# INNOVATION AND ATOMIC ENERGY: NUCLEAR POWER REGULATION, 1966–PRESENT*†

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## I
## INTRODUCTION

The government's role in nuclear powered generation of electricity is under attack. Blamed for the reduced orders for new plants, for the increase in the plants' cost, and most recently, for failing to insure the safety of plants, the Nuclear Regulatory Commission (NRC) is the focus of continuing debates over nuclear power.[1] This paper assesses the hypothesis that the NRC's procedures for licensing construction of nuclear power plants discourages innovation and diffusion of nuclear technology. The evaluation addresses three questions. First, are the procedures sufficiently flexible to allow or encourage the incorporation of new technical systems and new information? Nuclear technology is still experimental. As operating experience accumulates, and perhaps more dramatically, experience with unforeseen accidents like Three Mile Island, the design of reactors can be refined and improved. However, nuclear plants are subject to rigorous licensing and review.[2] If the reviews are not flexible, they will be unable to take advantage of experience. Second, do the preconstruction reviews unnecessarily delay construction of nuclear power plants? As is discussed in the next Section, licensing and licensing delays are expensive. Any increase in the cost of nuclear plants slows diffusion of the technology and slows innovation. Delays not associated with improved plant

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1. *See, e.g.*, Burnham, *Three Mile Island Accident: A Cloud Over Atom Power*, N.Y. Times, Sept. 23, 1979, § A (News) at 1, col. 3 (Sunday ed.); Voist, *Environmental and Regulatory Problems in Nuclear Power Plant Licensing*, 11 NAT. RESOURCES L. 507 (1979).

2. *See* 10 C.F.R. §§ 30-34, 40, 50, 51, 55, 73, 100 (1978); *see generally* Grainey, *Nuclear Reactor Regulation: Practice and Procedure before the Nuclear Regulatory Commission*, 11 GONZ. L. REV. 809 (1976); Comment, *A Survey of the Governmental Regulation of Nuclear Power Generation*, 59 MARQ. L. REV. 836 (1976).

safety or other benefits are unnecessary. To address this question both the costs and benefits of licensing must be considered. Finally, can current plans for streamlining the licensing process decrease licensing time, or increase predictability of licensing, without sacrificing flexibility or plant safety? Recent proposals for licensing reforms have included several concepts that change the roles of the NRC licensing boards and the public participants in preconstruction licensing.[3] Brief discussions of the probable outcome of these reforms are included in the final Section of this article.

In Section II, the impact of licensing delays and licensing procedures are considered. The purpose is to determine first, the overall effect of licensing on diffusion of the technology: cost increases due to licensing delays, and other adverse consequences for diffusion of the technology. Next, the overall process is considered, and several procedures that influence the ease with which the NRC can approve innovations are discussed. Sections III and IV summarize and discuss the results of a detailed study of licensing cases before the Atomic Energy Commission (AEC) and the NRC between 1966 and 1978.[4] The results form a basis to address the questions listed above. Concentrating on the impact of public participants (who are associated with many of the major licensing delays), possible causes and results of the delays are discussed.

The conclusions of the study are surprising. Delays in licensing are found to be mainly due to consideration by the NRC staff of important substantive issues. Moreover, the issues concern safety and environmental standards, rather than any particular plant design. Furthermore, delay does not result from public participants simply manipulating the process so as to hold up licensing, e.g., with procedural maneuvers or legalistic strategies. Such attempts are by and large unsuccessful. The study of licensing cases suggests that licensing delays are due primarily to NRC uncertainties about reactor safety. Consequently, recent proposals to streamline licensing may be considered a threat to safety.

## II
## NRC REGULATION AND INDUSTRY INNOVATION

The commercial nuclear electric generating industry in the United States is a product of government research and development (R&D). In the two de-

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3. A Congressional Budget Office study adds inflation, that is, the inflated costs of purchases after a delay. Assuming reasonably well-working money markets—admittedly an heroic asssumption—the inflated costs can be paid for through interim investment. *See* CONGRESSIONAL BUDGET OFFICE, DELAYS IN NUCLEAR REACTOR LICENSING AND CONSTRUCTION: THE POSSIBILITIES FOR REFORM (March 1979).

4. L. Cohen, Essays on the Economics of Licensing Nuclear Power Plants (Sept. 1, 1978) (unpublished Ph.D. thesis, Cal. Inst. of Tech.).

cades following World War II, the federal government undertook extraordinary measures to develop a nuclear electric generating industry and to encourage the diffusion of the industry to electric utilities.[5] The government declared victory in 1963 when it announced a contract by General Electric and Jersey Central Power and Light Company to build a nuclear generating unit without government subsidy.[6] The federal government subsequently withdrew from R&D in light water reactor (LWR) technology, although its research efforts in advanced nuclear technologies continued to expand.[7] No federal funds were allocated for development between 1966 and 1976.[8]

Nuclear power plants vendors—primarily Westinghouse and General Electric—took over as prime developers of nuclear power in the early sixties.[9] The vendors offered fixed-cost contracts ("turnkey" contracts) to utilities at what has been estimated to be very favorable terms.[10] The exact costs of the turnkey plants have not been published, but losses to vendors have been estimated at up to $1 billion.[11] These losses are assigned to development costs, although it is unlikely that the vendors actually planned to sustain such losses in the turnkey program.[12]

With the end of the turnkey era, LWR technology supposedly became a viable electric generation alternative. In 1966, utilities began ordering nuclear plants for which they assumed the risk of cost overruns.[13] Vendors continued

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5. Current commercial reactors are known as "light water reactors" (LWR) because they employ ordinary or light water as a moderator and coolant. Only one privately owned U.S. electric generating nuclear plant deviates from this model—the Fort St. Vrain plant—which is cooled by gas. Unless otherwise indicated, this paper is confined to light water technology. LWR design was developed by the U.S. Navy for use in submarines. Examples of early federal commitment to commercialization include a statutorily limited liability for reactor operators and direct subsidies for reactor construction. *See generally* I. BUPP & J. DERIAN, LIGHT WATER: HOW THE NUCLEAR DREAM DISSOLVED (1978). For interesting early views of the federal program, *see* THE AMERICAN ASSEMBLY, ATOMS FOR POWER (1957); Adams, *The Congressional Abandonment of Competition*, 55 COLUM. L. REV. 158 (1955).

6. The government declared victory in 1963 with the announcement by General Electric and Jersey Central Power & Light Company of a contract to build a nuclear generating unit without government subsidy. *Jersey Utility Plans Nuclear Power Unit Costing $68 Million*, N.Y. Times, Dec. 12, 1963, at 59, col. 2. *See also Why Atomic Power Dims Today*, BUSINESS WEEK, Nov. 17, 1975, at 98.

7. I. BUPP & J. DERIAN, *supra* note 5, at 50-52.

8. Since 1976 the Energy Research and Development Administration (later the Dept. of Energy) has had a small program for improving light water reactors. Funded at $42.1 million in 1976 and $48.9 million in 1977, the program is in part a response to changed political goals regarding breeder reactors. Its main thrust is toward improving the efficiency of LWRs with respect to uranium use. (Budget figures from W. SHAPLEY, RESEARCH AND DEVELOPMENT IN THE FEDERAL BUDGET: FY 1977, at 73 (1976) and W. SHAPLEY, D. PHILLIPS & H. ROBACK, RESEARCH AND DEVELOPMENT IN THE FEDERAL BUDGET: FY 1978, at 51 (1977)).

9. I. BUPP & J. DERIAN, *supra* note 5, at 5, 8.

10. *Id.* at 48-49, 72.

11. W. Montgomery & J. Quirk, Cost Escalation in Nuclear Power (Environmental Quality Laboratory Memo. No. 21, Cal. Inst. of Tech., Jan. 1978) at 14-15.

12. H. Burness, W. Montgomery & J. Quirk, The Turnkey Era in Nuclear Power (Cal. Inst. of Tech. Social Science Working Paper No. 175, Sept. 1977).

13. *Id.*

to offer long-term fuel contracts and the government continued to provide utilities with indemnification from public liability and with spent fuel buy back arrangements.[14] Since the mid-sixties, the primary government role in LWR technology has been regulatory: activities designed to ensure the safety of nuclear power plants and (ironically) public acceptance of the technology.[15] Currently, the NRC limits its R&D activities to confirmatory research; that is, research designed to confirm the safety specification of reactor components.[16] The program is budgeted at $95 million for 1979.[17]

As in other heavily regulated industries, claims are made that government intervention is detrimental to continued expansion of the industry,[18] and that current regulation decreases the rate of innovation in the industry. Expected and unexpected licensing delays influence innovation for several reasons. Diffusion of a new technology is considered to be an aspect of innovation.[19] Thus, the extent to which utilities avoid investment in nuclear power because of NRC licensing reduces the rate of LWR innovation. Second, invention responds to market demand. Numerous studies have shown that about three-fourths of all inventions are "demand pull" as opposed to "technology-push."[20] R&D expenditures are higher where greater returns can be expected: for instance, in industries that have a high growth potential. Slow diffusion and the expectation of continued barriers to the diffusion of LWR technology decrease private investment in LWR R&D. This effect is enhanced if longer licensing time is expected for the first nuclear plants that feature a design innovation.

The NRC's construction permit (CP) licensing process bears on this

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14. It was generally assumed that the government would develop end-of-fuel-cycle technologies including reprocessing, breeder reactors, waste disposal and plant decommissioning. Long-term fuel contracts are no longer available. *See* Joskow, *Commercial Impossibility, the Uranium Market and the Westinghouse Case*, 6 J. LEGAL STUD. 119 (1977).

15. The Energy Reorganization Act of 1974, Pub. L. No. 93-438, 88 Stat. 1233 (principally codified, with amendments, at 42 U.S.C. §§ 5801-5891 (1976)) formally separated the Atomic Energy Commission into two parts: the regulatory functions went to the Nuclear Regulatory Commission while research and development went to the Energy Research and Development Administration. The time period covered by this paper encompasses both the AEC and the NRC. Both agencies are referred to herein as "NRC" or "the Commission."

16. *See* 42 U.S.C. §§ 5845(b), 5845(f) (1976 & Supp. I 1977); Palfrey, *Energy and the Environment: The Special Case of Nuclear Power*, 74 COLUM. L. REV. 1375, 1403-07 (1974).

17. Personal conversation with Mr. Raymond Sanetrik, Director of the Budget, Nuclear Regulatory Commission, July 31, 1979.

The AEC's light water reactor research program after 1966 was likewise a confirmatory research program. A description and critique (in addition to a description of the technology) is contained in Study Group on Light-Water Reactor Safety, American Physical Society, *Report*, 47 REV. MOD. PHYSICS, SUPP. 1, at 1 (1975).

18. *E.g.*, Voist, *supra* note 1, at 507.

19. "Economists define an innovation as the first commercial application of a new or improved process or product." E. MANSFIELD, J. RAPOPORT, A. ROMEO, E. VILLANI, S. WAGNER & F. HUSIC, THE PRODUCTION AND APPLICATION OF NEW INDUSTRIAL TECHNOLOGY 12 (1977).

20. *Id.*

discussion in several ways. Licensing is expensive. Until the utility has a CP, work cannot proceed on the reactor.[21] Delays or extensions of licensing are associated with costs: carrying charges on capital already expended, substitute energy costs if the plant is not completed on schedule, costs of labor and delivery contracts that are arranged prior to CP issuance, and the costs (or savings) associated with changes in regulations and productivity at the time of CP issuance.[22]

The Congressional Budget Office (CBO) estimates the real cost of a month's delay in obtaining a CP at $3.6 million (about one-third of one percent of the total construction costs).[23] This figure takes into account only the interest and replacement charges. Other studies that have attempted a more complete analysis estimate the cost of a month's delay at over two-thirds of one percent.[24] While the cost estimates of these plants are notoriously bad, extentions of licensing time (particularly unexpected extensions) carry a significant charge.[25]

As Table I indicates, the average length of time for a utility to obtain a CP (the elapsed time between applying for and receiving a permit) rose from 13 months in 1966 to a high of 37.7 months in 1970. Since 1970 the licensing time has decreased somewhat. In addition, licensing time varies within years. Utilities are confronted with potential licensing delays and the resulting additional costs. To the extent that licensing increases the cost of nuclear plants, investment in them and the rate of diffusion of the technology will decrease.

A second effect of long licensing times is that it increases the time between conceiving a plan to build a nuclear power plant and the production of electrical generation. Lead times for nuclear units are estimated at ten to twelve years.[26] The problem with long lead times is the difficulty that utilities have in estimating accurate future capacity requirements. Since the 1973 Arab oil embargo, demand for electricity has failed to conform to the load forecasting models of utilities.[27] Accurately estimating demand twelve years in the future has become virtually impossible.[28] The implication to nuclear power is that in-

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21. The exact nature of construction allowed prior to CP issuance changed several times during this period. *See* p. 74, *infra*.

22. *See* CONGRESSIONAL BUDGET OFFICE, *supra* note 3.

23. *Id.* at 14.

24. L. Cohen, *supra* note 4, at 44. *Contra*, W. MOOZ, COST ANALYSIS OF LIGHT WATER REACTOR POWER PLANTS 41 (Rand Corp. Rep. No. R-2304-DOE, June 1978) (["C]onstruction permit time is probably not a significant determinant of plant costs.").

25. *E.g.*, W. Montgomery & J. Quirk, *supra* note 11, at 43-52.

26. *E.g.*, CONGRESSIONAL BUDGET OFFICE, *supra* note 3, at 19.

27. For a brief description of changes in electricity sales patterns since the 1973 oil embargo *see* Office of Utilities Programs, Federal Energy Administration, A Study of the Electric Utility Industry Demand, Costs, and Rates, Tab I at II-11 to II-12, Tab II at II-25 to II-26 (Conservation Paper No. 53, July 1976).

28. For a sample of assumptions which must be considered before estimates of demand can be made, *see, id.*, Tab II at IV-1 to IV-3.

TABLE I

ELAPSED TIME BETWEEN CONSTRUCTION PERMIT APPLICATION AND CONSTRUCTION PERMIT ISSUANCE

| Year of Application | Number of Applications | Average* | Standard Deviation* |
|---|---|---|---|
| 1966 | 16 | 13 | 4.7 |
| 1967 | 25 | 13.04 | 4.7 |
| 1968 | 12 | 23 | 11.9 |
| 1969 | 11 | 28.4 | 11.1 |
| 1970 | 17 | 37.7 | 10.3 |
| 1971 | 12 | 34.5 | 21.6 |
| 1972 | 6 | 24.2 | 5.7 |
| 1973 | 24 | 26.8 | 11.1 |
| 1974 | 40 | | |
| 1975 | 9 | | |
| 1976 | 4 | | |
| 1977 | 1 | | |

* The average and standard deviation calculations are based on a sample of units ordered. This procedure corrects for multiple unit applications. The sample is described in Section III. It is still impossible to calculate an average or standard deviation for plants licensed since 1974.

SOURCE: U.S. DEPARTMENT OF ENERGY (1978).

vestment in nuclear generating units becomes less attractive the longer the lead times for the units are because such investment requires that the utility rely on a demand forecast that is probably inaccurate. To the extent that NRC licensing contributes to longer lead times, it decreases nuclear investment.

A third difficulty with the licensing period relates to construction financing. Uncertain licensing times contribute to uncertain costs and payment schedules. This situation requires flexibility in the operation of the utility, including its financing arrangements. Utilities have had increased trouble arranging financing, particularly for nuclear power plants.[29] The publicized referenda over allowing construction work in progress in the rate base, a procedure that would allow the utility to finance construction from current sales to customers, attest to financing difficulties. The CBO cites financing as the major cause of 20 percent of construction delays at nuclear power plants.[30] If uncertain and long licensing periods contribute to financing difficulties, the utilities will be less likely to invest in nuclear units.

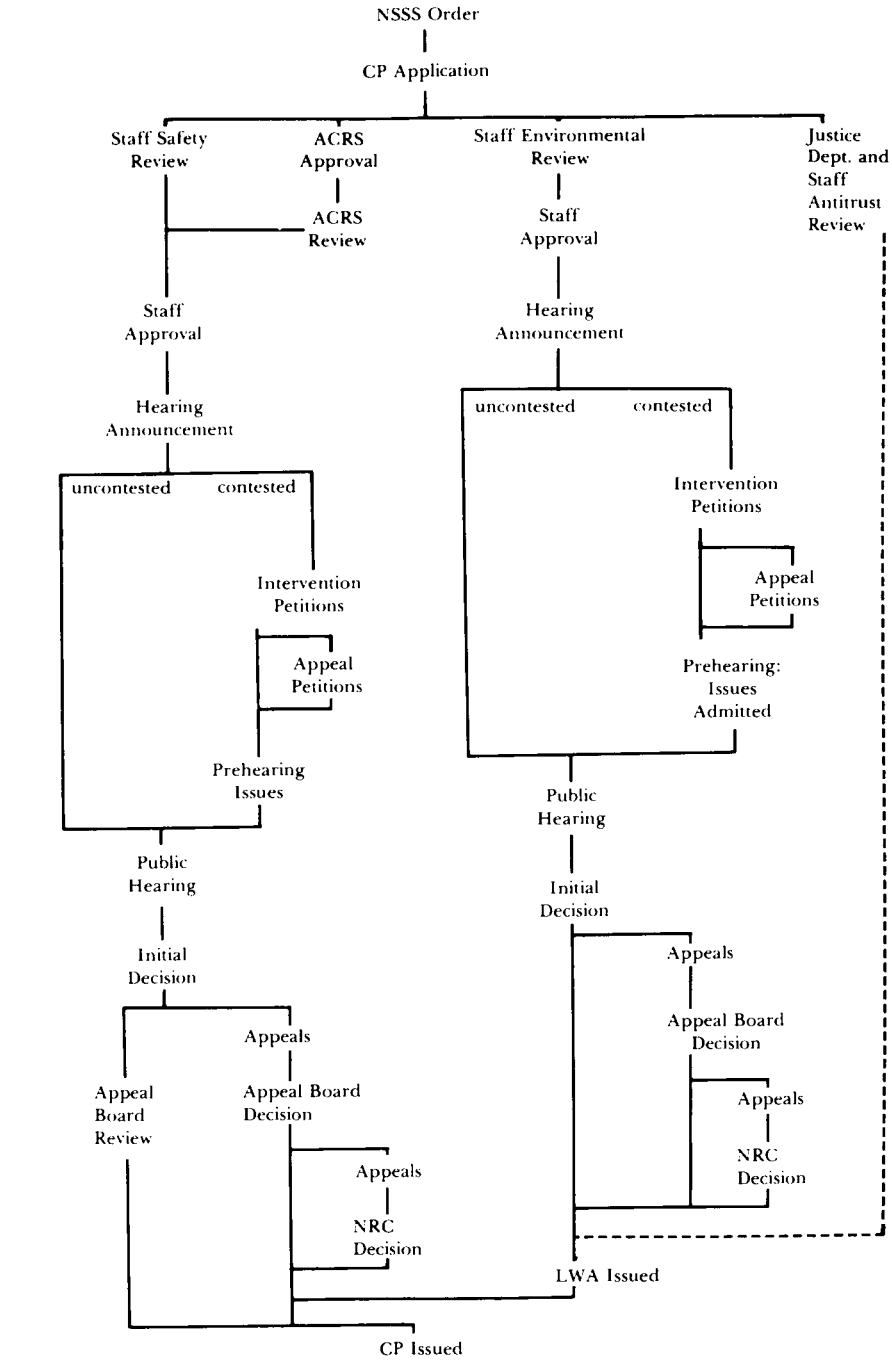
An applicant for a nuclear power plant CP and operating license (OL) goes through a complex licensing process. Figure 1 summarizes schematically the current NRC process.[31]

29. *See, e.g.*, Office of Finance and Incentives, Federal Energy Administration, Electricity Rates and the Energy Crisis 3, at 61-64 (August 1974).

30. CONGRESSIONAL BUDGET OFFICE, *supra* note 3, at 23.

31. *See, e.g.*, Grainey, *supra* note 2.

Figure 1. The NRC Licensing Process.




NSSS = nuclear steam supply system
ACRS = Advisory Committee on Reactor Safeguards
LWA = limited work authorization
CP = construction permit

Once the applicant files a CP application, four separate reviews are set in motion: (1) an antitrust review, (2) an environmental review by the NRC staff, and (3, 4) two safety reviews, one by the NRC staff, and the other by the Advisory Committee on Reactor Safeguards (ACRS). Upon completion of the staff reviews, the Commission issues hearing notices. Environmental review leads to a limited work authorization (LWA), permitting site preparation and construction of equipment that is independent of the reactor. The safety proceeding typically lasts longer and leads to CP issuance.

The environmental review is conducted to determine if the proposed plant is in compliance with the National Environmental Policy Act (NEPA).[32] Compliance involves an Environmental Impact Statement (EIS), an environmental cost-benefit analysis, a "Need for Power" analysis, proof that applicable environmental laws regarding thermal and atmospheric pollution are satisfied, and an overall finding that the proposed facility will not cause undue environmental harm.[33] Detailed[34] environmental[35] reviews were instituted after the 1971 *Calvert Cliffs* decision.[36]

Throughout the commercial period of nuclear power, the government banned all construction work on the reactor portion of the plant until CP issuance. Before the *Calvert Cliffs* decision clarified the NEPA requirements for the AEC, site preparation and certain construction activities could proceed prior to CP issuance. The Commission, however, continued to allow preCP construction in some cases and construction on plants with CPs that had not yet had complete environmental reviews.[37] As a result of the *Calvert Cliffs* decision, the AEC had to conduct environmental reviews for all plants that were either operating, under construction, or in licensing. A tremendous backlog of work ensued.[38] The Commission finally settled the preCP construction issue in 1974, issuing regulations that specified the preparatory work ("Limited Work") that could commence after successful completion of a site suitability and NEPA review.[39] Thus, except for a brief period in 1973, preCP construction was allowed at plants. However, for several years in the early seventies the practice elicited controversy and the utilities were subject to the threat (and sometimes reality) of unannounced construction halts.

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32. 42 U.S.C. § 4321 (1970).
33. 10 C.F.R. § 51.20(a) (1978).
34. *Id.* at § 51.20(b).
35. *Id.* at § 51.20(c).
36. Calvert Cliffs' Coordinating Comm., Inc. v. United States Atomic Energy Comm'n, 449 F.2d 1109 (D.C. Cir. 1971). For a detailed review of the *Calvert Cliffs* decision, *see* JOINT COMM. ON ATOMIC ENERGY, 92D CONG., 2D SESS., SELECTED MATERIALS ON THE CALVERT CLIFFS DECISION, ITS ORIGIN AND AFTERMATH (Comm. Print 1972).
37. *E.g.*, Toledo Edison Co. (Davis-Besse Nuclear Power Station), 4 A.E.C. 907, 907-10 (1972).
38. In 1972, in response to the apparent backlog and fears of power shortages, Congress allowed the AEC for about a year to issue temporary operating licenses without a NEPA review. Act of June 2, 1972, Pub. L. No. 92-307, 86 Stat. 191.
39. 10 C.F.R. § 50.10(e) (1978).

As a result of court decisions and major Commission actions, environmental reviews have become increasingly complex. For instance, since 1974, the review incorporates a consideration of the impact of energy conservation measures on the need for power from the proposed nuclear unit.[40] The safety reviews have addressed a consistent set of issues.[41] Findings are made on the adequacy of plant location in terms of surrounding population and expected radioactive releases, on the extent of normal radioactive releases on the consequences of the maximum credible accident, and on the integrity of the plant under other accident conditions.[42] Additionally, the Licensing Board evaluates the applicant's construction quality-assurance program and radiological monitoring programs,[43] and must find the plant not inimical to the common defense, security or safety of the public.[44]

The public part of safety reviews centers around a checklist of regulations. The regulations may not (except in very unusual circumstances) be challenged in a licensing case.[45] Instead, regulations are treated in rulemaking cases, and then applied to all future (and sometimes already completed) licensing cases. The most celebrated rulemaking cases of the early 1970s involved emergency core cooling systems[46] and the "as–low–as–practicable" radiation release standards.[47]

As is discussed below, the NRC is not required to make a final determination on all safety issues at the CP hearing. Upon completion of plant design the applicant applies for an operating license. The staff reviews the plant to assess previously unsettled issues and compliance with the conditions and promises in the CP. The termination of operating license cases is timed to coincide with actual completion of construction.[48] Public hearings in operating license cases have not been mandatory since 1962.[49] Prior to 1974, many

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40. Niagara Mohawk Power Corp. (Nine Mile Point, Unit 2), 7 A.E.C. 758 (1974).

41. The review of safety issues has, however, become far more complex as the staff has gained experience with operational reactors. As one staff member put it, "We know more about what can go wrong, so we have more things to look at." (Personal conversation with the author.)

42. 10 C.F.R. §§ 20.105, 100.10, 100.11(a) at n.1 (1978).

43. *See* 10 C.F.R. §§ 50.34(a)(7), 50.34(b)(3) (1978). Monitoring for radiation exposure to individuals at the reactor site is detailed in 10 C.F.R. § 20.202 (1978).

44. 10 C.F.R. § 50.40(c) (1978).

45. Baltimore Gas & Electric Co. (Calvert Cliffs Nuclear Power Plant), 4 A.E.C. 243, 244 (1969).

46. Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled Nuclear Power Reactors, Docket No. RM 50-1. For a discussion of the case, written while it was underway, *see* S. EBBIN & R. KASPER, CITIZEN GROUPS AND THE NUCLEAR POWER CONTROVERSY 125-39 (1974).

47. Effluents from Light-Water-Cooled Nuclear Power Reactors, Docket No. RM 50-2. The standard has been interpreted to preclude the NRCs establishment of a fixed numerical specification. York Comm. for a Safe Environ. v. U.S. Nuclear Reg. Comm'n, 527 F.2d 812 (D.C. Cir. 1975).

48. E. ROLPH, REGULATION OF NUCLEAR POWER: THE CASE OF THE LIGHT WATER REACTOR 65 (Rand Corp. Rep. No. R-2104-NSF, 1977).

49. Act of Aug. 29, 1962, Pub. L. No. 87-615, §§ 2, 189a, 76 Stat. 409, 42 U.S.C. § 2239 (1976).

operating license cases incorporated environmental reviews for those plants that did not receive full NEPA review during CP hearings.[50]

The long, complex licensing period is considered necessary because of the experimental nature of the industry. A rationale for the multiple reviews is uncertainty over technology—that some feature of the plant which is dangerous may be overlooked at one of the review stages. For instance, the Appeal Board Chairman in the *Gulf States* case characterized intervention as follows:

> Public participation in licensing proceedings not only 'can provide valuable assistance to the adjudicatory process', [footnote omitted] but on frequent occasions demonstrably has done so . . . many of the substantial safety and environmental issues which have received the scrutiny of licensing boards and appeal boards were raised in the first instance by an intervenor.[51]

Another rationale for multiple reviews is that nuclear technology is changing rapidly. Improvements and innovations can be accommodated within the current licensing process and no special procedures are necessary. This is particularly evident in NRC rules allowing uncertainties in plant performance at the time of CP issuance. According to the Commission rule, a CP can be granted even if all safety issues have not been resolved; the design details of nuclear power plants are in fact usually unfinished when the CP is issued.[52] The NRC reviews the plant design during construction and prior to issuing an operating license. Completed reactors are tested for about a year before they are run at capacity.[53] The "unresolved safety issues" issue was, for a while, a rallying contention of intervenors.[54] The issue actually was tested much earlier in court, and the NRC was found to have authority for not resolving all issues prior to CP issuance.[55] Like multiple review stages, the procedure should enable innovations to be made during the course of construction without major dislocations. However, it ensures the necessity of a public operating license hearing, from which further unanticipated delays can result.

Despite the expense of delays and design changes, the NRC has the authority to order retrofitting, particularly if the innovation significantly affects safety.[56] Only two major retrofits have been ordered by the NRC as of 1978:

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50. *E.g.*, Northern States Power Co. (Prairie Island Nuclear Generating Plant, Units 1 and 2), 7 A.E.C. 487-91 (1974).

51. Gulf States Utilities Co. (River Bend Station, Units 1 and 2), 7 A.E.C. 222, 226-27 (1974).

52. 10 C.F.R. § 50.35 (1978); *see also* 10 C.F.R. § 2.104(b)(1)(i) (1978).

53. Average of times for plants issued an operating license after 1970 as reported in UNITED STATES DEP'T OF ENERGY, U.S. CENTRAL NUCLEAR ELECTRIC GENERATING UNITS: SIGNIFICANT MILESTONES (DOE/ET-0030/4, 1978).

54. *See, e.g.*, Northern Ind. Pub. Serv. Co. (Bailly Generating Station, Nuclear-1), 7 A.E.C. 557, 564 (1974); Long Island Lighting Co. (Shoreham Nuclear Power Station), 6 A.E.C. 271, 280 (1973).

55. Power Reactor Dev. Co. v. Int'l Union of Electrical Workers, 367 U.S. 396 (1961).

56. 10 C.F.R. § 50.109 (1978).

emergency core cooling systems (ECCS), following hearings in which such systems were argued for by both outside and inside critics of older plants;[57] and, after the Brown's Ferry fire, new fire systems.[58] Major retrofits are expected to ensue due to the accident at Three Mile Island. The fire system retrofit cost only about $1 million per plant.[59] However, the ECCS retrofit is a major investment. Consolidated Edison shut down its Indian Point 1 plant, which had operated for some years, rather than install a costly ECCS system.[60]

Some plants were modified following the passage of NEPA.[61] In most cases, responsibility for ordering the modifications did not rest with the AEC. However, in the *Brunswick* case, the AEC (responding to the EPA) ordered construction of cooling towers, a change requiring the redesign and rebuilding of numerous parts of the plant.[62] Retrofits are rare events. They tend to be dramatic and command attention in industry and government folklore. Far more common are NRC-ordered changes at the design stage; as of 1978, no CP applications had gone through the NRC review without NRC-required design amendmeents.

Design changes and retrofits reflect one or more of the following points. First, experience with plants uncovered a weakness (e.g., the fire standards). Second, social values had changed, as reflected in the NEPA. Third, a system previously thought to be acceptable became unacceptable because of evidence unrelated to operating experience: simulation studies, theoretical work, or (conceivably) new inventions.[63] The motives that lie behind retrofitting indicate that its impact on innovation is ambiguous. A new product might define a new market or standard of safety and be required on past and future plants. This potential is an incentive for work on R&D projects that offer significant safety improvements,[64] and increase potential profits to small suppliers.[65] However, the threat of retrofits may decrease the incentive to invest in R&D by the entities that have the greatest opportunity to test for important

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57. *See* S. EBBIN & R. KASPER, *supra* note 46, at 127-30.

58. Petition for Emergency and Remedial Action, 7 N.R.C. 400, 424 (1978). *See also* [1978] NRC ANN. REP. 43-44.

59. CONGRESSIONAL BUDGET OFFICE, *supra* note 3, at 12.

60. *Id.*

61. 42 U.S.C. § 4321 (1970).

62. Carolina Power & Light Co. (Brunswick Steam Electric Plant, Units 1 and 2), 8 A.E.C. 1144, 1155-60, 1170 app. A (1974).

63. W. LOWRANCE, OF ACCEPTABLE RISK 6, 9 (1976).

64. *See generally*, Capron & Noll, *Summary and Conclusion*, in TECHNOLOGICAL CHANGE IN REGULATED INDUSTRIES 197-226 (W. Capron ed. 1971).

65. The discussion suggests that competition may be an aid to innovation. It is noteworthy that competition in this field is largely a by-product of the Price-Anderson Act, Pub. L. No. 85-256, 71 Stat. 576 (1957), which limits operators' liability for damage from reactor accidents. Critics of nuclear power assert that the Act promotes not competition, but the introduction of a hazardous technology before risks are fully understood. *E.g.*, Green, *Nuclear Power: Risk, Liability, and Indemnity*, 71 MICH. L. REV. 479, 506 (1973).

innovations—the utilities, the large vendors (if committed to standardized designs[66]), and the Commission itself.

These general characteristics of the licensing process demonstrate that the NRC allows for innovation and change.[67] Flexibility in licensing, however, comes at a considerable cost in terms of delays and uncertainty. Consequently, the procedures contribute to a decrease in innovation because of overall decline in nuclear investment due to cost increases, industry standardization to obviate the need for complex licensing, and intra-utility standardization to realize scale economies in licensing. All three outcomes are observed (though not entirely nor even predominantly because of these procedures). Decline in investment is shown in Table I. Standardization of plant design is one of the key features of the 1978 reform proposals, discussed in the last Section of this paper. Intra-utility standardization is seen in the utilities' practice of filing for multiple unit plants and obtaining construction permits for all the units while scheduling their completion far off in the future. For instance, Arizona Power and Light obtained CPs for Palo Verde 1, 2, and 3 in May 1976, although the units were originally intended to start commercial operation in 1982, 1984, and 1986, respectively.[68] Similarly, the Shearon Harris Plant Units 1, 2, 3, and 4 of Carolina Power & Light obtained CPs in a 1978 joint hearing, but were scheduled to begin operation in two–year intervals between 1984 and 1990.[69] Licensing multiple units in one process does not take appreciably longer than licensing a single unit. After the initial expense of designing an acceptable power plant, utilities are unlikely to promote major design changes, even though the units may not be completed.

Thus, NRC procedures designed to accommodate design changes are apparently unsuccessful. The lengthy and uncertain licensing time detracts from licensing flexibility so as to discourage new plant proposals and to encourage intra-utility standardization. On one hand, the AEC was initially set up so that an evolving industry could be licensed, but its licensing structure imposes costs on a marginally competitive industry and sets up incentives against a rapid rate of R&D.

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66. *See* pp. 86, 95-96, *infra*.

67. Somewhat standardized designs probably go through the licensing process with more ease than unusual ones. Unfamiliar with the novel designs, the NRC staff will take longer to review these applications. Lack of experience with a new type of reactor may cause concern at the public hearing. Thus, innovation, through delay, imposes a cost on the first utilities to propose it.

Only one reactor has been built that is exceptionally different, the Fort St. Vrain, a gas cooled reactor, described above. The Public Service Co. of Colorado applied for a CP in 1966 and obtained it 23 months later (compared to the 1966 average of 13 months). *See* U.S. DEP'T OF ENERGY, U.S. CENTRAL NUCLEAR ELECTRIC GENERATING UNITS: SIGNIFICANT MILESTONES 2 (DOE/ET-0030/4, 1978) (contains status of nuclear plants as of April 1, 1978).

68. *Id.* at 15.

69. *Id.* at 10.

## III

## DELAYS IN CONSTRUCTION PERMIT LICENSING 1966–PRESENT

Critics of the NRC licensing process claim that public participation causes undue delays in licensing, both extending the licensing process and contributing to the variability or uncertainty in licensing time.[70] Proponents of nuclear power assert that the NRC has established unnecessarily restrictive environmental and safety standards in response to uninformed public criticism.[71] The CP hearings are an important forum for public participation and an examination of them yields information on the validity of this claim.

Public participation in NRC licensing is mandated through the institution of intervention.[72] According to the 1954 Atomic Energy Act, interested parties can participate in cases involving licenses to construct and operate nuclear power plants by applying for intervention status.[73] The outcome of these cases are described in the decisions of the Atomic Safety and Licensing Boards, the Appeals Boards, and the Commissions. The decisions, published in the Regulatory Adjudication Issuances, form the data base core for this study. In order to examine systematically the outcome of licensing cases, a sample of 116 nuclear units was chosen. The sample includes applications for CPs between 1966 and 1974, omitting multiple units at a single site where the second, third, and/or fourth unit had an identical history to the first. In some of the Tables below, the 1974 applications are excluded because CP licensing history for many of these applications is incomplete. Table II shows the number of license applications and issuances for units in this sample.

Commission rules allow any interested individual who files the appropriate papers to have intervention status.[74] However, it is practically impossible to participate (as opposed to observe the proceeding) without expert witnesses and legal representation. The popular concept of intervenors is a well-organized, well-funded private group that intervenes with legal representation and becomes a full party to the case—e.g., the Calvert Cliffs Coordinating Committee, the Sierra Club, or the New England Coalition on Nuclear Pollu-

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70. *E.g.*, D. BURN, NUCLEAR POWER AND THE ENERGY CRISIS 46-47 (1978).

71. *See, e.g., id.* at 47-48; Gulf States Util. Co. (River Bend Station, Units 1 and 2), 7 A.E.C. 222 (1974). On the role of Congress in the licensing process, *see* B. Weingast, Congress, Regulation and the Decline of Nuclear Power (Center for the Study of American Business Working Paper No. 29, Washington U., St. Louis, Mo., April 1978).

72. 10 C.F.R. § 2.714 (1978).

73. The public also participates in individual licensing cases through state proceedings, ACRS review, and in general licensing through NRC rulemaking hearings and Congress. *See generally* Nelkin & Fallows, *The Evolution of the Nuclear Debate: The Role of Public Participation*, 3 ANN. REV. ENERGY 275 (1978).

74. 10 C.F.R. § 2.714a (1978).

TABLE II

LICENSE ISSUANCES IN THE SAMPLE OF LICENSING CASES

| | CP applications | CP issuances | OL issuances |
|---|---|---|---|
| 1966 | 8 | 0 | 0 |
| 1967 | 22 | 7 | 0 |
| 1968 | 11 | 20 | 0 |
| 1969 | 11 | 8 | 0 |
| 1970 | 15 | 8 | 0 |
| 1971 | 6 | 4 | 1 |
| 1972 | 5 | 9 | 6 |
| 1973 | 19 | 11 | 11 |
| 1974 | 18 | 17 | 12 |
| 1975 | 0 | 5 | 3 |
| 1976 | 0 | 3 | 2 |
| Total | 116 | 92 | 35 |

tion. However, many intervenors are individuals living near the plant who restrict their intervention to observation and limited participation at hearings. The expensive nature of intervention resulted in many requests for financial assistance from intervenors in 1974. In the *Vermont Yankee* case, intervenors requested twenty-five thousand dollars so they could "minimally" participate in a subsidiary aspect of an OL case.[75] Full intervention in a CP case is estimated to cost hundreds of thousands of dollars.[76]

The fate of intervenors lacking legal counsel was demonstrated dramatically in a 1974 case involving the Carolina Environmental Study Group and Duke Power Company.[77] The intervenors—who later became highly sophisticated—stipulated for an expedited hearing, at which they were allowed to present in written form, at one time, material they would have introduced during the course of a normal hearing. Apparently unaware of the legal concept of official notice, they requested that the Licensing Board take notice of certain technical journal articles. As the articles did not consist of generally accepted fact, under the rules concerning the taking of official notice the Board refused the request. As a result, the intervenors could not[78] present any of the information on the impact of radiation which they had collected. The Licensing Board attributed their quandary to lack of proper legal advice and noted in the initial decision that the Board had warned the intervenors

75. Vermont Yankee Nuclear Power Corp. (Vermont Yankee Nuclear Power Station), 7 A.E.C. 982 (1974).

76. S. EBBIN & R. KASPER, *supra* note 46, at 194.

77. Duke Power Co. (Catawba Nuclear Station, Units 1 and 2), 7 A.E.C. 659 (1974).

78. 10 C.F.R. § 2.743(i) (1978).

against undertaking a complex administrative procedure without proper counsel.[79]

In addition to private individuals, representatives of the states in which the plants are located frequently intervene. Some states participate vigorously, particularly in the environmental phases of the review. The earliest requests for considering thermal pollution came from state intervenors. Other states in the sample were merely onlookers, intervening in an observer status.[80]

Usually the opposing private intervenors consolidate and present one case. If public intervenors are opposing the license, private intervenors frequently support them and vice versa. In the 92 CP cases resolved prior to 1977, 18 percent were uncontested, and 33 percent had "major," or well-funded intervenors.[81] Historically, intervenor action has varied: all of the cases resolved in 1971 had major intervenors, as opposed to about 50 percent in 1973.[82] Table III provides more information about the distribution of contested and uncontested cases.[83]

Intervenors file a petition with a list of issues.[84] The Licensing Board rules on the petitions in prehearing conferences. A major reason for the conferences is to weed out and winnow down the list of objections, and (less successfully) to mediate compromises between parties. In an extreme case involving Duke Power Company's William McGuire plant, the Carolina Environmental Study Group filed a petition listing 223 issues. The Licensing Board allowed about a dozen of these issues to be raised in the hearing.[85] The criterion for admitting issues is that they can be resolved in an individual licensing case; they must *directly* relate to the proposed plant and to the Licensing Board decisions on environmental degradation or safety. The NRC is very careful to hear any issue that might develop into a valid one. Direct attacks on Commission regulations are considered "generic" and cannot be an issue in licensing

79. Duke Power Co., *supra* note 78, at 666.

80. A fourth type of intervenor are wholesale customers of the applicant. Prior to 1970 they intervened requesting antitrust reviews. Following a 1970 change in the Atomic Energy Act that made review mandatory, Act of Dec. 19. 1970, Pub. L. No. 91-560, § 6, 84 Stat. 1472 (amending 42 U.S.C. § 2135(c) (1964)), the intervenors used the AEC review to sue the applicant for antitrust violations. Antitrust reviews are separate from the other parts of the CP review. They have influenced the timing of construction in only one case since 1970, and then for only a few months. *See generally* L. Cohen, *supra* note 4, ch. 3.

81. L. Cohen, *supra* note 4, at 14.

82. *Id.*

83. A curious lineup occurred in 1974 decisions regarding the Vermont Nuclear Power Plant. The AEC staff and the Advisory Comm. on Reactor Safeguards argued that the containment atmosphere should be "inerted," or filled with nitrogen to avoid buildup of an explosive mixture of hydrogen and oxygen during an accident. The applicant and intervenors opposed the recommendation. *See* Vermont Yankee Nuclear Power Corp. (Vermont Yankee Nuclear Power Station), 7 A.E.C. 431 (1974).

84. 10 C.F.R. § 2.714(a) (1978).

85. Duke Power Co. (William B. McGuire Nuclear Station, Units 1 and 2), 6 A.E.C. 92, 93-94 (1973).

unless the intervenor presents evidence of immediate danger.[86] However, site-specific compliance with any regulation is a legitimate issue. Frequently issues are admitted on this basis, but when the intervenor attempts to address the regulation directly, the issue is rejected.

The case of radioactive release standards illustrates these concepts. NRC regulations state that, with certain qualifications,

> (a) There may be included in any application for a license . . . proposed limits upon levels of radiation . . . resulting from the applicant's possession or use of radioactive material . . . . The Commission will approve the proposed limits if the applicant demonstrates that . . . [they] are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem . . . .[87]

In addition,

> (c) [licenses] should make every reasonable effort to maintain . . . releases . . . as low as is reasonably achievable. . . . taking into account the state of the technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.[88]

The 0.5 rem level of section 20.105 was established in a generic proceeding.[89] On the other hand, an "as low as is reasonably achievable" challenge (which can address the same 0.5 standard) will be heard in licensing. As this rather simplified example shows, it is not always obvious in practice whether an issue is generic or site-specific, even according to the Commission rules. The Commission has the discretion to label an issue as "licensing" or "generic" when controversy persists.[90]

The distinction between generic and licensing issues is even fuzzier in the environmental area. The Environmental Defense Fund argued at the Nine Mile Point 2 hearing that the National Environmental Policy Act required the AEC to consider whether there would be a "need for power" from the proposed plant, and whether energy conservation measures might reduce—and counteract—that need.[91] The AEC considered the issue, but after hearing evidence, the Licensing Board ruled that energy conservation was not a legitimate issue. The AEC reversed this decision under threat of a probable court reversal opening the hearing to considerations of demand projections for the Niagara Mohawk service areas and viable alternatives to both the nuclear

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86. *E.g.*, Allied-General Nuclear Services (Barnwell Nuclear Fuel Plant), 7 A.E.C. 1015, 1019-20 (1974).

87. 10 C.F.R. § 20.105(a) (1978).

88. *Id.* at § 20.1(c).

89. Effluents from Light-Water-Cooled Nuclear Power Rectors, *supra* note 47.

90. Morningside Renewal Council, Inc. v. U.S. Atomic Energy Comm'n, 482 F.2d 234, 239 (2d. Cir. 1973).

91. Niagara Mohawk Power Corp. (Nine Mile Point, Unit 2), 7 A.E.C. 1046, 1060-67 (1974).

plant and increased electrical usage.[92] The Licensing Board's final decision rested on the "substitution theory"—that even if projected demand failed to materialize, Niagara Mohawk would benefit from the nuclear plant by closing down older, less efficient plants.[93] Ironically, shortly after this decision, Niagara Mohawk announced a one year delay in the plant's construction schedule because of an unanticipated reduction in electricity demand.

The issues raised during this period fall into six general categories, none of which are confined to a single year or subgroup of years. Table III shows the distribution of these issues by year of CP application.

The first two issues correspond to environmental reviews. Environment—EIS; NEPA includes issues relating to the form of the environmental review and the requirements of NEPA. Environment—Cooling; Technical comprises substantive environmental issues, e.g., the appropriateness of the plant cooling system in view of thermal pollution. While the first issue only has delay potential so far as licensing goes, theoretically the second could result in a different plant design.

The intervenors in the *Bailly* CP case[94] argued that the cost-benefit analysis performed for the plant was inadequate. Costs stemming from the entire nuclear fuel cycle should be included; alternatives to the Bailly site were treated inadequately in the cost-benefit study and the need for power analysis was inaccurate.[95] These issues are not just procedural. The site consideration constitutes a use of the cost-benefit analysis by the intervenors as a vehicle to argue against the Bailly site itself. But the issues immediately address the form of the Commission review rather than the plant itself. Alternately, the intervenors presented evidence that the construction plans would change the groundwater level and permanently damage the neighboring Dunes National Lakeshore Park. They further asserted that the proposed water towers would be ugly and detrimental to the local environment.[96]

Safety issues fall into three categories: normal operations, plant accidents, and quality assurance. The first relates to normal operations. The most common issue raised under this heading concerns the level of radiation released during normal operation of the plant—whether they are "as low as practicable" or "as low as is reasonably achievable." Another issue concerns plants near commercial fishing grounds—whether liquid radioactive releases might contaminate shellfish beds.[97] A third topic involves technical aspects of the

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92. *Id.* at 1079.
93. *Id.* at 1083-84, 1086.
94. Northern Ind. Pub. Serv. Co. (Bailly Generating Station, Nuclear-1), 7 A.E.C. 557 (1974), *aff'd*, 8 A.E.C. 244 (1974).
95. 7 A.E.C., at 615-25.
96. *Id.* at 589-91, 599-601.
97. *E.g.*, Boston Edison Co. (Pilgrim Nuclear Power Station), 5 A.E.C. 103, 111-12 (1972).

TABLE III

ISSUES RAISED: YEAR CP APPLICATION

| | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|
| Environment: | | | | | | | | |
| EIS, NEPA | – | 3 | 4 | 7 | 8 | 1 | 3 | 5 |
| % Cont.* | – | 21 | 66 | 100 | 80 | 100 | 100 | 62 |
| % Total† | – | 14 | 36 | 64 | 53 | 17 | 60 | 33 |
| Environment: | | | | | | | | |
| Cooling, Technical | 1 | 5 | 2 | 5 | 6 | – | – | 4 |
| % Cont. | 17 | 36 | 33 | 71 | 60 | – | – | 50 |
| % Total | 11 | 26 | 18 | 45 | 40 | – | – | 26 |
| Safety: | | | | | | | | |
| Normal Operation | 2 | 1 | 4 | 6 | 5 | – | 3 | 6 |
| % Cont. | 33 | 7 | 66 | 86 | 50 | – | 100 | 75 |
| % Total | 22 | 5 | 36 | 55 | 33 | – | 60 | 40 |
| Safety: | | | | | | | | |
| Emergency Operation | – | – | 2 | 5 | 8 | 1 | 1 | 2 |
| % Cont. | – | – | 33 | 71 | 80 | 100 | 33 | 25 |
| % Total | – | – | 18 | 45 | 53 | 17 | 20 | 13 |
| Quality Assurance, | | | | | | | | |
| Plans, Security | 2 | 2 | – | 2 | 6 | – | – | 1 |
| % Cont. | 33 | 14 | – | 29 | 60 | – | – | 12 |
| % Total | 22 | 9 | – | 18 | 40 | – | – | 7 |
| Proces | 4 | 6 | 6 | 7 | 10 | – | 3 | 7 |
| % Cont. | 66 | 43 | 100 | 100 | 100 | – | 100 | 87 |
| % Total | 44 | 27 | 55 | 64 | 66 | – | 60 | 47 |
| # Applications | 9 | 22 | 11 | 11 | 15 | 6 | 5 | 15 |
| # Contested applications | 6 | 14 | 6 | 7 | 10 | 1 | 3 | 8 |
| # Applications with major intervenors | 1 | 4 | 4 | 6 | 9 | 1 | 3 | 6 |

* % Cont. = Percent of contested cases started in year.
† % Total = Percent of total cases applied for in year.

plants such as pipes, welds, or bolts. The last topic overlaps with the safety division used here.[98]

The second category involves issues relating to plant accidents—the effectiveness of the emergency core cooling system. The category includes issues relating to major accidents such as the very low-probability, high-risk event. One frequent issue in licensing cases in this category is the definition of the Low Population Zone (LPZ).[99] The NRC calculates probable doses from various accidents as a function of distance from the reactor, meteorology and plant design. The LPZ is a restricted area intended, as its name implies, to include few residents. LPZ arguments concern both dose calculations and population projections.

The third safety category includes the quality assurance program, evacuation plans, and security plans. The category includes safety-related issues that are not matters of technical plant design.

The final category of issue is characterized as "Process." This includes complaints about how the CP proceeding is held and about the individuals involved. Process includes issues frequently associated with intervenors by proponents of nuclear power—legal maneuvers intended to delay the hearing, claims that the Licensing Board is biased, arguments over subpoenas, arguments over hearsay evidence and documentation. As shown in Table III, most cases with active intervenors involved one or more process issues.

The resolution of these issues in licensing cases reveals a remarkable pattern. To simplify the analysis, resolutions were categorized into nine possibilities. As is necessarily the case with simplifications, details of the resolutions are lost in translation, and judgment used (sometimes too liberally) in fitting resolutions into the categories. In each case, the final resolution of the issue was graded. Thus, the energy conservation issue in Niagara Mohawk, described above, shows up in Table IV as a major Environment EIS victory (the basic issue being whether or not to consider the issue in a cost-benefit analysis), despite the fact that the Board ruled that the applicant could go ahead with the plant. The *Bailly* groundwater case, described above, is classified as denied in the "Consider and Reject" category. This was the ultimate resolution of the issue although it went through numerous hearings and, on several occasions, the Board halted construction at the plant pending yet another hearing. The "not issue" resolution category includes numerous cases where the Licensing Board considered an issue, but upon hearing the intervenor's case, decided that the issue was generic and invalid for consideration in licensing.

Table IV reveals that the AEC ruled against the intervenors—resolutions

98. *See* L. Cohen, *supra* note 4, app. A.
99. *See* 10 C.F.R. § 100.3(b).

TABLE IV*

| | Environ: EIS | Environ: Technical | Safety: Normal | Safety: Accidents | Planning, QA, Security | Process |
|---|---|---|---|---|---|---|
| 1. Rejected | 12 | 3 | 14 | — | — | 16 |
| 2. Consider & reject | 5 | 1 | 2 | — | — | 1 |
| 3. Not Issue | 6 | 3 | 1 | 18 | 14 | 3 |
| 4. Consider at OL | — | 1 | — | — | — | 1 |
| 5. Resolve in different forum | — | 6 | 3 | — | — | — |
| 6. Granted–minor | 2 | 1 | — | — | — | 3 |
| 7. Monitor or Test | — | 3 | 4 | — | — | — |
| 8. Granted–major | 2 | 2 | — | — | — | 1 |
| 9. Mixed (process) | — | — | — | — | — | 16 |
| 10. Unknown | — | 2 | — | — | — | — |
| Subtotal 1–5 | 21 | 14 | 20 | 18 | 14 | 21 |
| Total | 25 | 22 | 24 | 18 | 14 | 40 |

* See Table III for complete issue headings

one through five—in the majority of cases. Where the intervenor's case was accepted, the outcome was typically to order more tests, to monitor, or various minor changes. (An example of "granted–minor" in the EIS category involved excluding tax revenues from the plant as a benefit in the cost–benefit analysis.) This pattern is particularly evident in the substantive issue categories—technical environmental and safety issues.[100]

The distribution of issue resolutions leaves little doubt that intervenors are having a negligible effect on plant design through CP case participation. This statement, however, needs considerable qualification. First, "plant design" means design of a particular plant being considered in the immediate licensing case. The Calvert Cliffs Coordinating Committee, by initially intervening in the *Calvert Cliffs* licensing case, had a major impact on both licensing and design of subsequently licensed nuclear power plants. The numerous ECCS interventions contributed to formulating regulations regarding ECCS design that have been applied to all commercial nuclear power plants. Other intervention initiatives have influenced the direction and intensity of NRC staff reviews. These changes, however, are generic. The observation raises questions about the impact of intervention in licensing cases, but not necessarily in the nuclear industry as a whole.

100. "Mixed process" resolution is for cases in which a multitude of procedural issues were argued over, and the intervenors lost on some, won on others. "Not an issue" refers to the situation where the licensing board decides the issue is generic. "Resolve in OL" and "Resolve in different forum" are tantamount to rejection: the licensing board rules that the issue cannot be ruled upon during the CP hearing. Issues that were reversed in one or more appeals, but ultimately rejected are said to be "considered and rejected."

Second, the licensing intervention may have had an indirect impact on some licensing cases. Although the intervenors "lost" in initial decisions, they may have influenced the staff reviews in the particular cases because the NRC staff took care to present particularly good cases if intervenors were present. Third, raising issues was accompanied by increased discussion during the hearings. Thus, issues that were eventually ruled "not an issue" were allowed to be discussed during licensing. This activity may have influenced the ultimate plant designs although the intervenors did not "win." Finally, the presence of intervenors may have influenced the nuclear industry indirectly through its impact on diffusion and innovation, as discussed in Section I.

These hypotheses can be tested by looking at the influence of intervention on licensing time.

## IV
## ANALYSIS OF LICENSING

Intervenors are expected to have externality effects on uncontested applications. This point can be demonstrated by a routine case: the Tennessee Valley Authority's (TVA) application for the Hartsville nuclear power plants.[101] Private intervenors did not contest the 1974 application. TVA received a construction permit thirty-two months later, in 1977.[102] The Comptroller General investigated the case, concluding that the application was unnecessarily delayed about seven months for the following reasons: (The events overlap, summing to longer than seven months slippage.)

> 1. The Commission took longer than its own regulations call for to formally accept the Authority's application. Before the Commission will begin reviewing a permit application, it checks the application to make sure it is complete. The Commission's regulations provide that such a determination of completeness will generally be made within [thirty] days, but for this project the Commission took [fifty-seven] days. An additional [eighteen] days passed while (1) the Commission notified the Authority that it would accept the application, and (2) the Authority supplied the required number of copies[;]
> 2. The Commission was late in making an announcement in the Federal Register. Once the Commission accepts an application, it then has a notice printed in the Register to alert interested parties that a public hearing will be held and that any parties interested in participating in the hearing must apply within [thirty] days. Getting this notice printed appears to us to be a very simple matter in that the notice is short and essentially pro forma and can be prepared during the acceptance review and sent to the Federal Register printer no later than [one] week after the application is accepted. For the Hartsville application, it took [thirty-three] days[;]
> 3. The Atomic Safety and Licensing Board was very late in starting the public hearing. The Commission's regulations state that a hearing should start no later than [thirty] days after the staff issues its final environmental statement,

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101. Docket Nos. 50-518, 50-519, 50-520, 50-521.
102. UNITED STATES DEP'T OF ENERGY, *supra* note 52, at 13.

> unless the parties agree otherwise or the rights of any party would be prejudiced thereby. The Board, therefore, should be timing its pre-hearing activities so that it will be ready to start the hearing shortly after the environmental statement is completed. This was not the case in the Hartsville application. The Commission staff established about a [six]-month target time that it would need to publish an environmental statement. But the statement was late [three] months. Therefore, the Board had a total of [nine] months to get ready for the hearing. Even so, the hearing did not start for [four] additional months, which means the Board took over [one] year to set up and begin the public hearing[;]
>
> 4. A [f]ederal court decision caused the Commission to temporarily stop issuing permits. The Authority applied for a second limited work authorization—to enable additional work to be done at the site—on June 10, 1976. While the Commission was reviewing the matter, a [f]ederal [c]ourt rendered a decision on the Commission's environmental reviews, which caused the Commission to suspend its issuance of permits. This suspension unavoidably delayed the issuance of this permit for about [three] months.[103]

According to this account, the project was delayed for about three months due to court decisions[104] directly ensuing from previous intervention in other Commission cases. Another partially overlapping six months in licensing slippage can be ascribed to ineptitude. Finally, the report states that the staff and Board took an unusually long time to review or prepare to review the application.

This story raises the following questions: Were the NRC's estimates of the appropriate amount of time to spend in review reasonable? Can the prolonged staff review be accredited to the number of applications filed in the year (suggesting case overload), the number of topics considered, or to staff preoccupation with other, contested cases?

Our model addresses these questions as follows: After controlling for various interventions during each year and other plant factors, estimates are derived for the base licensing time per year. The estimates are "correlated"[105] with the number of cases in the year (for case overload), the distribution of intervention and major intervention by year (for the straight externality effect), and issues raised in cases during the year and previous years (for topics). At the conclusion of this Section, licensing cases for two years are analyzed.

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103. *Nuclear Regulatory Comm'n Authorizations for Fiscal Year 1979: Hearings before the Subcomm. on Nuclear Regulation of the Senate Comm. on Environment and Public Works*, 95th Cong., 2d Sess. 114-15 (1978) (letter from the Comptroller General to Congressman Tom Bevill).

104. Aeschliman v. U.S. Nuclear Reg. Comm'n, 547 F.2d 622 (D.C. Cir. 1976); Natural Resources Defense Council, Inc. v. U.S. Nuclear Reg. Comm'n, 547 F.2d 633 (D.C. Cir. 1976), *rev'd sub nom* Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519 (1978). In response to the lower courts' rulings on fuel reprocessing and waste management, the Commission suspended issuance of operating licenses, construction permits and limited work authorizations on August 13, 1976, 41 Fed. Reg. 34, 707 (1976), and resumed licensing three months later under revised guidelines, 41 Fed. Reg. 49, 898 (1976).

105. As discussed below, the data are too crude for particularly sophisticated techniques. "Correlation" is not used here in a statistical sense.

Licensing time equals the number of months from when the applicant applies for a CP to the time that the NRC issues the permit. Initially an attempt is made to account for the variance in this variable ("elapsed time") across plants on the basis of three types of attributes.

First, the year of CP application is important. In particular, the staff workload, in terms of both the number of cases and the extent of each review, is determined by the date the applicant files for review, rather than the end of the public hearing. The NRC usually institutes a mild form of grandfathering for applications part way through the review process when regulations change. Typically, regulations about review procedures (not design requirements) are specified to apply to applications filed after a certain date, rather than to permits issued after a certain date.[106]

The second group of attributes concern what, if any, issues are raised in licensing. Issues are classified here into one of the six categories described earlier. By estimating coefficients for different issues and comparing the incidence of issues, two competing theories of intervention can be informally tested: first, if intervenors just delay all cases; second, if they generally delay cases because of substantive criticism.

The third group of attributes are certain exogenous plant characteristics: the vendor, the architect–engineer, and the plant type. Variation due to the utility is left in the residual. Since most of the sample plants are owned by different utilities, or different consortia of utilities, it is unlikely that the omission leads to serious bias.[107]

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106. *E.g.*, 10 C.F.R. § 50.34(a)(5) (1978).

107. The model described above is characterized by the following equation:

$$ELT_{it} = a + \sum_{s=66}^{73} b_s Y_s + \sum_{j=1}^{6} c_j Iss_j + \sum_{j=1}^{n} d_j D_j + e_i$$

where

$ELT_{it}$ is the exposed time of application i, filed in year t

$Y_s$ are dummy variables for the year of CP application:

$$Y_s = \begin{cases} 1 \text{ if } s = t \\ 0 \text{ otherwise} \end{cases}$$

$Iss_j$ are dummy variables for issues:

$$Iss_j = \begin{cases} 1 \text{ if the hearing considers issues j} \\ 0 \text{ otherwise} \end{cases}$$

the $D_j$ variables are dummy variables for the exogenous attributes.

a, a constant term, denotes the base-case elapsed time (for a plant with CP application filing in 1966, no intervenors and none of the exogenous attributes).

$b_s$, $c_i$, and $d_i$ are the coefficients associated with the variables $Y_s$, $Iss_j$, and $D_j$, respectively.

$e_i$ is the error term.

More complex models, allowing for interaction between issues and between issues and years, are discussed in L. COHEN, *supra* note 4. In view of the small sample size, the statistical exposition here is kept simple. This procedure is adequate to identify general trends in licensing, although the magnitudes of the estimated coefficients may not carry predictive value.

The results of the regression analysis are in Table V. None of the exogenous plant attributes consistently influenced the licensing time and they are excluded.

Coefficients of the year of CP applications reflect the expectation that licensing time is influenced by workload and review complexity. According to this model, a 1966 CP application with no intervenors had an anticipated elapsed time to CP issuance of 15.1 months. The increase from 1967 to 1968 is attributed to the *Calvert Cliffs* decision. The court decision required retroactive reviews prior to all subsequent licensing. The review requirement affected most 1968 applications, but not the 1967 applications.

The high values associated with 1970 and 1971 are probably due to a number of factors. First, applications filed in those years were most subject to the shifting environmental regulation described earlier. Lower values for 1972 and 1973 reflect in part a successful Commission adjustment to the timing, content, and requirements of the environmental reviews. Second, the caseload of the Commission increased dramatically and unexpectedly in the early 1970s. Not only were a large number of applications filed in 1970 (see Table I), but the 1971 *Calvert Cliffs* decision suddenly required environmental reviews for plants in the midst of the licensing process, as well as for some previously licensed plants. Most applicants who filed prior to NEPA passage,

TABLE V

COEFFICIENTS OF LINEAR REGRESSION MODEL*

$R^2 = .602$
Degrees of Freedom = 78
Constant Term = 15.1

| | *Coefficient* | *Standard Error* |
|---|---|---|
| *Issues* | | |
| Environ: NEPA, EIS | 6.4 | 3.4 |
| Environ: Tech | -2.2 | 2.9 |
| Safety: Normal | .5 | 3.3 |
| Safety: Emergency | 11.2 | 3.5 |
| Quality Assurance Plans | 7.1 | 3.2 |
| Process | -3.7 | 2.9 |
| *Year of CP Application* | | |
| 1967 | -1.5 | 3.9 |
| 1968 | 5.8 | 4.5 |
| 1969 | 8.1 | 4.6 |
| 1970 | 13.7 | 4.4 |
| 1971 | 15.7 | 5.3 |
| 1972 | 4.9 | 5.7 |
| 1973 | 9.8 | 4.2 |

* See Table III for complete issue headings.

but lacking CPs by that time, held an expedited environmental review before, or immediately after, CP issuance to determine if construction should be suspended pending final NEPA review.[108] The workload–delay hypothesis is supported by the large coefficient for 1973. As Table III (page 84) shows, 1973 had the highest number of CP applications since 1967).[109]

It is more difficult to find evidence for the intervenor–externality hypothesis that intervenors affect licensing time of not only the cases in which they participate, but also in subsequent cases. Neither the percent of contested cases nor the percent of cases with major intervenors (or simply the number of such cases) correlate very well to the "base" time for plants in year of Construction Permit Application. This suggests that intervention alone may not exert a very strong influence on licensing. However, the results support the hypothesis that intervention influences licensing through raising issues. Plants licensed after 1968 took longer than earlier plants. The high values for all plants licensed in the early 1970s reflect, in addition to increased workload, spillover from the high number of environmental interventions in the late sixties.

The variation in coefficients of the issues is important. First, the relative magnitudes of the coefficients do not correspond to the incidence of major intervenors raising varied issues. If delays are caused in licensing simply by the presence of intervenors (in the contested case rather than on all cases as discussed above), then the coefficient for "process" should be high; 94 percent of the contested cases with major intervenors had process issues. Additionally, the process issue has been emphasized as causing licensing delays; but neither this model nor a more complicated version supports that hypothesis.[110]

Although these estimates do not suggest that delays are due to procedural jockeying by intervenors, they do indicate that certain issues tend to be identified consistently with longer cases. Issues relating to the NEPA reviews have been associated with increased licensing time during this period. This is in addition to the general environmental–externality effect observed in the year coefficients. Because the NRC has been subject to almost continual judicial review for its NEPA treatment, licensing boards and staff would review

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108. *E.g.*, Toledo Edison Co. (Davis-Besse Nuclear Power Station), 4 A.E.C. 912, *rev'g in part*, 4 A.E.C. 907 (1972).

109. Some of the 1973 plants were held up in the licensing moratorium that affected Hartsville. This contributes to the size of the coefficient, and also increases the coefficients of the "issue" variables. Because the moratorium was a (blanket) result of intervention, it should not be controlled for.

110. *See* L. Cohen, *supra* note 4, ch. 1. It was thought that the "process" variable might be a surrogate for multiple issues during a single case. A regression was run that included other variables intended to pick up any multiple issue effect; in particular, dummy variables for cases with two issues, or three or more issues. The coefficient for the "process" variable in this regression is −1, with a standard error of 3.7.

cases with NEPA issues—potential court cases—more carefully. However, the effect tends to be small.

Alternately, from this analysis the environmental–technical issues do not appear to have a consistent impact on licensing time. A closer examination of the cases described below reveals that this conclusion results in part from crudeness of the statistical model. In most of the cases where this issue was raised, it did not cause an additional delay. In a few pre–1971 cases, the issue was responsible for major reconsideration and delays during licensing.[111]

The relatively small values for environmental coefficients supports the view that the NRC is primarily a safety–regulatory agency. The Commission will expend minimum effort on issues unrelated to its central mandate. The Commission faces serious staffing constraints as the licensing time increases for years with many applications. Faced with such constraints, an agency is expected to devote its limited resources to what it perceives to be its most important goal. The high values of coefficients for Safety-Emergency and Quality Assurance support this model of an agency (see Table V at 90).

According to this analysis the most important of the issues are related to accident conditions at plants. The accident–related issues are particularly interesting for two reasons. Unlike either environmental or the normal safety issues, accident issues are raised in longer cases throughout this period. It does not appear that the NRC has developed successful regulations for reviewing such issues.

The issue–delay connection is clarified by examining the case histories for certain years. Consider applications filed in 1972:[112] of the four separate 1972 applications, one (Grand Gulf) was uncontested, and had a licensing time of just under two years.[113] The other three cases involved numerous intervenors. The Nine Mile Point Application, discussed above, took two years to resolve.[114] The intervenors raised the "as low as practicable" (normal safety) issues, several process issues (including a request for financial assistance), and the issue of considering energy conservation as an alternative in the cost-benefit study and as a variable in the "Need for Power" analysis. During the public hearing, the main concern of the intervenors was with the latter issue and they prevailed. Licensing time was not particularly long for the plant.

The second contested 1972 case was Duquesne Light Company's Beaver

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111. There is a small negative correlation (about −0.06) between year of application and the residuals from cases where technical environmental issues were raised.

112. Niagara Mohawk Power Corp. (Nine Mile Point, Unit 2), docket no. 50-410; Duquesne Light Co. (Beaver Valley Power Station Unit No. 2), docket no. 50–412; Duke Power Co. (Catawba Station Unit 1) docket no 50–413; Mississippi Power & Light Co. (Grand Gulf Station Unit 1), docket no. 50–416.

113. Twenty-two months. UNITED STATES DEP'T OF ENERGY, *supra* note 52, at 11.

114. *Id.* The hearings are recorded in Niagara Mohawk Power Corp. (Nine Mile Point, Unit 2), 7 A.E.C. 1046 (1974) (*see also* text associated with notes 92, 93 and 94, *infra*.)

Valley 2 application.[115] Licensing took 18 months.[116] The intervenors' main case at the Beaver Valley hearing concerned low level radiation risks: methods of calculating the health effects of different low-level doses. In addition, intervenors claimed that the Licensing Board was unfair, that it attempted to "judicialize" the proceeding by invoking rules of evidence and thus, disadvantaging the intervenors. One group of intervenors brought up "Need for Power" issues. The issues were not novel and not given much consideration in the Licensing Board's decision.

The final 1972 case is complicated. The Carolina Environmental Study Group intervened in the *Catawba* case, a Duke Power Company plant. The licensing case took 35 months.[117] Intervenors brought up issues relating to "Need for Power," normal-operation safety, and the emergency core cooling system (ECCS). They also became involved in an enormous legal wrangle in which they were not represented by counsel.

The eventual outcome was invalidation of the intervenors' main safety case on grounds that the issues had been fully aired at a previous hearing.[118] The Board rejected the ECCS case of the intervenors while both staff and Board displayed concern over the ECCS. The application straddled two sets of regulations respecting the ECCS. Duke applied for—and eventually received—an exemption to the new ECCS Final Acceptance Criteria Regulations. Considering the history of plants licensed during this period, Duke had substantially more difficulty adjusting to the change in regulations than other utilities.

Examination of these recent cases reveals fairly efficient handling by the Commission of the environmental issues and substantially more trouble with the emergency safety issues. The NRC's ease with environmental reviews is not surprising as it had several years of experience prior to reviewing these plants.[119]

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115. Beaver Valley, along with other of the applications considered here, was the focus of a long antitrust suit, ostensibly conducted by the NRC. The suits are separated from the rest of licensing and are rarely relevant to the problems considered here. When the Commission rules on antitrust issues, so that they could conceivably contribute to case work overload, the application is credited with a "process" issue. See L. Cohen, *supra* note 4, ch. 3, for a discussion of the NRC antitrust cases.

116. UNITED STATES DEP'T OF ENERGY, *supra* note 52, at 11. The hearings are recorded in Duquesne Light Co. (Beaver Valley Power Station, Unit No. 2), 7 A.E.C. 711 (1974).

117. UNITED STATES DEP'T OF ENERGY, *supra* note 52, at 12. The hearings are recorded in Duke Power Co., 7 A.E.C. 659 (1974).

118. The discussion centered on the application of collateral estoppel to bar reconsideration of the safety aspects of the ice condensor and reactor vessel stud bolts, issues raised unsuccessfully by the same intervenor in Duke Power Co. (William B. McGuire Nuclear Station, Units 1 and 2), 6 A.E.C. 92, 101-04, 106-08, *aff'd in part, rem'd in part*, 6 A.E.C. 399, 401-04, 406-07 (1973).

119. See Joskow, *Inflation and Environmental Concern: Structural Change in the Process of Public Utility Price Regulation*, 17 J. L. & ECON. 291 (1974) for a model of regulation that predicts the environmental review response observed here.

The outcomes of licensing cases for plants with 1970 CP applications are different from the 1972 group; otherwise similar plants took longer to be licensed on all counts. Two logical explanations are the newly required environmental review and the higher number of applications. Five cases in this group were uncontested: *Forked River*,[120] *Edwin Hatch*,[121] *Zimmer 1*,[122] *Arkansas Nuclear 2*[123] and *Farley 2*.[124] The licensing time for Forked River is high: 37 months.[125] Other plants were licensed in 29, 30, 27 and 26 months, respectively. The main problem with the *Forked River* case was assembling a licensing board, which took 26 months.[126] Another case, *Hope Creek*,[127] was uncontested. However, the reactor site was moved from Newbold Island following a contested review in which it was decided that the site was near a too populated[128] area. During the second review an outside participant—not a formal intervenor—pointed out that liquid natural gas boats frequently passed the proposed site.[129] This caused some concern during licensing. The case took a total of 57 months to resolve (including the site change).

Six applications filed in 1970 were contested. In *McGuire* (29 months to completion),[130] *Waterford* (40)[131] and *San Onofre* (41),[132] the major issue was safety: accident estimates, low population zones, and, in the *McGuire* case, a group of technical plant characteristics. Although environmental issues were raised in all three cases, they were not emphasized. By contrast, *Bailly*[133] (45 months), *Limerick*[134] (51), and *La Salle*[135] (34) primarily involved environmental contentions. The *Bailly* intervenors challenged substantial environmental degradation due to plant construction and operation. Although the

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120. Jersey Central Power & Light Co. (Forked River Nuclear Generating Station, Unit 1), docket no. 50-363.

121. Georgia Power Co. (Edwin I. Hatch Nuclear Plant, Unit 1), docket no. 50-321.

122. Cincinnati Gas & Electric Co. (William H. Zimmer Nuclear Power Station), docket no. 50-358.

123. Arkansas Power & Light Co. (Arkansas Nuclear One, Unit 2), docket no. 50-368.

124. Alabama Power Co. (Joseph M. Farley Nuclear Plant, Unit 2), docket no. 50-364.

125. Numbers of months for licensing times in this and succeeding paragraphs are taken from UNITED STATES DEP'T OF ENERGY, *supra* note 52, at 3-10.

126. *See* W. Montgomery & J. Quirk, *supra* note 11, at 76.

127. Public Service Electric and Gas Co. (Hope Creek Generating Station, Unit 1), docket no. 50-354.

128. Public Serv. Elec. and Gas Co. (Hope Creek Generating Station, Units 1 and 2), 8 A.E.C. 745, 747 (1974).

129. 9 N.R.C. 14 (1979).

130. Duke Power Co. (William B. McGuire Nuclear Station, Unit 1), docket no. 50-369.

131. Louisiana Power & Light Co. (Waterford Steam Electric Generating Station, Unit 3), docket no. 50-383.

132. Southern California Edison Co. (San Onofre Nuclear Generating Station, Unit 2), docket no. 50-361.

133. Northern Indiana Public Service Co. (Bailly generating Station, Nuclear-1), docket no. 50-367.

134. Philadelphia Electric Co. (Limerick Generating Station, Unit 1), docket no. 50-352.

135. Commonwealth Edison Co. (La Salle County Nuclear Station, Unit 1), docket no. 50-373.

plant was eventually approved, it went through numerous AEC and judicial appeals and reached the U.S. Supreme Court.[136] On several occasions, construction was halted.

State regulation was the main holdup in the *Limerick* case, rather than the intervenors. Because the plant relied on cooling water from the Delaware River, the Delaware River Basin Commission had to approve it. Cooling water availability had not been ensured at the start of the AEC case. Consequently, neither a Final Environmental Study nor an Environmental Impact Statement could be completed. The water problem held up the utility's plans for plant construction timing and design.[137]

Thus, out of the group of 1970 plants, the plants that took unusually long to be licensed can be accounted for by substantive issues, uncertainty, and concern by both the NRC and intervenors over accident problems or technical environmental problems. The remaining plants with extended licensing —Limerick and Forked River—were caught in regulatory problems that in one case, might have been due to an intervenor–externality effect, and in the other, was independent of the NRC.

## V

## CONCLUSIONS

An important criterion for evaluating regulatory reform proposals is their influence on innovation. Light water technology has recently had a disappointingly low (to some) diffusion rate. In addition to electricity demand conditions, reduced new orders are attributed to the high cost of reactors and long lead times for them.[138] Because of the NRC licensing role in both of these causes, reform proposals have been aimed at streamlining and shortening licensing.

Current reform plans center around several concepts.[139] The reforms call for "site–banking," a procedure that allows utilities to obtain preliminary site approval prior to licensing. The centerpiece of the reforms is plant standardization.[140] Plant vendors can obtain approval for a standardized plant or plant

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136. Northern Ind. Pub. Serv. Co. (Bailly Generating Station, Nuclear-1), 7 A.E.C. 557, *aff'd*, 8 A.E.C. 244 (1974), *vacated*, Porter County Chapter of the Izaak Walton League, Inc. v. Atomic Energy Comm'n, 515 F.2d 513 (7th Cir.), *rev'd and rem'd sub nom.* Northern Ind. Pub. Serv. Co. v. Porter County Chapter of the Izaak Walton League, Inc., 423 U.S. 12 (1975), *aff'd on rehearing sub nom.* Porter County Chapter of the Izaak Walton League, Inc. v. Atomic Energy Comm'n, 533 F.2d 1011 (7th Cir.), *cert. denied sub nom.* Porter County Chapter of the Izaak Walton League, Inc. v. Nuclear Reg. Comm'n, 429 U.S. 945 (1976).

137. *See* Philadelphia Elec. Co. (Limerick Generating Station, Units 1 and 2), 1 N.R.C. 163, 167-70 (1975).

138. *E.g., Why Atomic Power Dims Today, supra* note 6.

139. *See* CONGRESSIONAL BUDGET OFFICE, *supra* note 3, at 31-47 for a description of the reforms and a different assessment of their probably impact than described herein.

140. *See generally* Muntzing, *Standardization in Nuclear Power*, 15 ATOMIC ENERGY L. J. 21 (1973).

component design, which is then marketed to numerous utilities. Westinghouse and Bechtel have developed a standard nuclear power plant system (SNUPPS) that they have offered to utilities since 1973.

Neither standardization nor site-banking (to a lesser extent) address the major issues associated with delays. As discussed above, major delays concern the appropriateness of Commission standards, not whether or not a particular plant satisfies those standards. The standardization plan has not caught on and SNUPPS plants appear to take as much time as other plants to license under the current process.

Other reforms have been proposals to limit reviews: to dispense with operating license reviews, remove generic issues from discussion during licensing, limit the role of public participation, and somewhat curtail the Commission's retrofit power. The Commission retains the right to order retrofits if significant danger is expected to ensue from not doing so.[141] The proposals would delete much of the current system's flexibility, and might inhibit innovation. The rationale is that nuclear plants are relatively standardized and elaborate review procedures are unnecessary. If public participation serves only to allow the public its day in court—not because the public can contribute to safety reviews—then, according to pro–nuclear forces, the role of the public can be sharply curtailed.

However, the analyses here indicate that this view is incorrect. As discussed in Sections II and IV, the long licensing process for nuclear plants is not an artifact of bureaucracy and red tape. NRC procedures are based on the proposition that the technology is changing and that current knowledge about light water reactors is incomplete. In this context, licensing boards allowed the so–called "generic" issues, most notably those concerned with accidents, into individual licensing case decisions. Although the ultimate rulings in these cases were that the issues could not be addressed during licensing, their presence resulted in more discussion, more careful reviews, and longer licensing time. The Commission's concern is clear: Licensing Boards have the authority to determine which issues can be discussed and could have eliminated these "generic" issues from the hearings altogether. Licensing Board decisions during the past twleve years reflect what the Three Mile Island accident publicly confirmed: the industry is not thoroughly understood. Current licensing procedures apply to a young and developing technology. If the process were less flexible, barriers would exist to approval of new concepts. In addition to the hearings, the examples discussed in Section II aid innovation: the NRC's current retrofit power and its right to issue CP's for partially undesigned plants. To make standardization attractive, both of these rights

141. 10 C.F.R. § 50.109 (1978).

must be curtailed. As a result, plans for plants that will not be operating for at least ten years are stabilized. Paradoxically, if the standardization plan achieves its goal of licensing control, more units could be ordered and the rate of diffusion of current technology would increase. Our evidence suggests that the plan—tenuous at best—is not desirable.