require backfitting of a closed-cycle cooling system to reduce adverse impacts on certain important fishery species of the presently operating open cycle (once-through) cooling system (NRC, 1976b). In support of the analysis of the aesthetic (and related water and land use) impacts of different types and heights of cooling towers, the NRC contracted for a special methodological study by Jones and Jones (1975), a landscape architecture and planning consulting firm. Another useful example involving the issue of risk perception and its possible impact on nearby tourism is found in the socioeconomic impact treatment of the proposed floating nuclear power plant near Atlantic City as set forth in the Draft Environmental Statement for the Atlantic Generating Station and a supporting contract study by Baker et al. (1977) on related impact assessment methodology (NRC, 1976c).

Regarding the possible interest of States in impacts associated with nuclear energy centers, a special projects study by the NRC commands attention. The Energy Reorganization Act of 1974, which established the NRC as an independent agency, mandated in Section 207 the development of a report which would provide any appropriate conclusions and recommendations concerning the feasibility and practicality of locating nuclear power reactors and other elements of the nuclear fuel cycle on nuclear energy center sites including information on a survey of possible sites (NRC, 1976d). The study design features and issues to which attention was directed are described in the Executive Summary:

> The Nuclear Energy Center Site Survey (NECSS) is a study of a potential alternative siting approach for nuclear power and fuel-cycle facilities—an approach that would cluster sizeable groups of such facilities on a relatively small number of sites, as contrasted with current "dispersed" siting practices. The largest aggregation of reactors on a single site being planned today is four, and this "quad" is assumed (for comparative study purposes) to be the typical "dispersed" site by the year 2000.

Three basic types of nuclear energy centers are considered:

- Power plant centers, consisting of 10 to 40 nuclear electric generating units of 1200-megawatt electric capacity each.
- Fuel-cycle centers, consisting of fuel reprocessing plants, mixed-oxide fuel fabrication facilities, and radioactive waste management facilities.
- Combined centers, containing both power plants and fuel-cycle facilities.

Concentrating on differences from dispersed siting approaches, the survey evaluates the feasibility and practicality of the nuclear energy center (NEC) concept.

The major technical *feasibility* issues include dissipation of waste heat from the energy center; transmission systems design, reliability, and economics; economics of energy center construction; and radiological and environmental impacts.

The major *practicality* issues include jurisdictional and institutional constraints; social, sociopolitical and socioeconomic factors; financing; questions related to accident risk, natural disasters, and national security; and safeguarding of strategic special nuclear materials from theft and nuclear plants from sabotage.

While feasibility evaluation is primarily a technical study, the practicality issues are people-oriented; they involve the various interests, perceptions and values of people and the characteristics of institutional instruments.

The survey also included a general screening effort directed towards identifying large land areas that would be likely to contain potentially suitable NEC sites. The screening was done for each of the nine electric reliability regions into which the area of the continuous United States is divided for coordinated planning of dependable electric power supply.

The screening was accomplished by use of selected coarse criteria involving water resources, seismicity, population distribution, and public lands. Both refinement of criteria applied and the factoring-in of additional considerations would be needed to identify specific sites. This would require substantial expenditures of time and money, and could not have been accomplished under the NECSS.

Another study of potential value to States which would participate at greater depth in nuclear power plant licensing reviews is the GESMO study (Generic Environmental Statement on the Use of Recycle Plutonium in Mixed-Oxide Fuel Light Water Cooled Reactors). The scope of safety, environmental and economic analysis of options regarding plutonium recycle found in this study provides far more useful information regarding short-range and long-range fuel cycle and (LWR) nuclear plant review considerations than its rather narrowly-defined title might suggest (NRC, 1976e). The study was prepared to aid the Nuclear Regulatory Commission in the process of arriving at a decision as to whether or not the use of mixed-oxide fuel (a mixture of recycled plutonium oxide and uranium oxide) in light water reactors should be permitted on a wide scale basis and, if so, under what conditions. Chapter 11 on "Economic Analysis and Cost-Benefit Balancing" includes parametric studies on the influence of growth (through the year 2000) in electricity demand; effects on uranium price, the price of separative work, MOX fuel fabrication price, fuel disposal cost; effect of discount rates on decisions to recycle; effect of the fast breeder reactor; and effect of uncertainties on fuel cycle costs.

In order to achieve the societal benefits of making the licensing process more stable and predictable and the cost advantages of reducing the overall time required to issue a construction permit and construct the nuclear power plant, the NRC has developed a number of initiatives resulting in studies or reports that would be useful to States in the exercise of their licensing or permitting responsibilities. These benefits, of course, are principally realized at the State level and particularly at the consumer level within the applicant's general service area. Hence, it would appear that States would have substantial interest in such initiatives, lending support and encouragement to facilitate the attainment of these objectives. A number of NRC efforts are noteworthy in this regard:

(1) Development of policy and the review of specific applications for standardized nuclear power plants (AEC, 1974 and NRC, 1977e).
(2) The formulation of acceptable procedures for early site review (NRC, 1977f).
(3) The development of safety and environmental Standard Review Plans which provide specific procedural instructions to the NRC staff responsible for conducting reviews for licensing applications in the construction and operation of nuclear power plants, including appropriate methodologies and review criteria where practicable and desirable (NRC, 1975b, 1979d, 1976f).
(4) The development or improvement of standards and technical specifications for plant operations which set effective limits on safety and environmental impacts pertaining to each reactor or plant design (NRC, 1976g,h; 1975c).
(5) The development or improvement of regulatory guides which provide information on the kinds of information and analyses to be submitted by the applicant for a construction permit or operating license (NRC, 1975d,e,f,g; 1976i; 1977g).

A number of the above NRC initiatives are intended to provide other benefits or advantages in addition to their role in making the licensing process more uniform and predictable or to achieve the cost reductions in shortening the licensing and construction time. For example, early site reviews hold promise of earlier and more effective public participation in the licensing process. Standard Review Plans will reduce unproductive detailed information and analyses for less consequential impacts and focus more

effectively on the more important safety and environmental issues, thus contributing to sounder and more defensible licensing decisions including mitigative measures. The development or improvement of standards, technical specifications and regulatory guides will have similar benefits.

A staff report by an NRC study group (Denton, 1977b) made a number of recommendations involving opportunities for improving the licensing of nuclear power plants involving the refining of a number of the above measures plus additional initiatives deserving of staff effort:

(1) Improve the quality of applications by improving guidance and strengthening acceptance criteria.
(2) Improve the quality of applications by eliminating unnecessary information.
(3) Increase pre-tendering coordination with applicants.
(4) Expand and restructure the Acceptance Review.
(5) Modify the current review process by developing an Early Safety Evaluation Report based on the application as docketed.
(6) Increase public participation during staff review.
(7) Improve the hearing process.
(8) Study of long-range standardization policy.
(9) Modify LWA (Limited Work Authorization) rules.
(10) Increase use of rulemaking.
(11) Eliminate mandatory ACRS review.

Staff task forces and committees are being organized within NRC to explore more fully the opportunities for licensing improvement of most of the above recommendations. Generic issues, or issues that are frequently raised in hearings and whose treatment has become relatively routine, might suitably be dealt with through rulemaking. In response to a Commission directive, the staff prepared an interim statement of general policy and plans for rulemaking, which the Commission approved for publication in the *Federal Register* (December 14, 1978). This interim policy statement fully supports Executive Order 12044 of March 23, 1978, requesting improvement of existing future government regulations so as to be as simple and clear as possible and avoid imposing unnecessary burdens on the economy, on individuals, on public and private organizations, or on State and local governments. The interim policy statement and supporting discussions are presented in an NRC report, *Preliminary Statement on General Policy for Rulemaking to Improve Nuclear Power Plant Licensing* (NRC, 1978e).

Ten candidate issues were identified by the staff for generic rulemaking: (1) future availability and price of uranium, (2) alternative energy sources to the nuclear option, (3) need for adding baseload generating capacity, (4) methodological and information requirements in the analysis of alternative sites, (5) criteria for the assessment of nuclear plant impacts and mitigative measures; (6) generic procedural criteria to define more concretely NRC responsibility in assessments and decisions regarding certain water-related impacts in relation to the statutory authorities of EPA and permitting states, (7) NEPA decision criteria for OL reviews, (8) occupational radiation exposure control, (9) generic radiological impact for normal lightwater reactor radionuclide releases, and (10) threshold limits for generic disposition of cooling tower effects. Criteria developed by the Steering Committee on Reactor Licensing Rulemaking to aid in identifying suitable candidate issues for rulemaking include the following: the issue must be generic; there must be a likelihood of a useful, definitive rule; and there must be a likelihood of a stable rule. Value-impact criteria for appraising the desirability and priorities of specific proposals for generic rules include:

- Achievement of more effective public input and improved public understanding of NRC's analytical procedures and decision criteria in treating potential environmental and safety issues in the licensing process for nuclear power plants.
- Improvement of the stability and predictability of the licensing process, including the provision of orderly and clear procedures for State-Federal cooperation in treating generic licensing issues.
- Accomplishment of an overall savings of manpower and financial resources of the NRC, the public, the utility industry, and other local, State, and Federal agencies involved in the nuclear licensing process.
- The short-term increase in dollar costs of the various participants in the rulemaking action, including contractual support.
- The additional impacts (i.e., opportunity costs) of diverting manpower and other resources to the rulemaking process and away from other productive uses for a temporary period.

As noted above, one of the ten issues identified for possible generic rulemaking was that of alternative site methodology and information requirements. In order to clarify this issue, the staff issued for comment simultaneously a report on December 14, 1978 entitled, *General Considerations and Issues of Significance on the Evaluation of Alternative Sites for Nuclear Generating Stations under NEPA* (NUREG-0499, Supplement 1). In addition to receiving public comments on the report, the staff conducted a three-day public workshop in March 1979 to actively seek comments and ideas on rulemaking for alternative sites. Representatives from industry, State and Fed-

eral government, public interest groups and others participated. Utilizing public comments and the results of the workshop, the staff drafted proposed amendments to 10 CFR Part 51 which pertain to the evaluation of alternative sites. These amendments were submitted to the Commission in July 1979 for their consideration.

There are a number of useful in-house studies of generic significance prepared by the NRC staff which would be appropriate references for case-related analyses in the preparation of environmental impact statements. As a desirable method of reducing paper work in EIS preparation, the new CEQ regulations (sec. 1502.21) encourage the incorporation by reference of materials relevant to impact analysis (CEQ, 1978). Moreover, the greater in-depth treatment of analytical methodologies, citations of pertinent data and discussions of the complexities and uncertainties of impact causal factors and potential mitigative measures which are pursued in generic studies make for sounder, more defensible environmental decisions.

One such generic study is the NRC staff report on "Coal and Nuclear: A Comparison of the Cost of Generating Baseload Electricity by Region" (Roberts et al., 1978). The purpose of this study is to improve the basis for the staff's independent analysis of the comparative economic evaluations of alternative fuel choices as provided by an applicant for a nuclear construction permit. The study compares the economics of a 2400 MWe nuclear and coal electric generating station in 10 different regions of the United States. Delivered coal costs are the primary cause of regional generating cost variations; therefore, the regions were based on the Department of Energy's (DOE) regions for delivered coal costs. The capital cost for coal-fired generating units includes the cost of sulfur removal. The economics are based on a station beginning operation about 1990 for an investor-owned utility.

The study is based on data inputs from numerous sources, and it avoids the pitfalls of cost analyses based on national averages by highlighting regional differences which—in addition to the transportation costs of coal affecting the delivered cost of coal to different regions—include variations in coal characteristics, and construction costs for labor and materials, as well as labor productivity.

A companion report by the NRC staff is a generic study of the "Sensitivity of Generation Cost with Changes in Electricity Growth Rates and Issuance of Construction Permits for Nuclear Power Plants" (Roberts et al., 1980). The study was done from the licensing point of view. In addition to meeting the NEPA "need for the facility" requirements, the study also provides a generic view of the impacts and costs incurred when it is necessary to deny or delay a construction permit for reasons other than "need for facility". The study identifies areas of the country and situations when economics are likely to be a significant factor in denying or delaying the issuance of a construction permit. An analysis is provided of the impacts on planning schedules and the sensitivity of generation cost with changes in forecasts of electricity demand and changes in issuances of construction permits. The report is based on a generic study of four scenarios for a large system that is representative of a very large utility or a regional reliability council and a small system large enough to accommodate a 1200 MWe nuclear unit either in a single utility system or in a cooperative arrangement involving several smaller utilities.

A preliminary estimate resulting from the *Three Mile Island Telephone Survey* (supra) is that about 144,000 persons temporarily moved out of the zone within 15 miles of the plant site, travelling an average distance of 100 miles to a total of 21 states. This, in itself, is an indicator of substantial psychological stress. Staff studies are in progress which deal with the interrelated topics of psychic (or anxiety) costs, risk perception and risk aversion related to alternative sources of energy for generating electricity (Spangler, 1979). Other staff studies of generic value as related to risk assessment include:

(1) *Demographic Statistics Pertaining to Nuclear Power Reactor Sites*, NUREG-0348, December 1977.

(2) *Aircraft Impact Risk Assessment Data Base for Assessment of Fixed Wing Air Carrier Impact in the Vicinity of Airports*, NUREG-0533, June 1979.

IMPROVED LIAISON AND COORDINATION WITH OTHER FEDERAL AGENCIES WHOSE ACTIVITIES RELATE TO NUCLEAR LICENSING

In Figure 6 of Part I (see Vol. 1, No. 1 of this journal) is shown a variety of activities of other Federal agencies which relate to nuclear power plant licensing. The NRC has already achieved a good measure of liaison and cooperation with such agencies in the performance of the licensing function. Copies of Draft Environmental Statements are routinely sent for review to potentially affected Federal, State and local agencies. For example, the DES for the proposed Black Fox (nuclear) station was sent by the NRC to the following governmental agencies for review (NRC, 1977h):

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development

Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Power Commission
Federal Energy Administration
Office of the Governor of Oklahoma
Mayor of Inola

Because of the frequent interrelation of NRC licensing reviews of certain environmental and safety issues with areas of responsibility and expertise of the Environmental Protection Agency and the Army Corps of Engineers, Memoranda of Understanding have been entered into between NRC and these agencies. A description of this relationship on a case basis is found in the FES for the Black Fox station (p. xiv):

In response to *Memoranda of Understanding* (NRC, 1975h, 1976j) which govern certain interactions of the U.S. Nuclear Regulatory Commission with the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers, the staff has submitted to those agencies, and received comments thereon, *Statements of Positions* (EPA, 1976 and ACE, 1976) which previewed interim staff conclusions and positions of environmental matters of mutual interest. The staff has considered these comments during the preparation of this Environmental Statement. While exclusive jurisdiction resides with the U.S. Environmental Protection Agency (EPA) to regulate nonradiological effluents (and it will do so via its NPDES permit when issued), the NRC is required to assess the environmental impact of permitted discharges. However, in order to ascertain the environmental consequences of power plant licensing, NRC is placing increasing reliance on EPA's permit system, a result of the National Pollution Discharge Elimination System (NPDES). A major step to avoid the confusion and inequity resulting from regulation of the aquatic environment by two Federal agencies was taken with the closely coordinated review of TVA's Yellow Creek Nuclear Station Construction Permit Application. As a consequence of the Yellow Creek Proceeding, which suggested that this approach was not only desirable but legally necessary, the NRC staff is striving to obtain EPA or State agency resolution of questions pertaining to water quality that may arise during NRC's environmental review.

Other relationships with other Federal agencies are generally established on an ad hoc case-by-case basis. For example, the licensing review of the generic statement for the Offshore Power System floating nuclear plant concept and the proposed floating units off the Atlantic Generating Station offshore of New Jersey required very close liaison and frequent meetings with the U.S. Coast Guard. The emergence of any concerns over endangered species habitats which might be affected by a proposed nuclear plant would require close consultation with the cognizant office in the U.S. Department of Interior (USC, 1973). Likewise, any concern over historic impacts would require consultation with the Advisory Council on Historic Conservation which provides an updating service regarding a list of sites throughout the United States of historic and cultural value (NPS, 1977).

Other consultations on technical data and related analyses are frequently made with cognizant Federal agencies regarding geology and seismology, hydrology, meteorology, ecology and the like. Since water supply problems are becoming more acute in various regions or water basins of the United States, increased liaison with cognizant State, regional or Federal agencies on these matters is assuming greater importance. The same is true for the developing State and regional programs under the Coastal Zone Management Act which provides for various kinds of Federal assistance to these programs including problems arising from large-scale energy developments in coastal areas (CZMA, 1972).

Additional detailed information on cooperation with other Federal agencies in the review of environmental and safety impacts involved in the licensing of nuclear power plants may be found in Chapter 3 of the 1979 Annual Report for the U.S. Nuclear Regulatory Commission. The past five years has witnessed a substantial growth in cooperation between Federal, State and local agencies in environmental impact analyses associated with nuclear power facilities. There is good reason to suppose this trend will continue; the alternative to increased cooperation is wasteful duplication, delay, and loss of effectiveness in serving the public interest of reconciling the country's needs for increased domestic sources of energy with protecting or enhancing environmental values.

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