M. Eisgruber, C. B. Braschler, in (4), pp. 19–46.

12. *LACIE: Wheat Yield Models for the United States* (NASA JSC LACIE-00431, rev. A, NTIS, Springfield, Va., 1977); C. M. Sakamoto and S. K. LeDuc, *NASA Tech. Memo. TM-74834* (1977); S. K. LeDuc, *NASA Tech. Memo. TM-74833* (1976). Each LACIE yield model was a zone-specific polynomial based on multiple linear regression of the form $y = x\beta + \epsilon$. The prediction error for this model was computed in the standard statistical manner:

$$(\text{Prediction error})^2 = S^2[1 + x_k'(x_k'x_k)^{-1}x_k]$$

13. The accuracy goal referred to as the 90/90 criterion is equivalent to the probability statement Pr $[|\hat{P} - P| \leq 0.1P] \geq 0.9$, where $\hat{P}$ is the LACIE estimate for a region and $P$ is the true production of the region. Under the assumption that $\hat{P}$ is normally distributed, this probability statement can be written in terms of the coefficient of variation of $\hat{P}$, $CV(\hat{P})$, and the bias, $B = E(\hat{P}) - P$. In terms of $B$ and $CV(\hat{P})$, the probability statement becomes

$$\Phi\left[\frac{0.1 - 1.1\,B/E(\hat{P})}{CV(\hat{P})}\right] - \Phi\left[\frac{-0.1 - 0.9\,B/E(\hat{P})}{CV(\hat{P})}\right] \geq 0.9$$

where $\Phi$ represents the cumulative standard normal distribution. To estimate $B$, estimates of $E(\hat{P})$ and $P$ are necessary. Direct estimation of $E(\hat{P})$ requires replications of the LACIE analysis at the country level, which limited resources prevented. The true production, $P$, is also unknown. We assumed the final government estimates to represent $P$. Fortunately, accurate estimation of $CV(\hat{P})$ requires no independent government estimates. In all countries where the LACIE system was tested, $CV(\hat{P})$ was sufficiently small to satisfy the 90/90 criterion (with no bias, $CV \leq 0.061$). Since $CV(\hat{P})$ could be accurately estimated, it was treated as a parameter, and the probability equation was solved to determine tolerances $[B_0,B_1]$ on $B$ that would satisfy the 90/90 criterion. We then tested the null hypothesis, $H_0$, that the LACIE production estimate, $\hat{P}$, resulted from a 90/90 estimator. To test $H_0$, we first fixed a value of $B$, say $B^*$, where $B^* \in [B_0,B_1]$, and tested the subhypothesis $B = B^*$ against the alternative $B \neq B^*$, using the statistic $\hat{B} = \hat{P} - P$ (the single-year estimate of bias at the country level) and assuming $\hat{B} \sim N(B,\hat{\sigma}_{\hat{P}}^2)$. A "probability value" for this test is given by $\Pi(B^*) = \Pr[|B - B^*| > |b - B^*|]$, given $B \sim N(B^*, \hat{\sigma}_{\hat{P}}^2)$, where $b$ is the observed difference between the LACIE and the official government production estimate. The overall hypothesis, $H_0$, is rejected if $\max_{B^* \in [B_0,B_1]} \Pi(B^*) < \alpha$, where $\alpha$ is a predetermined significance level.

14. A critical issue for technology evaluation in foreign countries is the reliability of the government's assessment of its own crop. In the U.S.S.R., reliability estimates are not available. Soviet production estimates are believed to be more reliable (6) than area or yield. The Soviets have no national survey for yield and only an incomplete survey for harvested area.

15. The U.S.S.R. releases a planning figure for total grain production early in the year and a post-harvest estimate of total grain production in early November; wheat statistics are not released until the following January or February.

16. For the years 1971 to 1976, averages are given in *U.S. Dep. Agric. Econ. Res. Serv. Foreign Agric. Econ. Rep. 132* (April 1977).

17. "Wheat situation," *U.S. Dep. Agric. Econ. Res. Serv. Rep. WS-239* (February 1977).

18. "Second forecast of 1977 Soviet grain crop," *U.S. Dep. Agric. Foreign Agric. Serv. Rep. FG 10-77* (8 July 1977).

19. "World grain situation 1977/78, crop and trade development," *U.S. Dep. Agric. Foreign Agric. Serv. Rep. FG 21-77* (20 October 1977).

20. Computed by the method of C. W. Thornthwaite, *Geogr. Rev.* **38**, 55 (1948).

21. D. R. Thompson and O. A. Wehmanen, *Photogramm. Eng. Remote Sensing* **45**, 201 (1979).

22. No test sites were available in 1975 for the total U.S. Great Plains. Most recent results of 1978 LACIE follow-on testing are included in Fig. 8 for comparison with 1976 and 1977.

23. A strip-fallow field is a series of narrow, alternating strips of small grain and fallow soil, which are rotated on a yearly basis to collect a soil moisture reserve before planting.

# A Federalist Strategy for Nuclear Waste Management

Kai N. Lee

*Summary.* The federal government plans to rely on a policy of "consultation and concurrence" with state governments in developing nuclear waste repositories. The weaknesses of the concurrence approach are analyzed, and an alternative institutional framework for locating a waste repository is proposed: a siting jury that provides representation for state and local interests, while maintaining a high level of technical review. The proposal could be tested in the siting of away-from-reactor storage facilities for spent nuclear fuel.

Once or perhaps twice in the remainder of this century the U.S. government will establish a permanent repository for high-level radioactive wastes. Entangled in the wider controversy over nuclear energy, the siting of a waste repository has become an unwieldy and controversial task. Since March 1977 more than 15 states have enacted laws that regulate storage or forbid disposal of radioactive wastes within their borders (*1*).

President Carter announced on 12 February a new policy on nuclear wastes (*2*). His statement embraces many of the recommendations of the Interagency Review Group on Nuclear Waste Management (IRG) chartered by the President in 1977 (*3*). The new policy provides that state governments are to have a "continuing role in decision-making with regard to the federal government's actions" (*4*) in nuclear waste disposal. This is the principle of "consultation and concurrence."

"Consultation and concurrence" is, perhaps unwittingly, a reaffirmation of traditional American values. Beer wrote of the Constitution (*5*),

> The essence of the invention of 1787 was the use of the same electorate to choose two sets of governments, each with constitutional protection. . . . Governing himself through two governments, the voter views the political world from two perspectives, one shaped by the social pluralism of the general government, the other shaped by the territorial pluralism of the state government.

The idea of giving state governments a role commensurate with federal executive agencies is so old that it has had to be rediscovered.

There is consensus on consultation. Sharing of information between federal and state authorities is widely thought to be an essential steppingstone toward orderly siting (*6*).

If consultation enjoys support, "concurrence" elicits delicate evasion and postponement. "States and localities will accept their share of responsibility," an interpretation by the Department of Energy (DOE) assumes (*6*), without suggesting why this acceptance should be expected. Indeed, no state will generate enough waste from commercial nuclear power to approach the capacity of a single geologic repository; what does a fair "share of responsibility" comprise? Which decisions should be taken to be final, once ratified by federal executive agencies and state governments? Land tenure, financing and capitalization, and transfer payments to mitigate localized impacts could presumably be settled in this fashion. But what about the roles of local government, citizen groups, or the Nuclear Regulatory Commission (NRC)? More generally, how are long-run interests and short-term pressures to be reconciled? Environmental pollution

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is not in anyone's long-run interest, but it occurs in depressing volume. Most important, what happens if state and federal governments "nonconcur"? The very word has an Orwellian ring.

A design for concurrence is suggested below in which a siting jury selected by states and local governments serves as a forum to settle conflicts between the federal government and its critics. It may be sensible to experiment with the jury approach in the siting of a storage facility for spent nuclear fuel.

The siting jury aims at overcoming the basic institutional problem posed by a nuclear waste repository, the mismatch between knowledgeability and accountability. Early in the decision process, not enough is known about which geologic strata and specific sites are suitable for a repository. Here there must be cooperation between local and national authorities if information needed for a technically satisfactory location is to be obtained. Late in the decision process, a politically stable choice requires that local and national authorities operate at arm's length, so that local interests may be fairly and credibly balanced against national ones. The goal of the proposed scheme is to preserve both early learning opportunities and independent judgment at the time a site is chosen.

## Competing Rationalities

Our image of the rational decisionmaker is a clearheaded autocrat, someone who knows what he wants and how to get it. Neither clearheadedness nor autocracy prevails in the world of public policy. Lack of clear thinking is most commonly complained of, but conflict and divided power are more frequently found (*7*).

Improving the probability of rational outcomes in the face of conflict begins with the recognition that conflict is itself often rational. Indeed, conflict can be thought of as competition between rational systems of ends and means—systems that are nonetheless incompatible with one another. The sequence of outcomes when conflict persists can mix the competing rationalities, appearing inconsistent and irrational. Consider two stereotyped viewpoints:

From the first of these, which may be labeled Technocratic Rationalism, radioactive waste disposal is a tractable technical problem; enough is known to proceed with an orderly program, as part of a continued expansion of nuclear power generation. Delay in developing the nuclear option threatens the economic well-being of the nation, without creditable technical cause.

Technocratic rationalists are optimistic: Estimates of waste confinement and of the dangers posed by release of wastes are reassuring, and these estimates are based on models and analyses that are sound. Public fears, while politically troublesome, are nothing more than misinformation compounded by antinuclear demagoguery.

Moreover, technocratic rationalism is confident. What is needed is strong presidential leadership, clear decisions, and implementation by the federal government; DOE should be designated the lead federal agency.

The other stereotype might be labeled Cautionary Consultation: Scientists and other credible experts disagree about how to proceed with the management of these long-lived residues of nuclear weapons development and the costly nuclear power program. The unease of the general public is politically compelling and has a sound basis in technical uncertainty. Although safe disposal of wastes is important, there is no need to rush; it is more important to reestablish public confidence. Nuclear power will have to wait.

Cautionary consultation emphasizes uncertainty: Highly simplified models of how radioactive materials will behave under geologic conditions are untrustworthy. Public fears are justified. There are no clear procedures for resolving disputes as they emerge.

Cautionary consultation also stresses patience: Given the need for additional research, and the fact that irreversible disposal is not urgent, it may be more important to proceed systematically with technical learning. In addition, bureaucratic momentum must not be allowed to force a premature choice in an inappropriate medium or location. In the meantime, vigorous conservation and development of alternative energy resources can adequately meet the nation's needs for electric power.

In the competition between rationalities, technocratic rationalism has traditionally guided federal waste management policy (*8*). But the politics of the nuclear waste issue have increasingly become those of cautionary consultation (*9*). Indeed, the odyssey of nuclear policy is an excellent illustration of Gamson's remark that "efforts toward broader planning . . . may have the incidental and unintended consequence of increasing the degree of competition" (*10*). Yet cautionary consultation offers few solutions to the problems facing the nuclear industry. Technocratic rationalists have suffered the frustration of pursuing goals they consider—with substantial public support—to be legitimate, but in a setting where their model of political process is inappropriate, even perverse.

These stereotypes are not meant simply to be descriptive nor are they necessarily predictive. When there is controversy, it is important to identify the different value implications of contending positions. What an actor thinks the political process *should* do influences his interpretation of what happens. Moreover, in the presence of irreducible uncertainty strongly held values compete with analysis as a means of achieving psychologically satisfactory explanations.

The IRG sought a middle path between technocratic rationalism and cautionary consultation. It has accordingly been criticized for legitimating both pro- and antinuclear positions through the deliberately ambiguous wording of its report. Compromise is not a lucid art. But finding a way to pursue safe waste disposal without imposing technocratic rationalism or acquiescing in cautionary delay remains a major challenge. The unresolved competition between these two rationalities links together issues in ways that inhibit conflict resolution. This social phenomenon has been labeled turbulence by Haas (*11*):

> The number of actors is very large; each actor pursues a variety of objectives which are mutually incompatible, but each is unsure of the trade-offs between the objectives; each actor is tied into a network of interdependencies with other actors who are as confused as he.

An indispensable aspect of policy development must therefore be an institutional approach that calms turbulence through recognizing and resolving conflicts. The struggle to create a permanent waste disposal system reflects tensions which are real and durable. They have not been resolved despite considerable scientific agreement, and they cannot be extinguished by presidential or congressional fiat even if either were forthcoming. Conflict is, accordingly, not necessarily a sign of trouble, except for those nominally in charge (*12*).

Managing conflict under conditions of high technological complexity and political uncertainty is, however, a task for which none of the principal contenders has much experience. Nuclear waste disposal, when it finally takes place, will require the reestablishment of a zone of consensus sufficient to permit pro-

ceeding with technically sophisticated administration; an organizational framework of sufficient internal stability and external responsiveness to improve even as it performs at a high level; local social arrangements able to accommodate the stresses of a dominant single industry; and a larger political environment, including a legislative mandate, in which important related questions, such as the viability of commercial nuclear power, inform the purposes of waste management without wholly disrupting progress toward safe disposal.

### Consultation and Concurrence

These long-term requirements may be compared against the concept of consultation and concurrence developed by the National Governors Association and partially adopted by the IRG and the President. Though it calls for "a comprehensive national nuclear waste management program" (*13*), the governors' statement emphasizes procedural steps, an indication that incremental rather than comprehensive solutions are being pursued. Moreover, while acknowledging that a long-term objective for the nation should be safe disposal of radioactive waste, the governors concede no short-run sharing of goals, warning that "the Department of Energy must 'obtain state concurrence prior to final waste disposal site determination' "(*13*).

Perhaps because of their desire to influence the Executive Branch, the governors stress administrative participation. A State Planning Council (SPC), whose representational status with respect to any particular state is left unclear, is put forth as the principal forum for state interests; it should be accorded "equal standing with federal agencies" in access to the President or Congress (*13*, p. 5).

Clout in the "permanent government" of Washington, D.C., does seem indispensable to the decades-long task of formulating a nuclear waste policy. Yet the governors opt for a heavily symbolic conception of political power: State governors are to dominate in the SPC, and the council, as the states' planning apparatus, should have a protected position in the White House staff (*13*, p. 7). Functionally, the SPC is to provide an annual report and supervise advisory committees. Neither of these activities is linked clearly to regional placement of facilities or site selection, the key responsibilities exercised by the council.

While accepting much of the position drafted by the National Governors Association, the IRG proposed a council that "would not involve implementation responsibilities" (*3*, p. 92). Given the abundant political dangers of becoming involved in nuclear waste operations, the governors might not want such responsibilities in any case. Bargaining between state and federal government has thus settled upon visible participation by state elected officials, seeking to legitimize the principle that "state governments, through their governors, are an effective medium for public participation in the national decisionmaking process" (*13*, p. 6).

This is the less than fully defined context of consultation and concurrence: "an on-going dialogue . . . and the development of a cooperative relationship between states and all relevant federal agencies" in site selection (*3*, p. 95). The implication of this policy is that the sharing of information will largely resolve conflicts between state and federal authorities. Yet the history of environmental controversies indicates that sharing of information can elicit still more conflict, in the short run at least (*14*). Thus the most serious deficiency of consultation and concurrence is that there is no means advanced by either the governors or the IRG for resolving cases of nonconcurrence. What seems to be involved is bargaining to achieve compromises over conflicting ends. But bargaining by whom, and on what range of stakes, remains unclear.

To summarize: The problem addressed by consultation and concurrence is that of insufficient understanding by state officials of both the technical findings to date and the technical uncertainties that remain. State governments are a key to the decisions that need to be made, because they exercise authority independent of the national government. Thus, an extended process of information diffusion—consultation—will lead, it is hoped, to agreement on the details of a waste disposal program—concurrence.

This noble hope seeks to preserve the principle of dual government embodied in the Constitution: that representation of citizens through both a national and a state government will provide better protection against tyranny than either alone. The social and territorial pluralism of the Constitution is reconfigured in an attempt to seek agreement on means through consultation, followed by agreement on ends, through concurrence.

Because the level of conflict is high and rising, thinking of consultation as exclusively a concern with means and concurrence as one with ends is too simple. For example, consultation on technical criteria will lead to the establishment of more than means alone. But this simple distinction warns us that agreement on means does not lead automatically to agreement on ends.

### Designing for Nonconcurrence

In fact, the history of nuclear waste management makes the DOE and other federal agencies unlikely allies of the states. The inclusion of state governments in national decision-making, although important in principle, must be designed with attention to its practical political feasibility. To draw in the states as the new federal policy does, siding with the national government and one of its most controversial agencies, may fritter away one of the few sources of legitimacy left in an already tattered political fabric.

A different approach begins with the observation that conflicts are two-sided affairs which frequently benefit from becoming three-cornered. The proponent of nuclear waste disposal is the federal government, backed by the nuclear industry. On the other side is a variety of adversaries: environmentalists concerned about long-term risks; local governments worried about short-term impacts; and antinuclear activists eager to strike at the Achilles' heel of nuclear power—the lack of long-term disposal credible to the public. Siting of permanent waste repositories will probably settle on one and perhaps two locations for intensive development by the turn of the century. Given this context of high conflict and sparse final decision points, can state governments become most constructively involved by siding with one disputant or the other? Populist pressures and short-run political calculations have led states to side thus far with opponents; the federal government seeks to draw the states into siding with proponents.

An alternative is for the states to act as third parties in the conflict. Intervention by a third party is essentially a judicial function, hence a siting jury.

Before describing the jury proposal, it is necessary to outline some structural requirements of a judicial approach. Intervention in a two-sided conflict by an impartial third party is often sought by the disputants themselves. Yet this triadic relationship is inherently fragile: once a decision is rendered, the triangle collapses into two-against-one (*15*). The loser is tempted to rethink his earlier be-

Table 1. The siting jury: membership and functions.

| Program phase | Jury membership | Function |
|---|---|---|
| National regional study | One foreman chosen in each state with potential for a site | Liaison to State Planning Council on generic technological issues and national policy questions |
| [State dropped from consideration by DOE] | [Jury membership terminated] | |
| Regional site-characterization studies | Add in each state one juror from a panel named by National Governors Association and one juror from panel chosen by National Conference of State Legislatures | Advise state on procedural and generic issues; liaison to NRC staff |
| [State dropped from consideration] | [Jury membership terminated] | |
| Site proposal | Add one juror representing local governments and one representing House of Representatives | Conduct hearings on suitability of site, and recommend on suitability to NRC and the President |
| [Site disapproved] | [Jury membership terminated] | |
| Site licensed | Same | Monitor construction and operation for state and local governments (at option of state) |

lief in the impartiality of the judge. This is one reason that all human societies have found it necessary to clothe their judges in a myth of evenhanded infallibility. Moreover, judges are aware of the frailty of rulings, and thus seek compromises—whether negotiated among the disputants or imposed by the judge—in order to avoid decisions of an all-or-nothing character.

Primitive societies chose their judges from the "big men" in the community—those with manifest skills in managing human affairs and with a stake in community esteem high enough to promote impartiality. The expansion of the social order beyond village scale made it necessary to formalize the judicial function, so that law, established by tradition, precedent, or legislation, came to structure the settlement of disputes. Not only did considerations of fairness and equity become law, but the judges became officials—persons who derive their status as much from the office they hold as from their standing in the community (*15*, pp. 322–325). An additional refinement in the Anglo-American tradition is to separate factual judgments from legal ones. The authority of juries to render factual findings derives from their status as a group of persons whose circumstances are equivalent to those of the parties at interest.

Such an anthropological perspective suggests that resolving a conflict between the federal proponent of a disposal site and its opponents is less a question of law than of stability. In short, what is called for is the modern analog of the "big men" of the community, to arrive at a judgment that can endure beyond the handing down of the decision. The importance of the symbols of power, therefore, lies in a rather different direction from that proposed by the National Governors Association: the point is less to influence a technically complex and inevitably controversial outcome than to strengthen the possibility that outcomes can be chosen in ways that are technically sound and politically sustainable.

The legitimacy of such a decision rests upon cultural, political, and legal bases. Hence the design of a leading legislative proposal, the Percy-Glenn bill (*16*), establishing a set of ad hoc fact-finding councils, with states being granted the right of appeal to Congress. Given the importance accorded nuclear waste disposal, some ad hoc governmental structure appears to be needed to supplement the existing channels of technical and political review in Congress, the NRC, and the Executive Branch (*17*). The siting jury idea, although similar in purpose to the Percy-Glenn proposal, places the burden of choice on a body appointed by state and local jurisdictions and so constituted as to harmonize the somewhat contradictory desires for decision-making that is both knowledgeable and accountable.

## The Jury Process

The federal government would propose one site after a sustained technical search and extensive consultation with states and interested citizens. (This discussion does not consider the complexities of competition among sites.) As part of the process of consultation, opposition to the site would be identified and competitive analyses undertaken from a variety of perspectives. These would all be brought before a siting jury, which would make a recommendation to the President about the suitability of that site.

A five-member jury would be formed in three stages, as DOE moves toward site selection. In the initial phase, while a nationwide program for identifying geologic regions is in progress, each state overlapping one or more strata of interest would appoint a state representative. In later stages, this person would become the foreman of the siting jury.

This state representative should be chosen jointly by the governor and the legislature and should serve—barring misbehavior—until a site has been chosen, or until the federal government states formally that no site within the state will be considered. Making the state representatives' tenure equal in duration to the site selection process serves two ends. First, these persons will have the chance to master the complex mix of scientific, managerial, and political questions at stake in nuclear waste disposal. Second, being insulated from political removal provides a degree of judicial independence that is conducive to both deliberation and credibility (*18*).

As DOE's work progresses to the selection of particular regions for site characterization, two members would be added to the jury of each state still under study, each juror being selected randomly from one of two panels. One panel would be selected by the National Governors Association, the other by the National Conference of State Legislatures. These jurors reflect territorial diversity at the statewide level. Like the foreman, they would serve until a site is selected or until their state is dropped from consideration. This three-person jury serves as an advisory body to the state with regard to procedural and generic questions, as described below.

When sites are identified by DOE, the jury of each state still involved would be brought to full strength with the addition of two more members. One would be chosen randomly from a panel selected by a national association of local government officials, the other from a panel

named by the U.S. House of Representatives. These jurors provide representation of jurisdictions smaller than states. In order to enhance the stature of the jury, hearings that combine voir dire with a programmatic review of the siting program could be conducted by the U.S. Senate.

The jury-empaneling process is summarized in Table 1. As indicated, the functions of the jury evolve with the siting process. At the start, states and the federal government jointly develop information on technically suitable locations for waste disposal. At the point of site selection, however, states need an independent, arm's-length relationship with the federal sponsor, in order to articulate the state's position about both the ends and the means of proceeding toward disposal at a particular location. For this reason, the jury's formal responsibilities would provide close ties only with the SPC and the NRC, not with DOE.

Although judgments about the acceptability of the risks remaining may differ at the moment a site is being chosen, it is impossible even to describe those risks if the states hamstring federal studies from the outset. By the same token, state cooperation can, with the siting jury, be premised on an independent determination of site suitability, a determination that ranges beyond the technical ambit of the NRC.

As the technical program to find suitable sites progresses, a host of procedural and scientific questions is sure to arise. For example, in what circumstances and with what conditions should states permit federal studies of geological strata? What priorities should be accorded the various criteria used to select sites? What role should be taken by states affected by transportation of wastes or other concomitant effects? Procedural questions can be assigned to an SPC, and Congress should explicitly authorize the SPC to arbitrate differences between federal agencies and states. Generic technical issues require a more complicated approach, since the NRC retains independent regulatory authority. For this reason, the siting jury would be assigned liaison responsibilities to work with NRC staff as a siting decision approaches. Such a consultative process would also permit informal NRC review of the technical program before the formal licensing procedure is initiated.

Once a site proposal is prepared by federal executive agencies, the siting jury would proceed in parallel with NRC. Hearings on the suitability of the site would be held, to put on the record controversial technical, environmental, and social issues. While the NRC review focuses on technical compliance with regulatory criteria, the jury's deliberations should concentrate on a broader, carefully argued judgment balancing local effects of siting, operation, and transportation against the national interest in safe, permanent disposal. If the jury's credibility with the public and Congress is high, its recommendation on suitability should carry considerable weight with the President—more weight, perhaps, than the state in question can bring to bear. If after NRC review the President grants a license, he should be required to state his reasons for accepting or rejecting the jury's advice, as part of a request to Congress to authorize construction or of the announcement of a decision not to proceed.

After a site is licensed, the siting jury's expertise should be of continuing utility to state governments in designing and operating ways to monitor federal activities in construction, operation, and eventually closure. This continuing relationship must not be negotiated, of course, until after the jury's decision, in order to preclude conflicts of economic interest.

This approach defines concurrence in a way that gives state and local governments politically influential voices, but without raising the vexatious question of whether the federal government has the right to preempt local decision-making. (The President's decision would presumably remain open to judicial appeal as well as congressional challenge.) By drawing upon the political bases of governors, state legislators, local government, and the House of Representatives, we would use to its maximum the territorial plurality of the constitutional scheme of representation—at least in theory. Whether such a design could rally political support in actuality is a rather different question, however.

This notional design ignores interactions among site proposals. In addition, it must be recognized that the jury will operate for a number of years and thus will become a political actor. Unlike the conventional petit jury, the siting jury would be susceptible both to charges of vested interest and to attempts to influence its decisions. These hazards seem worth running in order to provide enough time to learn the intricacies of repository siting. But these hazards may overwhelm the credibility of the jury in the eyes of affected populations. Moreover, institutional competition between the jury and the NRC needs to be studied. Further analysis of the jury idea is therefore desirable; perhaps more important, the idea can be tried out in a quasi-experimental fashion.

In the near term it is feasible to use a streamlined version of the siting jury to locate away-from-reactor interim storage facilities for spent nuclear fuel (AFR). These facilities may be required within 5 to 10 years, as storage at reactors fills to capacity. Four siting-jury panels could be created as outlined above, to explore the political and organizational problems of selecting representatives from the unusually structured national constituencies of governors, legislators, and local governments. No new legislation would be needed if the jury were to advise the Secretary of Energy instead of the President. Since AFR's are not disposal sites, no irreversible choices would be made, but in most other respects the institutional feasibility of concurrence based on state and local representation would be subjected to realistic experimentation.

### Linkage and Legislation

Social experimentation with an AFR siting jury would provide a badly needed institutional learning opportunity (*19*). In the meantime, Congress and the President must weigh the difficult political question of how waste disposal is to be disentangled from the broader nuclear controversy. Without an authoritative decision on this divisive issue, no ad hoc body such as the siting jury can reach politically legitimate recommedations on nuclear policy.

It is obvious by now that dispute over waste management is more than a question of the appropriate means to handle a toxic substance. It reflects as well deep divisions about the ends to be served by nuclear-generated electric power (*20*). To the embattled industry, an operational waste repository has become a strategic Gibraltar: the fortification controlling access from the confined and troubled waters of Three Mile Island to the boundless frontiers of a nuclear future. Opponents sense in the repository issue the industry's Waterloo instead.

Nuclear waste management has been transformed from an issue with no constituency to one with several conflicting ones. Neither situation promotes a stable, long-term resolution of the technological complexities of safe disposal. Conflict between single-interest constituencies like the nuclear industry and antinuclear forces puts before government the task of separating issues that are politically linked. Such an "internal" strategy should be contrasted with an

"external" approach that hastens down a so-called "fast track" (*21*). The internal approach offers structured assurance that scientific uncertainties will be coherently addressed; the external approach trusts to luck.

The feasibility of untangling linked issues in an election year is constrained, however. In the short run, it may be useful to enact legislation committing DOE formally to a policy of consultation with states, local governments, and citizen groups. At the same time, it seems sensible to defer formalizing concurrence, since no credible institutional design has yet emerged in federal policy discussions. Deemphasizing concurrence would also facilitate information sharing, since consultation would no longer be part of a bargaining relationship.

Early in the 1980's, however, Congress and the President should approach the question of whether commercial nuclear power should be held hostage by a continuing interregnum in waste management. One strategy to disentangle the two issues is to proceed with a scientifically sophisticated development program to dispose of the existing military nuclear waste inventory (*22*). Despite substantial technological differences from commercially generated waste, the long-run geologic containment requirements of defense wastes are identical. Progress in waste disposal need not entail endorsement of nuclear electric energy.

## Conclusion

Complexity is unavoidable in radioactive waste management. It is crucial to structure institutional incentives with care. The history of government regulation is replete with instances of agencies' being captured by those they are supposed to regulate; parochial log-rolling compromises that do not aggregate into a broader public interest; and insufficient budgetary and intellectual resources devoted to analysis. That the Carter Administration recognizes the large institutional questions at stake is an important sign of progress.

Research supportive of institutional design should be promptly expanded. Studies are needed of how complex technologies can be regulated, particularly the question of when and whether criteria can be established by delegation to administrative agencies. Institutional mechanisms for recognizing and managing conflict are seriously underdeveloped. And much less is known than is desirable about how long-term institutional stabilization takes place in mixed public-private enterprises of the sort likely to develop in radioactive waste management.

Consideration of the implementation problems of consultation and concurrence, in short, puts a different light on the long-term nature of the nuclear waste issue. However long the wastes themselves remain toxic, the political and technological solution to waste disposal will take at least half a century to achieve—a length of time comparable with the age of the Ford Motor Company or the Federal Bureau of Investigation. Rational, accountable control of enterprises of this temporal scale has been at best imperfect in the past; although much more than conceptual understanding of institutional design is required to meet this challenge, it remains the indispensable place to begin.

### References and Notes


1. *Congr. Rec.* **125**, S9496 (16 July 1979).
2. L. J. Carter, *Science* **207**, 851 (1980).
3. Interagency Review Group on Nuclear Waste Management, *Report to the President* (TID-29442, National Technical Information Service, Springfield, Va., March 1979).
4. President's message to Congress on radioactive waste management, 12 February 1980, quoted in (*2*).
5. S. H. Beer, *Am. Polit. Sci. Rev.* **72**, 14 (1978).
6. Office of Nuclear Waste Isolation, *Consultation and Concurrence* (ONWI-87, Department of Energy, Columbus, Ohio, 1980).
7. G. T. Allison, *Am. Polit. Sci. Rev.* **63**, 689 (1969); J. D. Greenstone and P. E. Peterson, *Race and Authority in Urban Politics* (Russell Sage Foundation, New York, 1973), pp. 100–109 and 264–293; C. Tilly, *From Mobilization to Revolution* (Addison-Wesley, Reading, Mass., 1978), chaps. 3 and 4; K. N. Lee, D. L. Klemka, M. E. Marts, *Electric Power and the Future of the Pacific Northwest* (Univ. of Washington Press, Seattle, 1980), chaps. 6 and 7.
8. D. S. Metlay, in *Essays on Issues Relevant to the Regulation of Radioactive Waste Management* (NUREG-0412, National Technical Information Service, Springfield, Va., 1978).
9. L. J. Carter, *Science* **206**, 312 (1979).
10. W. A. Gamson, *Am. Behav. Sci.* **12**, 20 (November–December 1969).
11. E. B. Haas, *The Obsolescence of Regional Integration Theory*, Research Series No. 25 (Institute of International Studies, University of California, Berkeley, 1975), p. 18.
12. See L. A. Coser, *The Social Functions of Conflict* (Free Press, New York, 1956), chap. 9.
13. National Governors Association, Nuclear Power Subcommittee, "Recommendations toward establishing a publicly responsive and acceptable national nuclear waste management policy," 8 May 1979, unpublished.
14. D. Nelkin, *Bull. At. Sci.* **30** (No. 9), 29 (1974).
15. M. Shapiro, in *Handbook of Political Science*, F. I. Greenstein and N. W. Polsby, Eds. (Addison-Wesley, Reading, Mass., 1975), vol. 6, p. 321.
16. U.S. Senate, S742, 96th Cong. 1st sess., 22 March 1979.
17. See M. O'Hare, *Public Policy* **25**, 407 (1977). Economic strategies for siting unwelcome facilities depend upon either negligible risk or equal access to information by proponent and affected constituencies. This is unlikely to be a credible assumption, even if defensible, in the case of nuclear waste.
18. The state jury foreman is not intended to be the only representative of state interests. In particular, independent state capability to undertake reviews of technical findings is needed as part of the consultation process.
19. The IRG recommended institutional learning through the formal licensing of an intermediate-scale disposal facility (*3*, p. 58). The emphasis here lies on the building of political consent before licensing; it would thus be possible to exercise the licensing process in the same case in which the siting jury had been tried.
20. A. B. Lovins, *Foreign Affairs* **55**, 65 (1976).
21. U.S. Senate, S2189, 96th Cong., 2nd sess., 3 January 1980, sect. 405.
22. Congress has been reluctant to proceed with disposal of military wastes, however, fearing competition with spending for current military capabilities as well as the uncertainties of repository licensing.


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