Chapter 6

The Regulation of Nuclear Power

Photo credit: Florida Power & Light

One of **aisles** in the document vault **at St. Lucie** 2

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Nuclear power is one of the most intensively regulated industries in the United States, and the scope and practice of regulation are among the most volatile issues surrounding the future of nuclear power. Strong—and usually conflicting—opinions abound among the participants in the nuclear debate on whether the current regulatory system is adequate to ensure safe and reliable powerplants or is excessive, and whether it is enforced adequately or is interpreted too narrowly.

Every aspect of the nuclear industry—from the establishment of standards for exposure to radiation to the siting, design, and operation of nuclear powerplants and the transportation, use, and disposal of nuclear materials–is regulated at the Federal, State, or local level. In general, the Federal Government retains exclusive legislative and regulatory jurisdiction over the radiological health and safety and national security aspects of the construction and operation of nuclear reactors, while State and local governments share the regulation of the siting and environmental impacts of nuclear powerplants and retain their traditional responsibility to determine questions of need for power, reliability, user rates, and other related State concerns.

This chapter describes the existing regulatory process at the Federal, State, and local levels; reviews the various criticisms of that process raised by the different parties in the nuclear debate; and discusses proposals for substantive and procedural changes in nuclear power regulation. The chapter focuses on the health and safety and environmental regulation of nuclear powerplants; financial and rate regulation are discussed in chapter 3.

It should be emphasized that this chapter primarily reports on the existing regulatory process and on proposals for changes in that process. Arguments for and against the existing system and proposed changes are presented as they appear in the literature or as OTA determined them in the course of this study. Such criticisms of the regulatory system can reflect the biases and vested interests of the commentators. In light of this, it is important to examine the arguments critically from a safety and efficiency perspective. Where OTA found sufficient documentation to support a particular argument, the basis for the conclusions is identified. In instances where OTA could not make such a determination, the arguments are presented without conclusions to illustrate the scope of the controversy and the wide divergence among the parties' perceptions of the current role of regulation and of the need for changes in the regulatory system.

FEDERAL REGULATON

The primary forms of regulation under the Atomic Energy Act (see box D) are: 1) the issuance of licenses for the construction and operation of reactors and 2) inspection and enforcement to ensure that nuclear plants are built and operated in conformance with the terms of a license. This section describes the licensing process that was put in place during the 1970's when the last group of plants received construction permits. This is precisely the licensing process that has been the target of so much criticism by the nuclear industry, utilities, nuclear critics, and regulators. In addition, this section discusses the way in which this licensing process might operate in the current climate. Although the basic regulations have not changed substantially since the 1970's, the way those regulations are applied to construction permits or operating licenses might be very different if an application were filed today.

Box D.—Historical Overview of Nuclear Regulation

Federal oversight of the nuclear industry began in the early 1940's with military control of the development of nuclear fission to produce weapons-grade fuel. In 1946, Congress passed the first Atomic Energy Act, which was designed primarily to protect "atomic secrets" so that the U.S. monopoly on nuclear weapons and technology would be preserved. The act also established an Atomic Energy Commission (AEC) to provide civilian control over nuclear weapons and investigate the potential for peaceful uses of atomic energy.* The 1946 act expressly forbade private ownership of nuclear materials and established an absolute government monopoly over nuclear energy. The Joint Committee on Atomic Energy, composed of nine Senators and nine Representatives, also was formed in 1946 as the prime congressional committee responsible for nuclear energy.

In 1947, the Reactor Safeguards Committee was established within AEC to review the hazards of proposed nuclear plants. But AEC remained largely preoccupied with weapons development until the early 1950's, when the Naval Reactors Branch successfully demonstrated a pressurized water reactor, thus laying the foundation for a workable technology to generate power through nuclear fission. Spurred by this demonstration and developments abroad, by the burgeoning demand for electricity, and by reports from the Joint Committee expressing dissatisfaction with AEC's lack of progress in reactor development, the Eisenhower administration urged Congress to amend the 1946 act so that private industry could enter the nuclear energy business.

In 1954, Congress amended the Atomic Energy Act, directing AEC to promote nuclear energy and to regulate the emerging nuclear industry by issuing licenses to private companies to build and operate commercial nuclear power stations and by adopting whatever rules were deemed necessary to protect the public health and safety. In 1957, a second obstacle to the investment of private capital in nuclear industry was removed when Congress passed the Price-Anderson Act. This law limits the liability of the builders and operators of nuclear plants to the general public in the event of injuries from an "extraordinary nuclear occurrence" and established a $560 million fund from which damages would be apportioned among the victims of an accident.

In 1955 and 1956, AEC issued the first sets of "basic regulations for civilian atomic industry" under the amended Atomic Energy Act. According to then-AEC Chairman Lewis Strauss, "the AEC's objective in the formulation of the regulations was to minimize government control of competitive enterprise . . . [and] open the way to all who are interested in engaging in research and development (R&D) of commercial activities in the atomic energy field." The basic notion underlying this first regulatory scheme was to allow industry the discretion to choose plant designs and build them using its own judgment on how best to satisfy the requirement for a "reasonable assurance that the health and safety of the public will not be endangered." The assumption at that time was that the industry would be able to handle the technology well, and regulation would entail only a brief design review of safety-related components and periodic inspections. As the civilian nuclear power industry grew, it became apparent that both the industry and AEC had underestimated the complexity of ensuring safety and, therefore, the degree of regulation that would be appropriate. Regulatory activity expanded throughout the 1960's and 1970's along with an increasing appreciation for the probability and consequences of reactor accidents; this in turn contributed to increased public participation in the regulatory process. Regulatory guidelines also increased in scope and complexity with the rapid evolution of nuclear technology.

*The Energy Reorganization Act of 1974 abolished the AEC and transferred its regulatory functions to the newly created Nuclear Regulatory Commission. The R&D functions of AEC were transferred first to the Energy Research and Development Administration and evenutally to the Department of Energy.

In the 1970's, a utility would undergo an initial planning phase before it would apply to the Nuclear Regulatory Commission (NRC) for a construction permit, It would select a site in accordance with NRC (and State and local) policies and guidelines; choose an architect/engineering (AE) firm; solicit bids for the nuclear steam supply system (NSSS) and the balance of the plant; award contracts; and assemble data to be submitted to NRC with the construction permit (CP) application. During this planning phase, the utility also would ensure compliance with State and local laws and regulations, which could require a variety of permits for approval of the facility.

The utility then would file an application for a CP, as indicated in figures 32 and 33. The application would include: 1) a Preliminary Safety Analysis Report (PSAR) that presents in general terms the plant design and safety features and data relevant to safety considerations at the proposed site; 2) a comprehensive Environmental Report (ER) to provide a basis for the NRC evaluation of the environmental impacts of the proposed facility; and 3) information for use by the Attorney General and the NRC staff in determining whether the proposed license would create or maintain a situation inconsistent with the antitrust laws.

NRC regulations require the antitrust information be submitted at least 9 months but not more than 36 months prior to the other portions of the CP application. A hearing might be held at the completion of the antitrust review, but it would not be mandatory unless requested by the Attorney General or an interested party, The NRC also must make a finding on antitrust matters in each case where the issue is raised before the Commission.

Upon receipt of a CP application, the NRC staff would review it to determine if it is complete enough to allow a detailed staff review, and request additional information if necessary. The application would be formally "docketed" when it met the minimum acceptance criteria.

In the past, the PSAR included very incomplete design information (only 10 to 20 percent in some cases). Most parties in the nuclear debate agree that many of the construction problems evident in today's plants could have been prevented if more complete designs had been available during CP review. I n recognition of this argument, NRC officials have indicated that they now would require an essentially complete design with a CP application, a move that has widespread support.

In the next step of the process, the NRC Office of Nuclear Reactor Regulation would compare the details of the permit application with the NRC's Standard Review Plan (SRP) and usually would submit two rounds of questions to the applicant. These questions often would result in changes in the plant design. The staff then would prepare a Safety Evaluation Report (SER) documenting the review and listing "open issues, " which are changes dictated by NRC but disputed by the applicant. Concurrent with the preparation of the SER, the Advisory Committee on Reactor Safeguards (ACRS) would review and comment on the application, and the NRC staff could issue supplements to the SER to respond to issues raised by ACRS or to add any information that may have become available since issuance of the original SER. During the 1970's, this review process culminating in SER might have taken 1 to 2 years. The review period could potentially be shortened if an application were filed now with essentially complete design information or a standardized design. Detailed design information would be likely to meet the minimum criteria for acceptance of the application with little delay. A standardized design could indirectly accelerate the process even more because it is unlikely that many new questions would be raised by the ACRS or about the SRP after approval of the first plant using that design.

During this period, the NRC staff also would be reviewing the proposed plant's environmental impacts and preparing a draft Environmental Impact Statement (E IS) to be issued for review by the relevant Federal, State, and local agencies and by interested members of the public. After comments on the draft EIS were received and any questions resolved, the staff would issue a final EIS.

Soon after a CP application was docketed, NRC would issue a notice indicating that it would hold

Figure 32.-NRC Responsibilities in Nuclear Powerplant Licensing

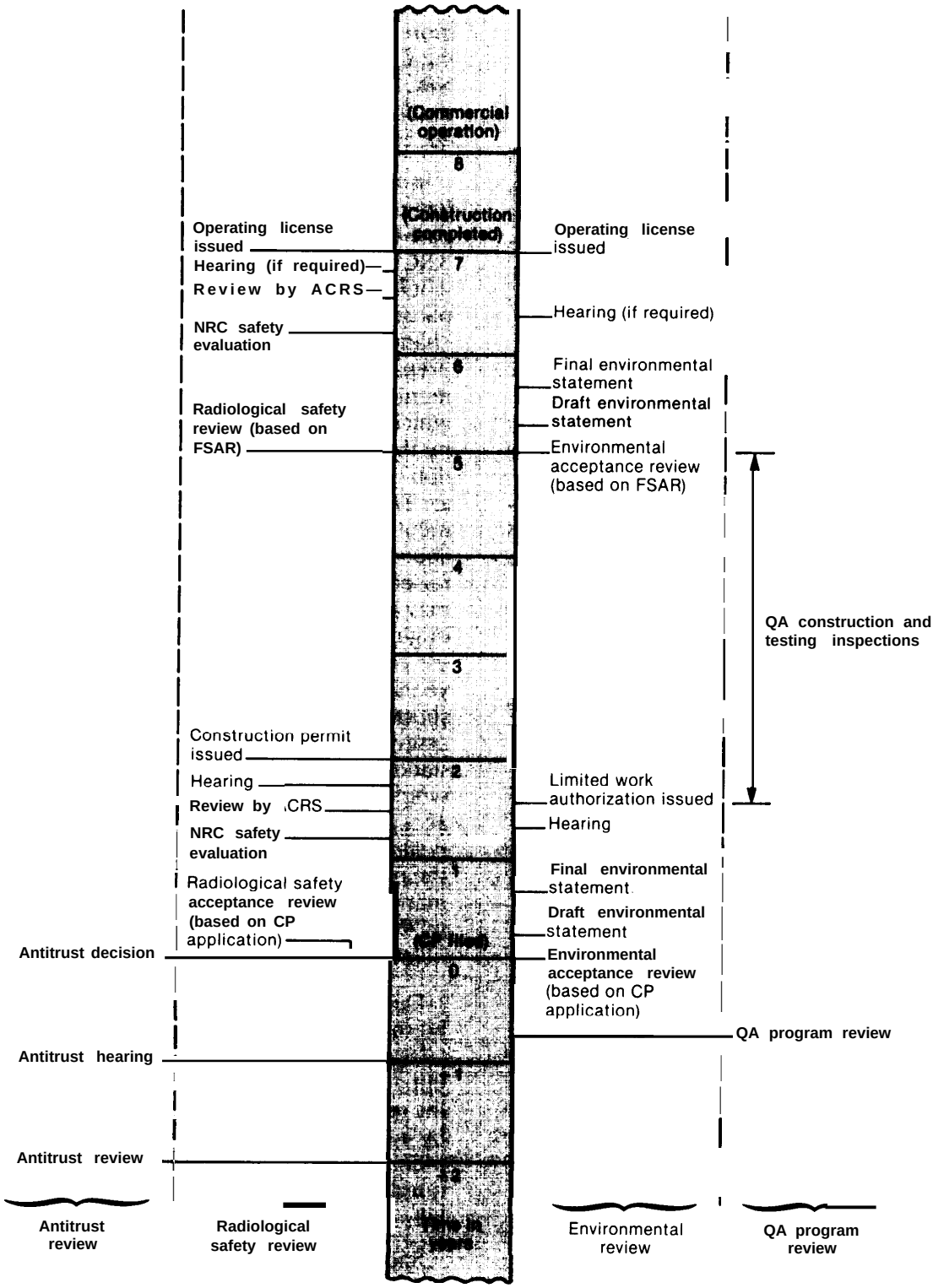
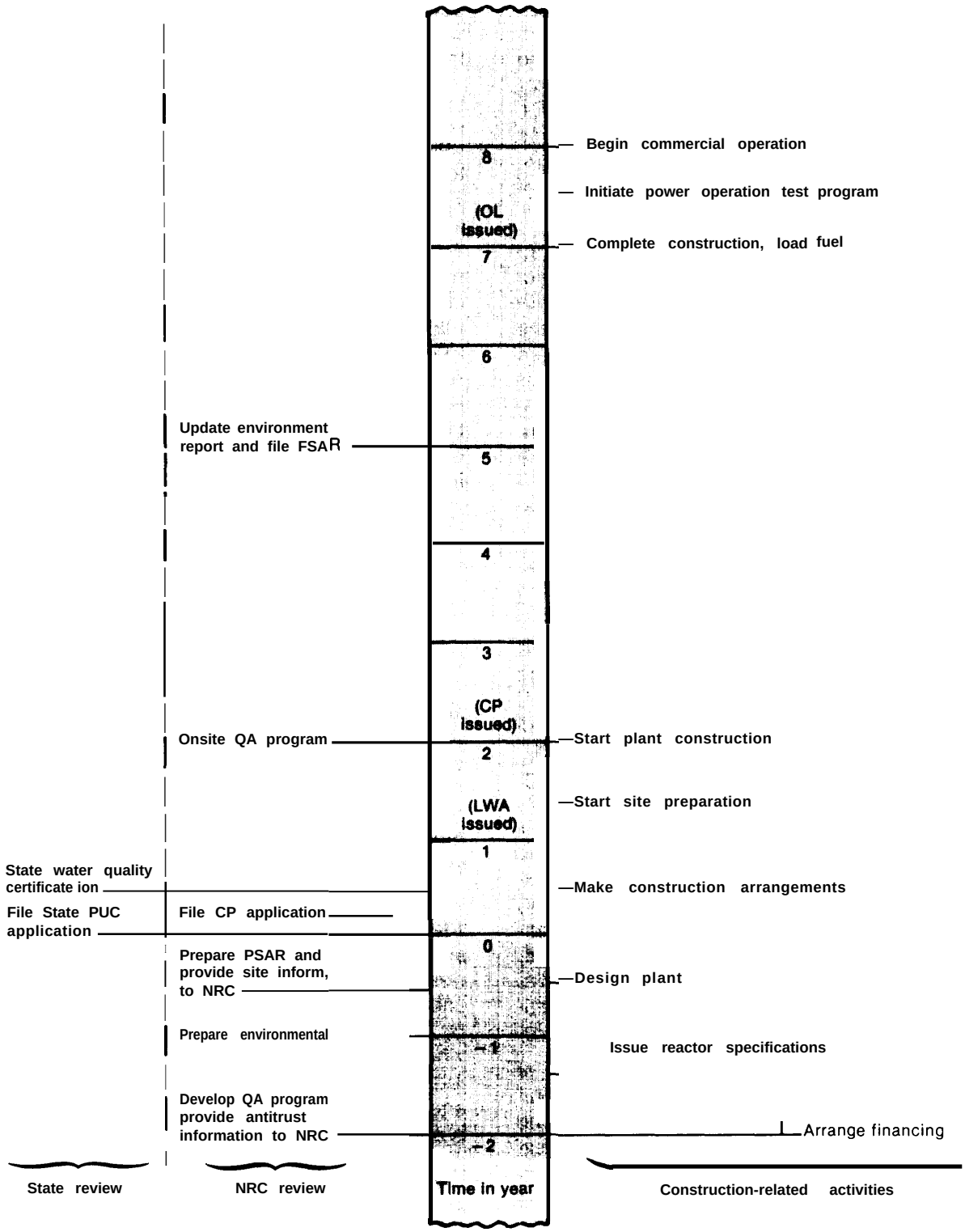


Figure 33.—Utility Responsibilities in Nuclear Powerplant Licensing and Construction



a hearing on safety and environmental issues raised by the application. Interested parties could provide written or oral statements to the three-member Atomic Safety and Licensing Board (ASLB) as limited participants in the hearings, or they could petition for leave to intervene as full participants, including the right to cross-examine all direct testimony in the proceeding and to submit proposed findings of fact and conclusions of law to the hearing board.

NRC regulations provide an opportunity at an early stage in the review process for potential intervenors to be invited to meet informally with the NRC staff to discuss their concerns about the proposed facility. This provision has not been commonly used; as a result, the safety concerns of the critics have not been considered seriously and formally until the hearings. The problem with this timing is that it places the critics in the position of attempting to change or modify a decision that already has been made rather than influencing its formulation.

The environmental hearings could be conducted separately to facilitate a decision on a Limited Work Authorization (LWA) or could be combined with the safety hearing. The SER and any supplements to it plus the final **EIS** would be the major pieces of evidence offered by the NRC staff at the hearing. The ASLB would consider all the evidence presented by the applicant, the staff, and interveners, together with proposed findings of fact and conclusions of law filed by the parties, and issue an initial decision on the CP. ASLB's initial decision would be reviewed by the Atomic Safety and Licensing Appeal Board (ALAB) on exceptions filed by any party to the proceeding or, if no exceptions were filed, on ALAB's own initiative ("sua sponte"). Since Three Mile Island, all ASLB decisions must be approved by NRC before they take effect. NRC also considers petitions for review of appeals from A LAB decisions.

NRC regulations provide that the Director of the NRC Office of Nuclear Reactor Regulation may issue an LWA after ASLB has made all of the environmental findings required under NRC regulations for the issuance of a CP and has reasonable assurance that the proposed site is a suitable location from a radiological health and safety standpoint, and after Commission approval. A licensing board may begin hearings on an LWA within a maximum of 30 days after issuance of the final EIS.

When construction of a plant had progressed to the point where final design information* and plans for operation were ready, an application for an **operating license (OL)** would be prepared. The OL process has been very similar to that for a CP. The applicant would submit a Final Safety Analysis Report (FSAR), which sets forth the pertinent details on the final design of the facility, including a description of the containment, the nuclear core, and the waste-handling system. The FSAR also would supply information concerning plant operation, including managerial and administrative controls to be used to ensure safe operation; plans for preoperational testing and initial operations; plans for normal operations, including maintenance, surveillance, and periodic testing of structures, systems, and components; and plans for coping with emergencies. The applicant also would provide an updated ER. Amendments to the application and reports could be submitted from time to time. The staff would prepare another SER and EIS and, as at the CP stage, ACRS would make an independent evaluation and present its advice to NRC by letter. The ASLB would also review the OL application and issue a decision. Until recently, the ASLB has granted all requests for OLS. However, in January 1984 the ASLB refused to grant an OL to Commonwealth Edison Co. for the two-unit Byron station. As in the procedure for a CP, this decision will be reviewed by the ALAB and the Commission.

A public hearing is not mandatory prior to issuance of an OL. However, soon after acceptance of the OL application, NRC would publish notice that it was considering issuing a license, and any person whose interest would be affected by the proceeding could petition NRC to hold a hearing. The hearing would apply the same adjudicatory procedures (e.g., admission of parties and evidence, cross-examination) and decision process that pertain to a CP.

***The final design illustrates how the plant has been built and thus reflects all amendments and variances issued and backfits ordered by NRC since the CP.**

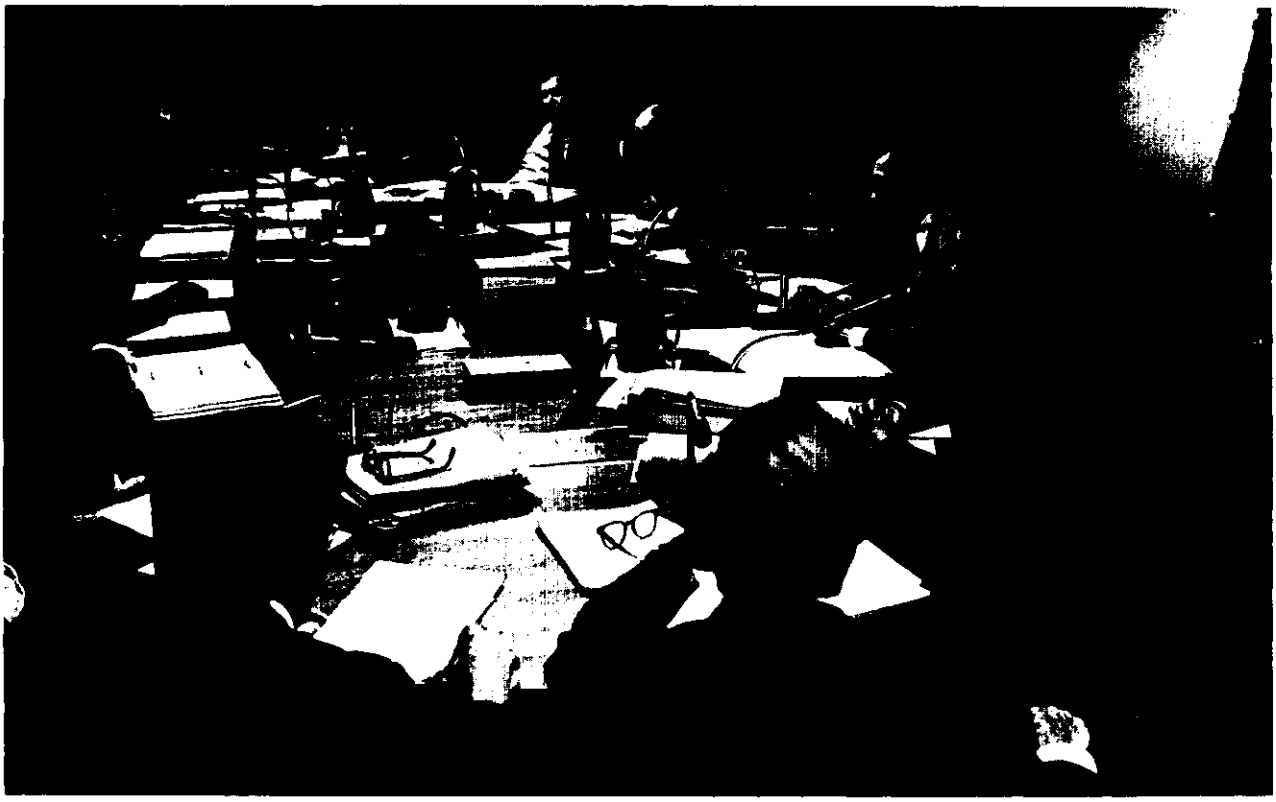


Photo credit: Nuclear Regulatory Commission

The members of the Nuclear Regulatory Commission are **meeting with the licensing staff of the** NRC to **review an upcoming operating license.** The Commission's meetings are open to the public

A stated goal of NRC (under normal circumstances and barring any important new safety issues) is to conclude ACRS and Office of Nuclear Reactor Regulation reviews and the hearing process before the utility completes construction of the plant. Current NRC regulations authorize the staff to issue an OL restricted to 5-percent power operation; full power operation must be approved by the Commissioners themselves. Upon receipt of the low-power OL, the utility could begin fuel loading and initial startup. The plant then would have to undergo extensive testing before it could begin commercial operation. Through its inspection and enforcement program, NRC maintains surveillance over construction and operation of a plant throughout its service life. As discussed in chapter 5, this surveillance is intended to assure compliance with NRC regulations designed to protect the public health and safety and the environment.

Other Federal agencies with statutory or regulatory authority over some aspects of the construction and operation of nuclear powerplants include: Environmental Protection Agency, U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration, Department of Energy, Department of the Interior, U.S. Geological Survey, Department of Agriculture, Department of Housing and Urban Development, Advisory Council on Historic Preservation, Department of Transportation, Federal Aviation Agency, Department of Defense, Council on Environmental Quality, River Basin Commissions, and Great Lakes Basin Commission. These agencies review, comment on, and administer specific issues under their jurisdiction.

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The Role of Emergency Planning

NRC requires license applicants and licensees to specify their plans for coping with emergencies. NRC regulations established in 1980 specify minimum requirements for emergency plans for use in attaining "an acceptable state of emergency preparedness", including information about the emergency response roles of supporting organizations and offsite agencies (16). For plants just starting construction, these plans have to be stated in general terms in the PSAR and submitted in final form as part of the FSAR. Detailed procedures for emergency plans would have to be submitted to NRC no less than 180 days prior to the scheduled issuance of an OL. Licensees with operating plants in 1980 were also required to submit detailed emergency plans to comply with post-TMl regulations.

NRC regulations specify a broad range of information that must be included in emergency plans. Utilities must develop an organizational structure for coping with radiological emergencies and define the authority, responsibilities, and duties of individuals within that structure as well as the means of notifying them of the emergency. Second, the utility must specify the criteria on which they determine the magnitude of an emergency and the need to notify or activate progressively larger segments of the emergency organization (including NRC, other Federal agencies, and State and local governments). Third, the utility has to reach agreements with State and local agencies and officials on procedures for notifying the public of emergencies for public evacuation or other protective measures and for annual dissemination of basic emergency planning information to the public. Fourth, programs must be established to train employees and other persons to cope with emergencies, to hold periodic drills, and to ensure that the emergency plan and its implementing procedures, equipment, and supplies are kept up to date. Finally, the utility must develop preliminary criteria for determining when, following an accident, reentry of the facility would be appropriate and when operation could be resumed.

The role of emergency planning has become increasingly controversial since the accident at Three Mile Island. Local governments must participate in the preparation of the emergency plan and reach agreements with the utility on public notification, evacuation, and other procedures, and they may intervene in the hearings on the plan. This is the principal leverage a local government has over the operation of a nuclear plant, and it can hold up the issuance of an OL. For example, at the Shoreham nuclear powerplant, significant differences in scope between the emergency plan proposed by the utility and that developed by the county are the primary issue that must be resolved before the utility can obtain an OL. There is a possibility that those differences might not be resolved. The adequacy of the utility's emergency planning also has become an issue at the Indian Point Station due to its proximity to densely populated New York City.

Such situations are of great concern to nuclear utilities, their investors, and the surrounding communities. If emergency plans are not developed in a timely and satisfactory fashion, the plant owners will not be granted a license to operate their plant. Moreover, emergency planning problems are difficult to anticipate, and their resolution is not necessarily assured by prudent management. Thus, they tend to increase the uncertainties associated with nuclear plant schedules. This source of uncertainty might be eliminated if final approval of emergency plans were required much earlier in the licensing process or even as a condition of State issuance of a Certificate of Public Convenience for a nuclear plant.

STATE AND LOCAL REGULATION

A wide range of State and local legislation, regulations, and programs affect the licensing, construction, and operation of nuclear powerplants. During the last decade, more and more States moved to a more thorough consideration of need for power and choice of technologies, environ-

mental policy, and energy facility siting. Table 22 identifies the various State authorities in these areas. In most cases, NRC requires State approvals to be obtained before the Commission will take any action on a CP or OL application.

Several States (e.g., California, Oregon, Vermont, Wisconsin) also have enacted special restrictions on the construction of nuclear powerplants on the basis of economic, environmental, or waste-disposal considerations. The U.S. Supreme Court recently upheld State authority to restrict nuclear power development when it ruled in favor of California's siting law, which bans new nuclear powerplants pending a method to dispose of nuclear waste. The Court held that the Atomic Energy Act does not expressly require the States to construct or authorize nuclear powerplants or prohibit the States from deciding, as an absolute or conditional matter, not to permit the construction of any further reactors.

The State regulation of environmental and siting issues discussed below adds to the complexity and uncertainty in planning and licensing nuclear powerplants. In a State with multiple layers of review within numerous agencies, dozens or even hundreds of State approval steps may be involved. However, the State regulatory process generally has been far less difficult to manage than the Federal regulatory aspects related specifically to nuclear health and safety.

Need for Power

Primary responsibility for regulating electric utilities has been vested for many decades in State public utility commissions (PUCs). PUCs set rate schedules designed to meet the cost of service and to earn the utility stockholders an appropriate return on investment, as discussed in chapter 3. Many PUCs also approve financing for new facilities deemed necessary to supply service and issue Certificates of Public Convenience and Necessity (CPCN), which certify that when the facility goes into service the capitalized cost will be added to the rate base.

Although the procedures for determining need for power and issuing a CPCN vary from State to State, no utility will proceed beyond engineering to construction without a CPCN or an equivalent guarantee that it will be allowed to earn a return on its investment. Furthermore, it is unlikely that a utility would apply to NRC for a CP without already having obtained a CPCN or at least being confident of receiving it.

Environmental Policy

Several Federal statutes, including the National Environmental Policy Act (N EPA), the Clean Air Act (CAA), the Clean Water Act (CWA), and the Housing and Urban Development (HUD) 701 Comprehensive Planning Assistance program, emphasize the State role in regard to environmental issues. Moreover, many States have enacted their own environmental legislation. Thus, the same environmental aspects of a proposed nuclear powerplant often are reviewed by both the State and the NRC, and in some cases, joint NRC-State hearings may be held on matters of concurrent jurisdiction.

Traditionally the States have been responsible for land use, and many States have comprehensive land-use planning programs. Energy facility siting also can be affected by States, local governments, or regional organizations through comprehensive planning activities under federally approved coastal-zone management programs and under the HUD program.

State water management agencies must approve a proposed nuclear powerplant, examining issues related to both the quality and quantity of water supply and to effluent discharge limitations. The States have programs to review water withdrawals from streams and structures placed in water, and they issue Water Quality Certificates under CWA, which include any effluent limitations, monitoring, or other requirements necessary to assure that the plant will comply with applicable Federal and State water-quality standards. These conditions become part of the NRC permit or license. In addition, if a nuclear facility will discharge into navigable waters, it must obtain a National Pollutant Discharge Elimination System (NPDES) permit. CWA establishes special procedures for NPDES permits dealing with thermal discharges.

Nuclear plants can have air-quality impacts from cooling tower plumes, but neither the States

Table 22.—State Siting Laws

State	Lead agency PUC[a]	Lead agency Ind.[b]	Forecasting plans required[d] (years) Env.[c]	Forecasting plans required[d] (years) Utility	Forecasting plans required[d] (years) State	One-stop licensing	Statutory decision time (months)	Preemption authority	Need for power determination	Legislation adopted Original	Legislation adopted Amended	Title of legislation or agency created
Arizona		x		10		No	—	No	Yes	71		Power Plant Siting Committee
Arkansas	x			2		No	—	Yes	Yes	73		Utility Facility Environmental Protection Act (two stop)
California		x			5-10-20	Yes	25-36[e]	No	Yes	74		Energy Resources Conservation and Development Commission
Connecticut		x		0		Yes	10	Yes	Yes	71	73	Public Utilities Environmental Standards Act (Power Facility Evaluation Council
Florida			x	10		No	14	No	Yes	73	75	Electric Power Plant Siting Act (1973)
Iowa		x		None		No	—[f]	No	Yes	76		State Commerce Commisson
Kansas		x		None		No	—	Yes	Yes	76		Corporation Commission
Kentucky	x			None		No	—	No	Yes	74		Power Plant Siting Act
Maine						No	—		Yes			
Maryland	x				10	No	—	Yes	Yes	71		Power Plant Siting Act
Massachusetts		x			10	Yes	6[h]	Yes	Yes	73	75	Energy Facilities and Siting Council (1975)
Minnesota			x	15		No	—[i]	Yes	Yes	73		Power Plant Siting Act
Montana	x			10		No	—	No	Yes	73		Utility Siting Act
Nevada	x			None		Yes	—	No	Yes	71		Public Service Commission
New Hampshire	x			10-15		Yes	14[j]	Yes	Yes	71		Electric Power Plant Siting Act
New Jersey			x		4	No	—	N/A	N/A	73		Coastal Area Facility Review Act
New Mexico	x			None		No	—	No	No	71		Public Utilities Commission
New York		x			15	Yes	—	Yes	Yes	72	75	Board of Electric Generation Siting and the Environment
North Dakota	x				10	Yes	—	No	Yes	75		Energy Conversion and Transmission Facilities Siting Act
Ohio		x			10	Yes	—	Yes	Yes	72		Power Siting Commission
Oregon		x		10		Yes	24[k]	Yes	Yes	71	75	Energy Facility Siting Council (1975)
South Carolina		x		10		No	—	Yes	Yes	71		Public Service Commission
Vermont		x		None		Yes	—[m]	Yes	Yes	75		Public Service Board
Washington		x		10		Yes	12[h]	Yes	Yes	70	76	Energy Facility Site Evaluatior Council (1976)
Wisconsin		x		0		No	18	Yes	Yes	75		Public Service Commission (two stop)
Wyoming		x		5		yes	—	No	Yes	75		Industrial Development and Siting Act

[a]Public Utility Commission
[b]Independent.
[c]Environmental.
[d]Indicates the period of time which utility or state prepared forecasts must cover (e.g., Arizona utilities are required to submit a 10-year forecast).
[e]California allows extended time upon mutual agreement by Commission and applicant.
[f]Statute specifies that "the Commission shall expeditiously render a written decision with complete determination . . ."
[g]Only available information is given.
[h]A 1976 amendment provides for the time period to be nonbinding if "compliance with said requirements will prevent the Council from rendering a decision upon the application . . ."
[i]The Minnesota statute contains an emergency certification provision for "demonstrable emergency." The provision authorizes certification "no later than 195 days "following acceptance of an application."
[j]A 1976 amendment allows the state legislature opportunity to disaffirm findings by the siting council 45 days after council certification of nuclear power facility.
[k]Nine months for combustion and/or geothermal generation.
[m]Certification of nuclear power facilities is contingent upon approval by the Vermont General Assembly.
[n]Allows for extended time upon mutual agreement by the Energy Facility Site Evaluation Council and applicant. A 1977 amendment also provides for "expedited processing" of an application upon request by "any person."

SOURCE: U.S. Nuclear Regulatory Commission, *Improving Regulatory Effectiveness in Federal/State Siting Actions,* NUREG-0195, Washington, D.C., May 1977; J. Williams, Nuclear Siting and Licensing Act of 1978, *Hearings,* U.S. Congress, Serial No. 95-187, Washington, D.C., July 1978.

nor the Federal Government have standards governing such emissions. Rather, the primary effects of CAA and State air-quality programs under that act are through restrictions on the siting of and emissions from fossil-fueled plants, which may increase the attractiveness of the nuclear option for electric utilities.

State Siting Activities

Twenty-five States currently have siting laws. These include "multistop" regulation by a variety of State agencies, each concerned with a separate aspect of the construction or operation of a plant; State licensing through a "one-stop" agency charged with determining the suitability of all aspects of a particular site on behalf of all State regulatory bodies; or State ownership of the site, with a single agency empowered to administer the terms of a lease with the utility or consortium that owns the plant.

ISSUES SURROUNDING NUCLEAR PLANT REGULATION

For the last decade, nuclear plant regulation has been slow, unpredictable, expensive, and frustrating for many involved in licensing. Moreover, it has failed to prevent accidents such as those at Three Mile island and Browns Ferry as well as construction problems like those experienced at Diablo Canyon and Zimmer. Even in the case of the Byron plants where the OL was denied by the ASLB, the problems were not acted on until the two plants were nearly complete. The frustrations, costs, and uncertainties have resulted in extensive criticisms of the regulatory process and a variety of proposals for changes in that process. The focal points for such criticisms are backfitting, * hearings and other NRC **procedures, the current two-step licensing** process, NRC responsibilities not directly related to safety, the use of rulemaking, and safety goals.

The principal concerns about nuclear plant regulation expressed by utilities and the industry are that neither the criteria nor the schedules for siting, designing, building, and operating nuclear plants are predictable under the current licensing scheme. The industry and some regulators also complain about the extensive opportunities for public participation in licensing, arguing that such participation prolongs hearings unnecessarily without adding to safety. They believe that these factors have contributed to higher costs and longer construction times and may have reduced safety by requiring the applicant and the regulators to focus more of their efforts on the procedural aspects of licensing to the detriment of substance.

Nuclear critics, on the other hand, argue that the lack of predictability and construction difficulties were due to the immaturity of the tech-***nology*** and a "design-as-you-go" approach. The critics feel that many of their safety concerns would not have arisen had it not been for the rapid escalation in plant size and number of orders that occurred in the 1960's and 1970's, utility and constructor inattention to quality assurance, and inconsistent interpretation and enforcement of regulations within NRC. While some critics say that nuclear plants will never be safe enough, others believe that the current regulatory process could ensure safety if it were interpreted consistently and enforced adequately. Most critics agree that limiting the opportunities for interested members of the public to participate in licensing will detract from safety.

This section will describe in detail the various parties' views (as determined by OTA) on NRC regulation—what they believe works, what they believe doesn't, and why they hold their views–and how they think the regulatory process could be improved. These views were solicited by OTA

***Although "backfitting" technically refers only to design or regulatory changes ordered by NRC during plant construction, and "ratcheting" to changes imposed after a plant goes on line, "backfitting" usually is used in the literature to refer to both types of changes. Modifications requested by the permit or license holder are termed "amendments" or "variances. "**

at workshops and panels involving a broad spectrum of interested parties, including nuclear critics and representatives from utilities, vendors, and AEs. These meetings were supplemented by a survey conducted for OTA in which a small sample of qualified individuals responded to an extensive questionnaire(l 5). Suggestions for revisions to current NRC regulations and procedures have been made by a number of interested parties. They will be presented in the following text as originally proposed and then evaluated on the basis of the information available to OTA. The discussion of regulatory revisions will focus on two legislative packages currently before Congress: The Nuclear Powerplant Licensing Reform Act of 1983, submitted by NRC (23), and the Nuclear Licensing and Regulatory Reform Act of 1983, proffered by the U.S. Department of Energy (DOE) (21).

The evaluation of proposals for changes in NRC regulation must depend first on an assessment of the goals to be served by regulation and by the individual changes. The primary goal of NRC regulation as defined in the Atomic Energy Act is to ensure that the utilization or production of special nuclear material will be in accord with the common defense and security and will provide adequate protection to the health and safety of the public. Therefore, in analyzing proposals for changes in licensing, the first consideration must be whether they are necessary to further the fulfillment of this goal. If changes would further this health and safety goal–or at least not detract from it–then secondary policy goals might be:

- to provide a more predictable and efficient licensing process in order to assure license applicants that a plant, once approved, can be built and operated as planned;
- to increase the effectiveness of public participation in licensing; and
- to improve the quality of NRC decisions in order to increase public confidence in plant safety.

Achieving these secondary policy goals probably is a necessary condition in ensuring (whether for national security, economic, or other reasons) that nuclear power remains a viable option for utilities in choosing their mix of generating technologies. However, it should be emphasized that these goals cannot be accomplished through licensing changes alone. Rather, they also will require a commitment to excellence by all parties in the management of plant licensing, construction, and operation, as well as a commitment to resolving outstanding safety and reliability issues.

Another consideration in evaluating proposals for change in the licensing process is whether amendment of the Atomic Energy Act is necessary to accomplish a particular change, or whether it can be accomplished through rulemaking or even simply more effective implementation of the existing regulations.

BACKFITTING

The utilities' and the nuclear industry's complaints about lack of predictability in reactor regulation focus principally on the potential for changes in regulatory and design requirements during plant construction and operation ("backfitting").

The present NRC regulations define backfitting as" . . . the addition, elimination or modification of structures, systems or components of the facility after the construction permit has been issued" (16). Under the **present** regulations, the standard NRC may use (the language in the regulations is discretionary) in ordering a backfit is whether it will "provide substantial additional protection which is required for the public health and safety or the common defense and security."

NRC never has invoked the backfit definition formally to amend a permit, license, rule, regulation, or order. Rather, it has changed its requirements through a variety of less formal procedures, such as bulletins, circulars, regulatory guides, and informal meetings. While NRC has justified the changes on a safety basis, the decisionmaking process has not been as transparent nor as pre-

dictable as desired by the industry or its critics. The industry would like to have the backfit rule rewritten and the procedure for invoking it revised so that it would provide greater certainty and stability **in terms of costs and** schedules and greater flexibility in implementation. The critics would like to see NRC follow an established and documented procedure in ordering backfits to facilitate evaluation of safety considerations.

Specific Concerns

Until recently, NRC's Office of Nuclear Reactor Regulation has been responsible for reviewing and coordinating backfit proposals. The nuclear industry has perceived that review to be unsystematic, haphazard, and without reference to any regulatory standard. The industry does not believe that all of the changes made to plants over the years have contributed significantly to safety. In fact, it considers some of these changes to have made plant design and operations more complicated, less predictable, and possibly less safe (8). Moreover, these changes have absorbed a large share of the utilities' financial and technical resources. For example, after a decade of operation, there were still hundreds of people working to make changes at the Browns Ferry nuclear plants (5). At another utility, the backfits in 1980 alone required $26 million and 10 to 12 staff-years of engineering. In addition, the long-term expenditures associated with Three Mile island backfits are estimated to cost $74 million at the same plant (26). Thus, there are powerful incentives for the nuclear industry to try to have the backfit rule and its implementation changed.

Nuclear critics counter that the rule would be adequate if it were implemented consistently and understandably. They contend that backfits serve an important safety function, since many problems arise only after construction or operation has been initiated. The critics, however, agree with the industry that it would be more appropriate to allocate resources to the design phase rather than using them to satisfy safety concerns with backfits. Unfortunately, this is not an option for existing plants, but can be applied only to the next generation of nuclear reactors.

To review these claims about backfitting, OTA undertook a survey of people of all viewpoints connected with nuclear power, including industry representatives, regulators, and critics. The results of this survey form the basis for the analysis presented here.

There are certain ways in which backfits have the potential to adversely affect the safety of nuclear plants. First, additional equipment can impair normal operations or safety functions; backfits related to seismic protection often are cited as examples of these problems. As discussed in chapter 4, requirements for additional pipe hangers and restraints increasingly have constrained the layout of the piping systems in nuclear powerplants. This could contribute to thermal stresses in normal operation and make the system more prone to failure in accident situations. Another adverse consequence associated with seismic backfits is that they can lead to overcrowding, making some equipment virtually inaccessible for inspection or maintenance.

Backfits also can affect safety by disrupting normal plant operations while new equipment is being installed. While this potential problem is less a result of NRC's management of backfits than of utility planning and expertise, it is important to recognize that there are safety implications associated with installation. Such an incident occurred at the Crystal River plant in 1980 when the utility attempted to install a subcooling monitor while the unit was still operating. This action triggered a series of unplanned events, eventually followed by safe shutdown of the plant.

It should be noted that while examples can be found in which backfits have adversely affected safety, this does not imply that the overall impact has been negative. In fact, one recent study indicates that modifications made to plants after Three Mile Island may have reduced the probability of a large-scale accident by as much as a factor of six at some plants (1 3). However, the overall gain or loss in safety due to backfits has not been analyzed in any comprehensive fashion.

OTA concludes that, while most backfits represent safety improvements, they can have a negative impact when deployed in a manner

that does not allow for sufficient analysis of the consequences of installing or modifying equipment and its interaction with other systems. A more rational and less hurried approach could improve this situation for current plants. if the next generation of reactors is an evolutionary development of today's light-water reactors (LWRs), new plants should be even less troubled by backfits. New LWR designs will incorporate the lessons learned from Three Mile Island and the accumulated experience of current reactors, and they will address unresolved safety issues with state-of-the-art technology. However, if an alternative reactor design is selected for commercial deployment, it maybe impossible to avoid extensive backfitting until the technology is fully mat ure.

NRC backfit requirements also have been criticized by the nuclear industry as being overly prescriptive to the point of being incompatible with practical design, construction, or operating techniques. Rather than establishing general guidelines or safety criteria and allowing individual utilities some flexibility in applying them, NRC generally issues detailed and specific requirements. Nuclear powerplant designers must conform to the regulations and appendices in 10 CFR Part 50 as well as 10 other major parts to title 10, over 150 regulatory guides, three volumes of branch technical positions, numerous inspection and enforcement circulars and bulletins, proposed rules, and over 5,000 other voluntary codes and standards that may be invoked at any time by regulatory interpretation. During construction, these standards and codes often are interpreted in the strictest sense possible, with no allowances for engineering judgment. For example, the fillet weld, which is commonly used in field construction, varies in width along the length of the weld. Plant designers recognize that some variation will occur and set the design requirements according to an average width. An inspector, by strict interpretation of an industry code, may not look at the average width, but reject an otherwise acceptable weld if it is slightly less in width than called for by the designer at any point along the length of the weld. Constructors compensate for such anomalies by overwelding, which entails considerable time and expense (19).

It is OTA's conclusion that the requirements associated with the design, construction, and operation of nuclear powerplants are prescriptive and, in some cases, internally inconsistent or in conflict with other good practices. However, while the inconsistencies and contradictions are problematic, **the prescriptive nature of the rules should not pose insurmountable difficulties for plant owners and designers.** Some utilities have been able to accommodate to the same prescriptive requirements that govern all nuclear construction and still complete their plants efficiently and with few regulatory difficulties. Moreover, NRC is not wholly responsible for prescriptive regulation. The nuclear industry has developed a large and growing set of voluntary standards to provide guidance in interpreting NRC criteria. These standards were expanded greatly in the mid-1970's to match the growth in NRC requirements and often were written with little consideration of their impact. In addition, many of the early standards were written too rapidly to reflect field experience and a convergence of accepted practices. NRC magnified these problems by invoking the standards precisely as written rather than allowing them to evolve gradually (19).

Another concern about backfitting is that there are no clear and consistent priorities. Permit and license holders argue that they have not always been given consistent and stable criteria by which to construct and operate a plant and, as a result, some less important backfits have been imposed before more critical ones. The prime example of this cited by utilities and the industry is the Three Mile Island action plan, in which the NRC gave the utilities no guidance on the relative priorities among approximately 180 requirements of varying importance. The action plan was developed with little comprehensive analysis. As discussed above, if the next generation of plants incorporates a clean-sheet design based on past experience with LWRs, backfits should not be as serious a problem as they have in the past. While a lack of priorities has been troublesome for plants currently under construction or in operation, it is unlikely that future LWRs will experience the same degree of difficulty.

A final concern about backfitting is its potential contribution to increases in construction lead-

times and plant costs, These issues are discussed in greater detail in chapters 3, 4, and 5 and are only summarized here. The most recent plants to obtain CPs from NRC required 30 to 40 months after docketing (i.e., not including the preliminary utility planning phase) to obtain their permits, compared to 10 to 20 months between 1960-70. Similarly, construction (the time between issuance of the construction permit and the operating license) typically takes 100 to 115 months, up from the 32 to 43 months in 1960-70 (18). Backfitting has been suggested as one of the sources of delay, along with deliberate delays due to a decrease in the need for power and difficulties in financing construction.

In order to examine the impact of regulation on nuclear powerplant construction leadtimes, OTA analyzed case studies of the licensing process, which are detailed in volume 2 of this report (1). Because it is difficult to separate the effects of backfitting from other regulatory activities, they were considered in the context of the entire licensing process. Based on these case studies, on published analyses of the causes of increases in nuclear plant construction leadtimes, and on extensive discussions with parties from all sides of the nuclear debate, OTA has concluded that **the regulatory process per se was not the primary source of delay in nuclear plant construction.** Rather, during the 1970's (when leadtimes escalated the most), utilities delayed some plants deliberately because of slow demand growth and financial problems, Plant size was being scaled up very rapidly and construction was begun with incomplete design information. The increasingly complex plant designs meant that more materials—concrete, piping, electrical cable—were required, and constructors often experienced delays in delivery of equipment and materials. At the same time, worker productivity declined substantially, at least in part because plants were more complicated and thus more difficult for the utilities to manage and build (3).

Backfits did lead to delays in some plants, especially those subject to the extensive regulatory changes that followed the accidents at Browns **Ferry and Three Mile Island, but in others the effects of regulatory changes were moderated** through strong management. All plants had to accommodate to some backfits that resulted from the immaturity of the technology and the overly rapid scale-up of plant size. In these cases, regulatory delays must be considered positive. Moreover, in some plants that have experienced regulatory delays, such as Cincinnati Gas & Electric Co.'s Zimmer plant, regulatory actions were an appropriate response to evidence of improper construction practices(9). NRC should not be arbitrarily limited from imposing backfit requirements that lead to long delays in such cases, since interest in the public health and safety should supercede concern for minimizing leadtime and cost .

In general, OTA concludes that, as in other aspects of quality control, **skillful management by the utility, its contractors, and NRC is the key to avoiding delays that otherwise might result from the licensing process.** Thus, licensing is most likely to proceed without hitches with experienced, committed utility and contractor management personnel; a clear need for power from the plant; and a constant and open dialogue among NRC staff, nuclear critics, and utility and construction managers. Since skillful management has not been a hallmark of NRC administration, changes to make the organization more responsive and efficient should enhance the licensing process and reduce unnecessary delays. However, such changes cannot substitute for good utility management and a commitment to safety in construction and operation.

Proposals for Change and Evaluation

In 1981, NRC created the Committee for Review of Generic Requirements (CRGR) to respond to some of industry's concerns and to reduce some of the burdens that the utilities felt backfitting had imposed on them. The CRGR review should guide the industry in assigning priorities, even if it does not solve some of the more fundamental problems with backfitting. The NRC and **DOE** proposals for reform attempt to address the larger issues,

In evaluating the proposals outlined below, it is important to recognize that backfitting cannot

be eliminated entirely, but will continue to be applied to plants under construction or in operation as long as there are outstanding generic safety questions. As discussed in chapter 4, the current generation of LWRs still is troubled by a number of potentially serious safety issues even though they have been studied extensively by NRC and industry groups. Nuclear critics are concerned that the resolution of problems such as steam-generator degradation and cracking in primary system components might be compromised in the interest of limiting backfits. Therefore, they are skeptical about proposals that would restrict NRC's freedom to impose legitimate backfit requirements or emphasize cost and efficiency at the expense of safety.

The debate about backfitting centers on four main considerations of the backfitting rule: 1) whether the current definition and standard need to be revised or simply invoked and enforced; 2) if they do need to be changed, how should the new definition and standard be phrased, 3) what criteria should be applied by NRC in ordering a backfit; and 4) whether any changes that may be needed should be made legislatively or through rulemaking. As discussed in the previous section, some change in the manner in which backfits are managed and enforced within NRC probably is necessary so that the primary regulatory goal of ensuring safety is achieved. Moreover, to provide license applicants with more stability and certainty, and to increase the effectiveness of public participation in licensing, the backfit procedures and criteria at least must be made more explicit.

Definition

The present definition of a backfit in the NRC rules includes any design or technological change ordered after issuance of the CP. In doing so, it ignores the reality that much design information is not available when the CP is issued, and not all evaluations and modifications of designs should be considered backfits merely because they are postpermitting. From another perspective, however, the present definition may be too narrow in that it focuses only on changes in "structures, systems, or components of the facility," and thus excludes important institutional and management changes.

One alternative definition has been put forward by the NRC Regulatory Reform Task Force (RRTF) in its proposed revisions to the NRC rules: "the imposition of new regulatory requirements, or the modification of previous regulatory requirements applicable to the facility, after the construction permit has been issued" (23). Prior to the invocation of a backfit, NRC would set approved design and acceptance criteria for the protection of public health and safety and national security. Once a licensee embarked on the design, construction, or operation of the reactor and had committed substantial resources to and was acting in accordance with the NRC criteria, then, according to the definition above, any proposed change in those criteria should be considered a backfit and should trigger a special decisionmaking process.

A second definition (proposed in the DOE legislative package) is "an addition, deletion, or modification to those aspects of the engineering, construction or operation of a . . . facility upon which a permit, license or approval was issued" (21). This definition may be slightly narrower than the RRTF definition in that it applies backfit criteria only to the conditions in a license rather than to the full range of regulatory requirements applicable to a facility.

The most important attributes of any NRC requirement are explicit criteria and consistent application of these criteria by NRC management. Thus, either NRC or DOE proposed definitions would be preferable to the current one, under which it is unclear when a change ordered by NRC should be considered a backfit, provided that the application of the definition by NRC is consistent and clear to all interested parties. Such a change should contribute to more predictability about backfits.

The definition of a backfit would be particularly important if it were coupled with a threshold standard for triggering it. One approach would require a backfit to result in a substantial increase in public protection, with benefits from the increased protection exceeding both the direct and

indirect costs of the backfit. **While such a cost-benefit standard would presumably assure consistency, OTA concludes that the available methodologies are inadequate to fully quantify improvements in safety.** Thus it is likely that a cost-benefit standard alone (or the use of quantitative safety goals to justify backfits, as discussed in detail below) would be unworkable until such methodologies are developed further. Rather, some combination of engineering judgment coupled with cost-benefit analysis, as has been used in the past, will be necessary.

Within this context, however, NRC could improve the process of evaluating and imposing backfits by making its standards more explicit and by specifying the relative consideration to be given to factors such as the effects for ordering backfits on public and occupational exposures to radioactivity; the impact on safety given overall plant system interactions, changes in complexity, and relationship to other regulatory requirements; the cost of implementing the backfit, including plant downtime; the resource burden imposed on NRC; and, for backfits applicable to multiple plants, the differences in plant vintage and design. While these factors probably are considered in some form in NRC's current deliberations, the decisionmaking process is frequently inscrutable.

Other changes could be made in the backfit review process to ensure that criteria and standards are applied consistently. A centralized group such as CRGR or ACRS could review backfits routinely and judge them according to standards established by NRC. Alternatively, an independent panel of experienced engineers drawn from utilities, the public, and industry (but not from the organization that did the design) could be set up for centralized review.

General Procedures

Changes in overall procedures and guidelines for backfitting also have been proposed. The DOE bill would shift the burden of proof from industry to NRC by requiring NRC to demonstrate that a backfit is cost effective. Moreover, the DOE bill would restrict the information that NRC can require from licensees. In addition, it implicity directs NRC to employ a lower standard of safety for older plants with shorter remaining operating lives, even though these are often the plants most in need of upgrading. Further, the DOE bill would apply to breeder reactors and reprocessing plants where backfitting is likely to lead to significant improvements in safety.

These procedural changes in the DOE bill would have the effect of making it more difficult for NRC to order safety-related improvements after a construction permit has been issued. Such changes will be controversial without other assurances—absent in the DOE bill—that safety can be assured.

A more general and fundamental change has been proposed by the nuclear industry, which would like to see NRC's prescriptive rules replaced with a few general criteria. In such a system, each utility could determine how it might best satisfy NRC's criteria, subject to concurrence by NRC. OTA finds that the latter proposal has some merit in that it might encourage innovative approaches among the more capable utilities and vendors. Treating the problems generically rather than prescriptively also might reinforce the use of owners' groups and data pooling. However, it should be noted that such an approach also could pose severe resource problems for NRC. **If NRC** staff had to review numerous different proposals for changes rather than devise a single solution of its own, it would severely tax a system that already has difficulty with coordination and organization.

It generally is agreed that the key to a shift to performance standards is to make the industry (including utilities, vendors, and AEs) accept full responsibility for safety and to design and build plants according to a consistent regulatory philosophy rather than making numerous modifications as problems rise. Acceptance of this responsibility could be demonstrated in part by industrywide improvements in management practices, quality control, performance records, and event-free operations. If the evidence indicates that the industry has matured sufficiently to be able to construct and operate plants safely and reliably, NRC may be able to allow more flexibility in the interpretation of its guidelines. **However, as long as**

any industry participants demonstrate an inability to guarantee safe operations, OTA believes that the current level of detail in the backfit regulation probably is necessary to fulfill NRC's primary legislative mandate of protecting public health and safety.

Legislation

OTA found that congressional action is not necessary to change the backfit rule. Changes that would contribute to reactor safety, and lend stability and certainty to, and increase the effectiveness of public participation in this aspect of regulation can be accomplished better administratively, through rulemaking. This would allow greater flexibility in adjusting to changing construction and operating experience and in applying risk assessment and cost-benefit analysis than a backfitting standard rigidly determined by legislative action. Because of the extensive public comment process associated with rulemaking, it also might permit greater participation in development of a backfit rule by all parties. This was the rationale followed by NRC in drafting its legislative regulatory reform proposal, which did not include provisions related to backfitting. NRC personnel reportedly are working on a draft revision of the current rule, which will appear as a notice of proposed rulemaking.

HEARINGS AND OTHER NRC PROCEDURES

Hearings and other procedural aspects of NRC licensing and safety regulation, including the conduct of safety reviews, management problems within NRC, the use of rulemaking, and some aspects of enforcement, are highly controversial. The industry and the utilities perceive the hearings and other procedures as contributing minimally, if at all, to plant safety, but requiring overwhelming amounts of paperwork and management resources. Nuclear critics, on the other hand, see these procedures as their only means of raising safety concerns, and they strongly object to any attempts to limit the process and their participation.

Hearings

The current licensing process includes adjudicatory hearings, * with public participation, before a CP is issued and optional hearings (generally requested) at the OL stage. Formal adjudicatory hearings probably are not required under the Atomic Energy Act, which does not specify the type of hearing that the Commission must hold. However, they have been granted for so long that it would be difficult, if not impossible, to interpret the act as allowing anything less than a formal adjudicatory hearing. Furthermore, trial-type hearings are required under the principles of administrative law to the extent that the examination of evidence is necessary to resolve questions of fact, as opposed to issues of law or policy, which can be resolved in legislative-type hearings.

Part of the debate concerning hearings has focused on the appropriateness of using an adjudication process to resolve technical issues. Industry and utility representatives claim that the current system leads to unnecessary delays and inefficient allocation of resources. On the other hand, nuclear critics view the hearing process as an opportunity to examine NRC records and raise issues that might have been overlooked. In this sense, the adjudicatory hearings are appropriate for NRC licensing because they are designed, legally, to illuminate the contested issues of fact and cause the utility and NRC to justify their technical decisions more thoroughly than they might in a legislative-type hearing.

Closely associated with the issue of appropriateness is the efficiency argument. The industry claims that hearings have been too long (spread out over a year or more in extreme cases) and costly due to the highly technical and complex nature of the subject matter and the inclusion of

***A formal adjudicatory hearing is similar to a trial, in that the parties present evidence subject to cross-examination and rebuttal, and the tribunal or hearing officer/board makes a determination on the record. The key ingredient is the opportunity of each party to know and meet the evidence and the arguments on the other side; this is what is meant by "on the record. "**

issues not directly germane to safety, such as need for power and alternative means of generating that power, It is possible that changes could be made to the hearing process to reduce inefficiencies while preserving the right of the critics to participate effectively. As discussed below, legislative action would not necessarily be required, since most of the problems could be ameliorated by strict conformance to the NRC rules of administrative procedure.

A final important consideration is the degree to which critics participate in the decisionmaking process and their effectiveness in raising safety concerns. Timing is a central issue concerning participation. In the past, plant designs have been so incomplete at the CP hearing stage that it has been virtually impossible to make constructive criticisms about them. But by the time the OL hearings are held, the final design is complete, it has been reviewed and approved by the NRC staff, and the plant is built. Therefore, any concerns the critics raise are directed toward a group that has already decided upon the plant's safety.

Another issue related to participation is the effectiveness of the interaction between critics and the NRC staff. Industry representatives interact with the staff prior to hearings and reach agreements on the major safety issues. When the critics question these resolutions at the hearings, they feel that the staff does not give adequate attention to their complaints. Furthermore, the critics feel that they have even less influence with the staff when they are not in an adjudicatory setting. The critics cite occasions on which they were ignored by the NRC staff when they informally raised issues such as emergency core cooling, environmental qualification, and fire protection. These issues later proved to be major concerns.

Proposals for Change in the Hearing Process and Evaluation

There have been several proposals to address the industry's and critics' complaints about the NRC hearing process, including changing the format of the hearings, improving management of the hearings and other procedures, and changing the structure of licensing so that safety issues are addressed in a public forum before the CP or OL hearing.

The industry and some regulators would like to see the hearings restructured to a hybrid format that would combine some of the elements of adjudication and legislative-type hearings. In a hybrid hearing, all testimony and evidence would be presented first in written form, as in a legislative hearing. Adjudicatory hearings would be granted on issues that present genuine and substantial factual disputes that only could be resolved with sufficient accuracy by the introduction of evidence in a trial-like setting.

Both the NRC and DOE legislative packages would amend the Atomic Energy Act to provide for hybrid hearings. Under the NRC proposal, hearings on CPS would be optional rather than mandatory, and the Commission could substitute hybrid hearings for adjudication, after providing the parties an opportunity to present their views, including oral argument on matters determined by the Commission to be in controversy. Such arguments would be preceded by discovery, and each party, including the NRC staff, would submit a written summary of the facts, data, and arguments to be relied on in the proceeding. The hearing board then would designate disputed questions of fact for resolution in an adjudicatory hearing based on the standard described above and on whether the decision of the Commission is likely to depend in whole or in part on the resolution of a dispute.

The hearings as proposed by NRC and DOE would be limited to matters that were not and could not have been considered and decided in prior proceedings involving that plant, site, or design unless there was a substantial evidentiary showing that the issue should be reconsidered based on significant new information, The NRC bill defines "substantial evidentiary showing" as one sufficent to justify a conclusion that the plant no longer would comply with the Atomic Energy Act, other Federal law, or NRC regulations (23).

The DOE bill would require hybrid hearings to be substituted for adjudication. This maybe contracted with the NRC bill, in which the shift to a hybrid hearing would be discretionary. The DOE bill would allow anyone to introduce writ-

ten submissions into the record. Interested parties could petition the hearing board for oral arguments, which would be granted on contentions that had been backed up with reasonable specificity. As in the NRC bill, oral argument would be preceded by discovery and submission of written facts and arguments. After oral argument, each party could file proposed findings that set forth the issues believed to require formal hearings. Under the DOE bill, the hearing board's decision as to which issues required adjudication would be reviewed by the Commission.

The DOE bill specifies that issues raised and resolved by NRC in other licensing proceedings could not be heard again unless "significant, new information has been introduced and admitted which raises a prima facie showing that action is needed to substantially enhance the public health and safety or the common defense and security." New issues would not be admitted unless they were "significant, relevant, material and concerned the overall effect of the plant" on health, safety, or security (21).

Efficiency improvements

Hybrid hearings are intended to increase the efficiency of the hearing process and to improve the effectiveness of public participation in that process. In terms of efficiency, proposals for hybrid hearings are directed toward complaints that hearings are too long and costly and tie up too much of staff and industry resources without contributing to plant safety. Although it is true that the hearings can be unduly long and expensive, OTA found, based on extensive discussions with utility and industry representatives, regulators, and nuclear critics and public interest groups, that **if management of the hearings were tighter, either through enforcement of the existing regulations or through changes in those regulations, a formal shift to hybrid hearings would be unnecessary.** Most of the problems cited by the industry that contribute to unnecessarily long hearings can be remedied through better management control by the utilities and NRC to ensure that safety issues are resolved early in the licensing process and through tighter management of the hearings by the licensing boards or hearing officers without making fundamental and highly controversial changes in the structure and scope of the hearings themselves. Furthermore, because proposals for a shift to hybrid hearings include more opportunities for requesting hearings than under the present licensing process, and more administrative decisions subject to appeal, it is likely that these proposals actually would increase the amount of time taken up by hearings.

Other changes in NRC regulations or in management of the hearings could contribute to more efficient hearings. Such changes include: vigorously enforcing existing NRC regulations that impose time limits in hearings; excluding issues not raised in a timely manner without a showing of good cause; requiring all parties to specify the factual basis for contentions; resolving generic issues through rulemaking once they have been litigated in a licensing proceeding; using summary disposition procedures for issues not controverted by other parties; excluding issues that were raised and resolved in earlier proceedings unless a showing of significant new information can be made; and eliminating consideration of issues not germane to safety that are best considered in other forums. Only the last of these changes would require legislative action.

improvements in Public Participation

The hybid hearings proposed by NRC and DOE also can be assessed in terms of the effectiveness of public participation. DOE and the industry argue that these proposals would provide more opportunities for critics to influence the decision process. As stated by Secretary of Energy Donald Hodel:

> After a plant is essentially complete, with many hundreds **of millions–or billions–of dollars already spent, the view of the public cannot, as a practical matter, be considered as effectively as it could be at the beginning of the licensing process. Therefore, [DOE is] proposing a system with multiple opportunities for public participation early in the process, before firm decisions are made by the Commission and the applicant (6).**

Under the DOE bill, these opportunities would occur if and when standardized plants are considered for approval, when the specific site is con-

sidered for approval, and when the issuance of a combined CP/OL is being considered. The NRC bill would allow hearings at these points as well as on construction permits, operating licenses, and preoperational reviews for plants with CP/OLs.

In analyzing whether hybrid hearings would improve the effectiveness of public participation in licensing, it is important to distinguish the timing and number of hearings from the scope of those hearings. To the extent that the NRC and DOE bills would increase the number of opportunities for public involvement in nuclear plant licensing before final decisions have been made, they would improve the effectiveness of public participation in the hearing process. **However,** if those opportunities are not provided when design decisions are being made and safety issues are being raised and resolved—all of which currently occurs in industry-staff interactions from which members of the public are excluded—then the public's ability to have its safety concerns heard will not be improved, and the critics still will feel that decisions will have been made prior to the hearings.

Nuclear critics contend that the means proposed by DOE and NRC to increase the efficiency of the hearings would serve to undercut the effectiveness of public participation by severely limiting the scope of that participation. They note that both bills would weaken the rights of the public to cross-examine NRC and utility witnesses, which they argue is often the only way to uncover safety problems and uncertainties that could not be revealed through examination of written testimony. Furthermore, the critics feel that both bills (but especially the DOE bill) may make it more difficult for members of the public to raise serious safety issues by raising the standards for admission of evidence.

Nuclear critics also point out that, under the bills' provisions for hybrid hearings, the hearing board would have to decide in each case which evidence is subject to cross-examination—a decision that often would be appealed, thus lengthening the process rather than shortening it. Under the DOE bill, the Commission itself would have to review the hearing board's decision, plus the written submissions and oral presentations, and affirm or reverse the board's designation on each issue. The critics are especially cautious about NRC dictating to the hearing boards which issues to consider. They cite quality assurance at Zimmer and the steam generators at Three Mile Island as issues NRC previously has taken away from hearing boards on the grounds that the staff was working on them. In the critics' view, all of the points listed above are serious defects that would seriously erode public confidence in the effectiveness of NRC safety regulation.

OTA concludes that the effectiveness of public participation in licensing can be improved without causing the hearing process to negatively affect costs or construction schedules. First, the proposals for early design and site approvals would permit extensive public participation in hearings on safety issues prior to the start of construction of any particular plant. Then, when a utility applied for a CP based on an approved design and site, the only questions that would remain to be heard in the CP hearings would be the combination of the site and the design, plus any safety issues that were not resolved in the design approval. This might alleviate the critics' concern that design-related safety issues are resolved in private industry-staff interactions. Allowing public involvement early and often in utility planning for nuclear power also would enhance the effectiveness of public participation in the licensing process.

Second, a funding mechanism for public participation in licensing would ensure that the critics could make a substantive contribution to design and safety issues by enabling them to devote more resources to the identification and analysis of reactor engineering and safety. This would respond to the industry's complaint that the critics are not sufficiently knowledgeable about reactor engineering and safety, as well as to the critics' view that the utility, and to a lesser extent the NRC staff, can devote extensive resources to defending design decisions.

Funding of public participation has been a part of the rulemaking proceedings in the Federal Trade Commission, the National Highway Traf-

fic Safety Administration, DOE, and the Environmental Protection Agency, and of both rulemaking and public hearings in the National Oceanic and Atmospheric Administration and the Consumer Product Safety Commission. In the mid-1970's, NRC considered an intervener funding program but did not implement one, arguing that NRC adequately represents the public interest in reactor safety and that the present method of funding through citizen contributions is a more democratic measure of public confidence in how well NRC does its job. Given the extent of the criticism of NRC management and expertise expressed to OTA by all parties, any policy package intended to revitalize the nuclear option should include reconsideration of an intervener funding program and alternatives such as an office of public counsel within NRC.

Changes in the Role of the NRC Staff

The NRC staff currently participates as an advocate of the license application in the hearings. This role is a consequence of the detailed involvement of the staff in licensing issues and the resolution of most issues to the satisfaction of the staff and the applicant prior to the hearings. The disadvantage of this situation is that the staff may be perceived as being less effective in resolving safety problems than it might be. This concern could be addressed by limiting the staff's participation in contested initial licensing proceedings to those issues on which it disagrees with the applicant's technical basis, rationale, or conclusions. The staff then would not be perceived as defending a particular plant in a hearing and might be more effective in aiding ASLB.

A related issue is the ex parte rule. Like a court trial, an agency adjudication is supposed to be decided solely on the basis of the record so that a participant in an adjudicatory hearing will know what evidence may be used and will be able to contest it. These rights can be nullified if agency decisionmakers are free to consider facts outside the record without notice or opportunity to respond.

The most common problem of extrarecord evidence occurs when there are ex parte contacts–communications between any interested party and an agency decisionmaker that take place outside the hearing and off the record. The Administrative Procedures Act (APA) prohibits such communications once a notice of hearing has been published for a particular proceeding. When an improper off-the-record contact does occur, the A PA requires that it be placed on the public record; if it was an oral communication, a memorandum summarizing the contact must be prepared and incorporated into the record.

Strict interpretation of the ex parte rule effectively cuts off communication between the Commissioners and some parts of NRC during a licensing determination or requires that the communication be made public. The Rogovin Report recommended more active involvement by the Commissioners in individual licensing determinations, but implementation of this recommendation is constrained by the ex parte rule (14). In its rulemaking options, NRC's RRTF argued that the Commissioners should be allowed to talk to staff supervisory personnel who are not participating directly in a particular hearing. The ex parte rule could be interpreted more liberally to allow such Commission/staff interaction—especially if the role of the staff in hearings is limited—as long as true ex parte communications continue to be made public.

Other NRC Procedural Issues

Additional issues related to NRC procedures include the role of ACRS in the conduct of safety reviews; management problems within NRC and other aspects of safety reviews; the use of rulemaking; and NRC enforcement methods.

Advisory Committee on Reactor Safeguards

The Atomic Energy Act requires ACRS to review each license application referred to it, at both the CP and OL stages, even if the Committee does not judge the review to be merited. Many observers consider ACRS to be particularly adept at revealing previously unrecognized safety problems, but because its members devote only part of their time to ACRS activities, it has few resources to pursue such problems in depth. Both the Rogovin Report and the President's Commission report on

Three Mile Island recommended that ACRS be relieved of its mandatory review responsibilities and be allowed to participate in hearings (7,14). A 1977 NRC review of the licensing process also recommended that the ACRS be given discretionary authority to decide which license applications merit its review (22).

The DOE bill would make ACRS discretion very broad; it would amend the Atomic Energy Act to make ACRS review of applications to grant, amend, or renew a CP, OL, combined construction and operating license (COL), or site permit discretionary unless the Commission specifically requested a review. Only ACRS review of design approvals or amendments and renewals would be mandatory under the DOE bill. Further, the DOE proposal specifies that neither the ACRS decision to review nor the NRC decision to refer an issue to ACRS would be subject to judicial review. Under the NRC legislative proposal, ACRS review of CPS, OLs, site permits, design approvals, and amendments to any of these would continue to be mandatory.

OTA concludes that the ACRS review of designs should be mandatory to ensure that safety problems are identified early in the licensing process. If proapproval of standardized designs were implemented, only discretionary ACRS review of a CP application should be required because it would be based on a thoroughly studied design, Similarly, if site-banking were implemented, ACRS reviews of sites also could be discretionary. Another mandatory ACRS review might be appropriate before granting an OL or deciding to allow a plant to begin operation under a COL, since at this stage significant safety issues can arise about compliance with the original design.

Management Control

According to the industry, the primary problem with NRC procedures is lack of management control within NRC, as reflected in uneven safety and other reviews, in a lack of priorities, and in the problems with backfitting discussed previously. There does not appear to be any true decisionmaking process; rather, NRC appears to react to immediate, pressing problems. As a result, small problems can be given proportionately more attention than is warranted. Furthermore, the decision path within NRC is virtually untraceable, making it difficult to knowledgeably critique the staff's analysis and resolution of safety concerns.

Another concern that is shared by the NRC staff and the industry is that the regulatory process is too cumbersome and legalistic in an area that is primarily technical. This produces requirements for an inordinate amount of paperwork and may divert attention away from the primary mission of ensuring plant safety. For example, the Sholly Rule (which requires that a notice be put in the Federal Register before any change—no matter how trivial–is made in a plant's technical specifications) requires extensive staff attention and resources, but produces little accompanying benefit to the public. Similarly, the industry thinks it has to report too much to NRC, and that significant safety issues may get lost in the resulting paperwork.

Another problem concerns consistency of reviews; the SRP helps to even out reviews, but it is limited by the resources of the NRC staff. This review is, of necessity, an audit review, with the ratio of hours spent on the design to those spent in review on the order of 10,000 to 1. Consistency will be increasingly difficult to guarantee as more review functions are shifted to the NRC regional offices.

It is unclear how to address these concerns. Good management cannot be legislated. Adding more technically qualified staff probably would improve the quality of substantive reviews but would not necessarily improve management. Further, it is generally agreed that the ultimate responsibility for safety rests with the utilities and the industry. Even the most competent and effective NRC could not make an incompetent or unwilling utility operate safely short of shutting down a plant if the utility did not accept this responsibility. Financial sanctions other than fines, such as might be imposed through insurers or financiers, may be the most effective in this regard.

As noted above in the discussion of backfitting, it is important that NRC procedures be explicit,

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workable, and applied consistently, but even the best written regulations or legislation cannot achieve this if there is not a firm commitment by top NRC management to ensure that the regulations are implemented properly. For example, the current NRC rules of administrative procedure, for the most part, are adequate to increase the effectiveness of the hearing process but are not enforced by NRC.

The Use of Rulemaking

In other agencies, increasing the use of rulemaking, as opposed to bulletins, circulars, notices, and regulatory guides, has improved the quality of management decisions due to the extensive opportunities for external review and comment by all interested parties. However, NRC is not perceived as being particularly good at rulemaking. Many NRC rules are considered incomprehensible due to the poor wording that results from the cumbersome internal review process: a rule drafted by the technical staff is revised by numerous others culminating with the legal staff-by which time it may be unrecognizable—but the technical staff is reluctant to change the wording lest it has to start the review process all over again. Thus, the staff tends to avoid rulemaking because fulfilling the review requirements is likely to make the final product look much different than the initial intention.

If NRC could streamline its rulemaking procedure, it might be particularly useful in resolving generic issues–those common to more than one plant. As discussed earlier, one of the factors that can contribute to inefficiency in the regulatory process is the consideration of generic questions during the licensing or oversight of a particular plant. The Rogovin Report and the President's Commission on the Accident at Three Mile Island recommended the increased use of administrative rulemaking procedures to resolve issues that affect several licensees or plants, as opposed to considering such issues during the licensing or oversight of individual plants (7,14). NRC has been heading in this direction over the past decade with its rulings on emergency core cooling systems and its environmental statement on mixed oxides. However, considerably more progress could be made in resolving generic issues through rulemaking.

OTA concludes that resolution of generic questions through administrative rulemaking would remove a source of regulatory inefficiency if the rulemaking procedure were improved. Moreover, it also would improve the effectiveness of participation by the public (including the industry, nuclear critics, and other interested parties) on these issues because of the opportunities for review and comment through publication in the Federal Register and, often, for public hearings on a proposed rule. Furthermore, a rule is an enforceable regulation, and thus is a stricter means of instituting requirements than notices, circulars, regulatory guides, or bulletins. Also, as discussed previously, generic treatment of safety concerns would facilitate industry use of owners' groups and other management tools.

NRC is not particularly adept at rulemaking, producing poorly worded regulations that are difficult to interpret by those who must implement and enforce them. But, because of the regulatory and enforcement problems posed by the use of alternatives to rulemaking for generic issues, NRC would be better off to improve its ability to write comprehensible rules than to continue to develop solutions to generic problems through licensing or notices on individual plants.

RRTF suggested that a generic question be heard once in a license proceeding and then be published as a proposed regulation within 45 days after resolution in that proceeding. If the regulation were adopted by NRC following the requisite public comment period, it could not be relitigated in subsequent licensing proceedings unless "special circumstances" were shown. If the "hearing" of the initial rulemaking were in an adjudicatory setting, then this proposal would provide for comprehensive discussion of generic issues for all parties. However, if the hearing were limited to a legislative-type proceeding, critics of the regulation may not feel that they really have been heard.

If the RRTF suggestion is not implemented, some other means of involving as many parties

as possible in the development of rules—before they are published in the Federal Register for cement—should be devised. NRC is involving the industry in the development of the generic rule for radiation protection but not the critics. As a result, when the draft rule is published, the critics may view it with skepticism and distrust of the process. Their only recourse would be the public comment process and, ultimately, a petition to change the rule after it has been finalized.

In addition to the concern for rulemaking procedures, there is another issue relating to content of NRC rules. The current NRC technical regulations have evolved over a 25-year period with each new rule devised on a largely ad hoc basis. The relative contribution of each of the numerous regulations to safety is undetermined, although it is likely to be highly variable. As one utility representative expressed it:

> **Many codes and standards were contrived and written by well-qualified, well-meaning individuals projecting ideal situations. They never had any idea that in this day and age of rigid quality assurance and quality control, the codes and standards would be enforced to the letter (1 2).**

Some industry representatives and regulators argue that it is now time for a wholesale revamping of NRC's technical regulations to reflect the current state-of-the-art and the accumulated operating experience. Before such a radical step, however, what is needed is a detailed analysis of the existing technical rules. A possible starting point would be to initiate a thorough revision of the technical regulations related to licensing. Any such effort also should examine the relative advantages and disadvantages of a shift away from hardware-based (prescriptive) standards and toward performance criteria, the role of safety goals and PRA, and the source-term work.

Enforcement

With regard to enforcement, nearly all parties to the nuclear debate agree that the procedures could be improved. First, there are some 80 or more means by which NRC can transmit information to a utility or the industry, but only two, orders and rules, are mandatory in the sense that the recipient would be subject to fines or other enforcement action if he did not respond. Although many observers would prefer to see a greater use of rules to change requirements, NRC's current problems with wording could lead to enforcement problems. inspectors in the field have to enforce a rule based on what was written, which may differ from what was meant. Individual judgment on the inspectors' part as to whether the intent of a rule is being met is discouraged to prevent the matter from ending up in court. Yet, inspection and enforcement staff rarely are asked to participate in the formulation of regulations, and thus have little contribution to their enforceability.

Second, there is general agreement that the current system of fining utilities for violations does not work, although the range of opinions about why it doesn't work is quite broad. The utilities contend that they are less inclined to identify safety concerns when they know that a fine is likely to follow. Further, they state that the present system of fines does not distinguish between a one-time simple human failure and continual inattention to problems or negligence. Utilities would prefer to see a system in which they could begin by informally negotiating solutions to safety concerns with NRC. If the problem is not remedied immediately, the Commission then could resort to fines and press releases. This procedure currently is followed by some NRC Regional Administrators.

Nuclear critics agree that the present system of fines is inadequate, but they cite different reasons. They point out that a large fine ($500,000) is equivalent to a single day's outage cost for a major utility and, in some cases, can be passed on to the ratepayers. They would like to see NRC change its enforcement policy to include the option of shutting down a plant or denying an OL and making it clear that those options will be invoked. The current perception that NRC does not enforce the regulations already in place does not bode well for convincing the critics or the industry that strong enforcement is a real threat. The recent ASLB action in denying an OL for the Byron plants may contribute to a change in the perception of NRC's willingness to enforce its regulations.

THE TWO-STEP LICENSING PROCESS

The current two-step licensing process (CP and OL) was instituted before the nuclear industry was fully mature. There were many first-time license applicants, designers, and constructors with unproven and incomplete design concepts; at that time, plant designs needed a final evaluation prior to operation. Now, reactor engineering may have matured to the point where final designs for most plants can be described at the CP stage. Therefore, the industry argues that a two-step licensing process no longer is necessary.

The utilities and the nuclear industry contend that the two-step procedure exacerbates construction scheduling problems because the plant design, regulatory design review, and hearings all occur during construction. They would like to change this to a one-step process that would place all three activities before construction begins. They believe this would improve the predictability and efficiency of the licensing process by making scheduling more certain. Also, an OL is perceived in many cases to be pro forma, but it still requires a full EIS and optional but usually requested hearings. * They suggest that a one-step procedure might encourage earlier identification and resolution of licensing issues while continuing to accommodate participation by interest groups and State and local governments.

There are two ways to achieve the equivalent of a one-step NRC licensing process: by combining the CP and OL, and by banking reactor designs and sites. The NRC and DOE legislative packages include proposals for both of these measures. it should be noted that neither the DOE nor the NRC bills is tied to the use of standardized designs, either in the provisions for combined CP/OLs or for design banking. However, in the following discussion of these proposals, it is assumed that plants will be much less customized, relying on only a few standardized and complete designs. An earlier OTA study, ***Nuclear Powerplant Standardization,*** found that standardization of designs and construction, operation, and licensing practices could alleviate many of the nuclear industry's difficulties in verifying the safety of individual plants. In addition, standardization could facilitate the transfer of safety lessons from one reactor to another and could help reduce the rate of cost and leadtime escalations (1 O). As discussed in detail in chapter 4, it is likely that any new plants would try to maximize these advantages by standardizing designs to the greatest extent possible.

The NRC legislative proposal specifies that to get a COL, an application must contain "sufficient information to support the issuance of both the construction permit and the operating license. " The NRC staff analysis of the proposal interprets this to mean that the application must include an essentially complete design. Under the NRC bill, an optional hybrid hearing could be requested before the COL is issued and again before the plant goes into operation for matters that were not considered in the first hearing. The final review before a plant goes on line would end with NRC issuing an "operation authorization" that would be the regulatory equivalent of a license for purposes of inspection and judicial review (23).

This proposal would eliminate the duplication of detailed environmental and safety reviews that are currently needed for an OL; otherwise, it is the equivalent of the present two-step process with a new name. It is likely that hearings would still be held before construction and again before operation. Moreover, if the plant were a unique rather than standardized design, this procedure could take even more time than the current two-step process.

In the DOE legislative proposal, NRC would provide an expedited procedure for COL holders to start operation by allowing the licensee to certify safety when the plant is virtually complete. NRC would publish notice of the certification with a 30-day comment period, and the staff would have 45 days from the date of that notice to review the plant for safety, consider the public comments, and recommend action to NRC. There would then be an additional 30-day peri-

***The ASLB refusal to authorize an OL for Commonwealth Edison Co.'s Bryon plants may indicate a change in approach at NRC. Even if the decision is overturned by the ALAB, it is unlikely that utilities will ever again consider the OL to be a formality.**

od in which NRC could take action to prohibit or limit operation if the certification was found to be incorrect. If NRC did not prohibit operation during that period, the plant could goon line. The only opportunity for public hearings would be at the issuance of the initial COL.

The COL proposal is controversial because of uncertainty about the level of design detail that would be required to obtain a combined license, since this is left up to NRC to specify through rulemaking. In addition, neither bill directs NRC to resolve all outstanding safety issues prior to licensing. Nuclear critics argue that the number of design changes still being made between a CP and an OL and the critical safety issues still being uncovered at the OL stage indicate that the industry and NRC are not yet ready for one-step licensing. Such a procedure could reduce attention to unresolved safety issues raised at the CP stage and could be used to restrict NRC's ability to order backfits. Regulators and critics especially object to the DOE bill because it allows the licensees themselves to certify safety, with a limited time for the NRC staff to verify that certification, and no real opportunities for citizen participation.

Some utilities are not convinced that a one-step process would be any more predictable than the current two-step process in terms of requirements for a license and backfits. Furthermore, it is possible that the proposed COL procedure, when coupled with hybrid hearings, would take longer than the current CP and OL process. Using procedural changes to improve the management of the hearings and implementing site- and design-banking, which together would serve as a surrogate for one-step licensing, probably would do more to increase the efficiency and predictability of licensing than a switch to a COL.

Current NRC regulations allow for design review prior to the filing of the CP application, but the results of the review are not binding upon the CP determination. Alternatively, reactor vendors can submit generic designs for approval through rulemaking. Many industry analysts argue that reactor engineering has matured sufficiently to allow proapproval of standardized plant designs, or of major system or subsystem designs, and both the NRC and the DOE bills include provisions for "design-banking." Debate continues, however, on the degree of specificity that should be required for proapproval of designs and whether such approval would act as a disincentive to the continued improvement of designs.

Under the NRC legislative proposal, a binding design approval valid for 10 years could be granted without reference to a particular site and could be renewed for 5 to 10 years unless NRC found that significant new safety information relevant to the design had become available. The public would have an opportunity to request hybrid hearings *on* the design before NRC granted approval. Issues related to the design could not be raised in a subsequent CP, OL, or COL hearings unless the combination of a design with a particular site resulted in new issues that had not been addressed in the design approval or there was convincing evidence that reconsideration of design issues was necessary.

The DOE bill also would allow utilities to choose a preapproved plant or major subsystem design as an alternative to selecting a unique plant design. Design approvals would be subject to hybrid hearings. Once approved, a design would be valid for 10 years and then could be renewed for 10 years but would be subject to the same backfitting requirements as normal plants under the DOE bill. Preapproved designs would be incorporated into a CP or COL application, and the review of design issues in the hearings would be strictly limited. The DOE bill would require NRC to define the level of detail necessary for design approvals through the normal rulemaking process.

Proapproval of standard designs might make a substantial contribution to a more efficient and predictable licensing process by removing most design questions from the licensing of a particular plant, but it is likely to be as controversial as the proposal for a COL. Issues include the degree of specificity required for design approval, the conditions and procedures under which the utility or its contractors could deviate from a preapproved design once construction has begun, and the ability of NRC to order backfits on approved designs.

Nuclear critics are concerned that discussion of new or previously unresolved safety issues would be foreclosed in the CP or COL hearings on preapproved standardized designs, especially in light of the provisions that prohibit the raising of generic safety issues in the licensing of particular plants and of the provisions that shift the burden of proof to the public to show that a preapproved design does not meet current safety standards. Proponents of this change argue that proapproval of designs could improve the effectiveness of public participation in that it would allow earlier and more detailed discussion of design issues in hearings without the time constraints imposed by the licensing of a particular plant.

The critics also object to the length of time for which a design approval would be valid, given the frequency with which design changes have been instituted in the past, and to the subsidy granted by deferral of the application fee until the design is used. Furthermore, there is concern that once a design has been approved, the vested interest in it would remove any incentives to improve it. However, as discussed in chapter 7, the industry argues that its need to remain competitive with foreign countries should be incentive enough.

In the present system, NRC approval of site suitability is not initiated until the CP application is docketed, which places site review on the "critical path" for reactor licensing. The existing NRC regulations permit review of site suitability prior to filing of the CP application, but the outcome of this review is not binding in the final CP decision unless a special ASLB decision is obtained. Both the NRC and the DOE legislative packages recommend a procedure for binding early site approval that would be independent of a CP application.

In the NRC legislative proposal, a site approval that does not reference a particular nuclear plant could be granted for up to 10 years, with renewal possible for 5 to 10 years. Federal, State, regional, and local agencies, as well as utilities could apply for site approvals, thus encouraging broader planning. In the NRC bill, a site approval would not preclude the use of the site for an alternative or modified type of energy facility or for any other purpose. However, other uses not considered in the original approval may invalidate the site permit, as determined by NRC. The public would have an opportunity to request hybrid hearings on the site approval, but issues related to the site would be excluded from further licensing proceedings unless matching the site with a particular plant design raised issues that were not considered at the time of the site approval.

The DOE proposal is similar to NRC's, except the site-approval procedure in the DOE bill would not allow alternative uses and would allow CP applicants to perform limited construction activities before issuance of a permit. A site approval would be valid for 10 years, with 10-year renewals. Under the DOE legislative proposal, the public could request hybrid hearings prior to NRC approval of a site.

As with design approvals, OTA concludes that site-banking could improve the efficiency and predictability of the licensing process by taking siting out of the critical path entirely. As long as the site-approval process allows adequate opportunity for public participation and ensures consideration of issues related to the combination of a particular site and design prior to issuance of a CP, binding early site approval should not be a controversial change. In fact, severing site approval from the CP could facilitate earlier and more substantive public participation. The principal objections nuclear critics have to these bills are the length of time for which approvals are valid (including renewals, 20 years in the NRC bill and an indefinite period in the DOE) and the subsidy introduced by deferring the application fee until the site actually is used or the approval expires. Furthermore, the selection of particular sites—whether they are matched with a plant or not—will remain controversial, as discussed in chapter 8.

OTHER NRC RESPONSIBILITIES

In licensing a nuclear powerplant, NRC is required to make several determinations that are not related directly to safety. These include certification of the need for power from the plant (required under NEPA) and of compliance with antitrust laws,

There is general agreement that NRC is poorly equipped to judge need for power on a local or regional basis, and therefore that it is a waste of staff resources to make such a determination. Moreover, at least 45 States already require other agencies to determine the need for power either in the certification or licensing of powerplants, in rate cases, in the approval of financing, or in an independent planning process (20). Furthermore, evaluations of the need for power and the choice of alternative types of generating technologies can take up hearing time and staff time that could be better spent in the analysis of safety and design issues.

Both the .NRC and the DOE legislative packages provide for binding NRC acceptance of a need for power determination made by a Federal, State or other agency authorized to do so. The NRC bill also provides for acceptance of other agencies' rulings on alternative sources of generating capacity. Only where no other agency is required to make such a determination would NRC perform a de novo review of the need for power. In both bills, these provisions are embedded within the section on a one-step licensing process, but they could be separated out. Because each agency is required under NEPA to make these determinations, legislative action would be required to delegate that authority to the States or other Federal agencies. it is possible that this provision would result in expanded opportunities for public participation in the discussions of the need for power and choice of technology. However, neither bill sets minimum standards for public participation in delegating this authority to the States, nor do the bills mandate consideration of the full range of alternatives, as required in NEPA.

Under current practice the Department of Justice performs a comprehensive review of license applications for compliance with antitrust laws. Although NRC weighs the opinion of the justice Department heavily in its determination, the Commission remains responsible for the final antitrust decision. As in need for power, it may not be appropriate for NRC to devote staff resources to antitrust law. One option is for NRC to adopt the Justice Department's decision on antitrust unless an affected party objects within a specified time after notice of the decision. If the objection is found to have merit, then NRC could remand to Justice for further consideration or do an independent review. Legislative action would be required to delegate this authority to the Justice Department.

The U.S. General Accounting Office (GAO) also has recommended that the NRC provide better coordination with State and local governments in NEPA reviews. At least 23 States have statutes requiring preconstruction environmental reviews similar to those required under NEPA, but NRC's NEPA regulations make no provision for coordination with the States or for eliminating duplication of efforts. GAO recommends NRC work jointly with all the States to identify common legal and procedural requirements as a first step in coordinating environmental reviews (2).

Finally, it has been suggested that introducing a little flexibility into the concept of exclusive Federal jurisdiction over reactor regulation would go a long way toward alleviating State and local concerns and improving public acceptance. For example, Oregon has a memorandum of understanding with NRC that sets forth "mutually agreeable principles of cooperation between the State and NRC in areas subject to the jurisdiction of the State or the NRC or both. " This memorandum is intended to minimize duplication of effort, avoid delays in decisionmaking, and ensure the exchange of information that is needed to make the most effective use of the resources of the State and NRC. To accomplish these ends, the memorandum provides for potential future subagreements in areas of mutual concern, including siting of nuclear facilities, water quality, nuclear plant operation, radiological and environmental monitoring, decommissioning of nuclear plants, emergency preparedness, personnel train-

ing and exchange, radioactive material transportation, and other areas. Subagreements adopted to date include a protective agreement for the exchange of information, and an agreement on resident inspectors at the Trojan plant, the only nuclear powerplant in Oregon (11).

SAFETY GOALS

One concept that has attracted much attention in discussions of backfitting and other changes in the NRC technical regulations is the use of safety goals* to establish safety requirements and gage the need for changes in those requirements.

NRC currently is developing a safety goal policy, and the DOE legislative proposal emphasizes the importance of this effort by endorsing the Commission's efforts. The DOE bill would require NRC to report to Congress within 1 year on its progress in developing and implementing a safety goal policy. The NRC proposal is described below.

NRC Safety Goal Proposal

NRC has issued a policy statement on safety goals for nuclear powerplants that is being used on an experimental basis (25). It currently plays no part in licensing decisions, and license applicants do not have to demonstrate compliance with it. If the proposed policy receives sufficiently favorable response, NRC will consider amending its regulations to include safety goals in licensing decisions.

In developing a safety goal policy, NRC considered qualitative goals that would interpret the Atomic Energy Act's standard of adequate protection of public health and safety, as well as quantitative goals that could provide a more exact standard against which risks could be measured. Qualitative goals were adopted to lend NRC safety decisions "a greater coherence and predictability than they presently appear to have," supported by numerical guidelines as goals or benchmarks (25). The NRC report notes that this approach allows it to capture the benefits of qualitative goals and quantitative guidelines in measuring performance while avoiding the vagueness of qualitative goals without numerical guidance. It does not lock NRC into quantitative goals that may not be able to yield technically supportable results given the uncertainties inherent in quantitative risk assessment.

The qualitative safety goals established **in the** NRC policy statement are:

> **Individual members of the public should be provided a level of protection from the consequences of nuclear powerplant accidents such that no individual bears a significant additional risk to life and health**
>
> **Societal risks to life and health from nuclear powerplant accidents should be as low as reasonably achievable and should be comparable to or less than the risks of generating electricity by viable competing technologies (25).**

The intent of the first safety goal is to require a level of safety such that individuals living or working near nuclear powerplants should be able to go about their daily lives without special concern by virtue of their proximity to such plants. The second safety goal limits the societal risks posed by reactor accidents and includes an implicit benefit-cost test for safety improvements to reduce such risks.

These goals focus on nuclear powerplant accidents that may release radioactive materials to the environment. They do not address risks from routine emissions, from other parts of the nuclear fuel cycle, from sabotage, or from diversion of nuclear material. The policy statement notes that the risks from routine emissions are addressed in current NRC practice through environmental impact assessments that include an evaluation of the radiological impacts of routine operation of the plant on the population around the plant site. For

***NRC defines a safety goal as "an explicit policy statement on safety philosophy and the role of safety-cost tradeoffs in the NRC safety decisions" (25).**

all plants licensed to operate, NRC has found that routine operations will have no measurable radiological impact on any member of the public. Therefore, the object of the experimental policy is to develop safety goals that limit to an acceptable level the additional potential radiological risk that might be imposed on the public as a result of accidents at nuclear powerplants.

In establishing the numerical guidelines to support these safety goals, NRC noted that progress in developing probabilistic risk assessment (PRA) techniques and in accumulating relevant data since the 1974 Reactor Safety Study (24) has led to recognition that it is feasible to begin to use quantitative assessments for limited purposes. However, because of the sizable uncertainties still present in the methods and the gaps in the data base–essential elements in gaging whether the guidelines have been met–NRC indicated that the quantitative guidelines should be viewed as goals or numerical benchmarks that are subject to revision as further improvements are made. Many of the participants in the Safety Goal Workshops held by NRC agreed that quantitative goals were not feasible at this time, but numerical guidelines could be used to support qualitative goals. Finally, in setting the numerical guidelines, NRC specified that no death attributable to a reactor accident ever will be "acceptable" in the sense that the Commission would regard it as a **routine or permissible event. NRC intends that no such accidents occur but recognizes that the possibility cannot be eliminated entirely.**

With these caveats, NRC established four experimental numerical guidelines: two for individual and societal mortality risks for prompt and delayed deaths; a benefit-cost guideline for use in decisions on safety improvements that would reduce those risks below the levels specified in accordance with the longstanding regulatory principle that risks from nuclear power should be "as low as reasonably achievable"; and a plant performance guideline that proposes a limitation on on the probability of a core melt as a provisional guideline for NRC staff use in reviewing and evaluating PRAs of nuclear powerplants. These guidelines are:

The risk to an individual or to the population in the vicinity of a nuclear powerplant site of prompt fatalities that might result from reactor accidents should not exceed 0.1 percent of the sum of prompt fatality risks resulting from other accidents to which members of the U.S population are generally exposed.

The risk to an individual or to the population in the area near a nuclear powerplant site of cancer fatalities that might result from reactor accidents should not exceed 0.1 percent of the sum of cancer fatality risks resulting from all other causes.

The benefit of an incremental reduction of risk below the numerical guidelines for societal mortality risks should be compared with the associated costs on the basis of $1 ,000/man-rem averted.

The likelihood of a nuclear reactor accident that results in a large-scale core melt should normally be less than 1 in 10,000 per year of reactor operation (25).

In its experimental safety goal proposal, NRC left open a number of questions for future consideration. These include: whether the benefit side of the tradeoffs should include the economic benefit of reducing the risk of economic loss due to plant damage and contamination outside the plant; whether a numerical guideline on availability of containment systems to mitigate the effects of a large-scale core melt should be added; and whether there should be a specific provision for risk aversion and, if so, what it should be. In addition, the proposal sought further guidance on developing a detailed approach to implementing the safety policy, including decision making under uncertainty; resolving possible conflicts among quantitative aspects of issues; the approach to be used for accident initiators that are difficult to quantify (e.g., seismic events, sabotage, human and design errors); the terms for definition of the numerical guidelines (e.g., median, mean, 90-percent confidence); and identifying the individuals to whom the numerical guidelines should be applied (e.g., the individual at greatest risk, the average risk).

Shifting from prescriptive regulation to a safety goal approach could have far-reaching consequences. Such a change might contribute to a more favorable regulatory environment for the nuclear utilities since the number and unpredictability of regulatory actions probably would be reduced. Furthermore, utilities would be allowed

to select the least costly route to compliance, with resultant gains in efficiency. Another result of the safety goal approach might be to encourage diversity and innovation in developing alternatives for improving safety. Such activities, however, may not be consistent with the standardization of nuclear powerplants (4).

The proposed safety goals and numerical guidelines are not free of controversy. The proposed guidelines have been criticized as being "too remote from the nitty-gritty hardware decisions that have to be made every day by designers, builders, operators, and regulators to be of much use" (25). Most regulators and industry representatives agree that while, in principle, it would be nice to be able to use overall goals to supplant the myriad specific decisions NRC must make about the adequacy of hardware and procedures, they find the proposed goals too general and abstract to provide specific guidance for dealing with practical questions, and withhold judgment on whether they will prove useful. As one Commissioner noted, the only reliable guides to reactor safety remain time-tested engineering principles:

> redundant and diverse means of protection against core damage, sound containment, **sufficient distance from populated areas, effective emergency preparedness, and, of course, careful attention to quality assurance in construction and operation.** To **provide guidance to the NRC technical staff and the nuclear industry, and to inform the public, the Commission should distill its experience and state clearly and succinctly that each of these [engineering] principles must be satisfied separately, and how this is to be done. Unfortunately the Commission seems to be on an opposite course (25).**

The nuclear critics object more strongly to the safety goal **proposal, arguing that to adopt goals with no viable means of confirming their achievement is** a useless exercise. They do not believe there is any immediate prospect of PRA being developed sufficiently to provide a means of confirmation. Therefore, the critics argue that it is not feasible to use quantitative guidelines for limited purposes, and NRC only misleads the public in saying that PRA calculations will be used to support qualitative goals.

LICENSING FOR ALTERNATIVE REACTOR TYPES

Nuclear powerplant licensing experience in the United States, for the most part, is based on the LWR design concept. The exceptions are the Fort St. Vrain high-temperature gas-cooled reactor (HTGR), which achieved full power in 1981, and the Clinch River breeder reactor. Yet variations on the LWR and other reactor design concepts are attracting attention for their possible safety and reliability advantages over the LWR, as discussed in chapter 4. Given the extent of the licensing and regulation experience with LWRs, it is reasonable to question whether a shift to a different design would entail substantial changes in the regulatory process, such that the same problems encountered in the regulation of LWRs would be repeated with alternative reactors, and whether the development of a licensing process for such reactors would delay their implementation.

Small LWRs contributed greatly to the original development of commercial nuclear power in the United States. However, as operating experience grew, apparent economies of scale motivated utilities to purchase larger reactors. Today the norm is over 1,000 megawatts electric (MWe), but interest in smaller reactors is reemerging, primarily for financial and system flexibility reasons. A shift to smaller reactors could not be accomplished by replicating existing small plants because the designs of those plants do not meet all current safety requirements. NRC has established a systematic evaluation program specifically to review these older designs and improve their safety where possible. New small reactors would require new designs based on current NRC regulations, although such designs would not necessarily differ substantially from large LWRs except in the size of the core and other plant

components. Thus the regulatory process probably would be similar to that for current large LWR designs, including the potential for backfits, unless small LWRs were standardized within the context of proapproval of designs.

The high temperature gas reactor has little operating experience in the United States. The primary safety concerns are quite different from the LWR and have not been studied as intensively. As a result, the potential for the emergence of significant unforeseen safety concerns probably is higher than for the LWR. On the other hand, inherent characteristics of HTGRs make them less susceptible to certain types of accidents that can progress more quickly or have more serious consequences in a LWR. This eventually may simplify the licensing process after any initial problems are resolved.

During the early 1970's, several utilities made CP applications for HTGRs. As a result, NRC made a significant effort to formalize design requirements and establish review plans for the HTGR. Nevertheless, several years would be required to make the regulatory process for this design as mature as that for LWRs. Backfitting requirements for the HTGR are uncertain but should be reduced through the operating experience of the Fort St. Vrain plant and the 900 MWe prototype that DOE is sponsoring.

The heavy water reactor, as represented by the well-proven Canadian CANDU design, has attractive safety and reliability features, but licensability is a major constraint on the adoption of this design by U.S. utilities. The NRC requirements for seismic protection and thicker pressure tube walls would require design changes in the CANDU that might reduce its efficiency and could lead to backfits until these changes were proven. NRC would have to establish new design criteria and standard review plans before a heavy water reactor could be licensed.

The Process Inherent Ultimate Safety (PIUS) reactor is the least developed of the alternative design concepts. It has readily visible safety advantages, but they might not be accounted for in the regulatory process until significant operating and construction experience is established. If PIUS is forced to include all the engineered safety features of the LWR, it is not likely to be competitive. Successful development of PIUS, therefore, depends on NRC determining what level of safety is appropriate and crediting the inherent safety features of PIUS during the design approval and licensing process.

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