ESSAYS ON THE ECONOMICS OF LICENSING NUCLEAR POWER PLANTS

Thesis by

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ABSTRACT

Essays on the Economics of Licensing Nuclear Power Plants concerns the regulation and licensing of nuclear power plants by the United States Atomic Energy Commission and the United States Nuclear Regulatory Commission.

Chapter 1 contains an overview of the licensing process, and the issues raised in licensing cases. Based on a sample of plants licensed between 1967 and 1978, a statistical study of the impact of public participation in licensing is performed. The study concludes that public participation has had a major impact on licensing and power plant costs. The impact is due to a fundamental weakness of the Commissions: their inability to resolve certain issues related to acceptable social risk. The study has important policy implications for reforming the federal licensing process.

Chapters 2 and 3 address two of the issues raised in licensing. Chapter 2 contains an analysis of the Price-Anderson Act, a federal program for compensating victims of large nuclear accidents. The Price-Anderson Act is placed within the context of generalized federal disaster relief. A model is developed that allows an evaluation of compensation programs on the basis of moral hazard and equity principles.

Chapter 3 analyzes the Nuclear Regulatory Commission's treatment of its mandatory antitrust review of applicants for nuclear power plants. The main conclusion of the chapter is that the reviews have not addressed the central economic issues of antitrust that are relevant to nuclear power. Instead, the reviews contribute to further cartelization of the electric utility industry. While politically expedient, the reviews are counterproductive to the development of an optimal industry structure.

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Numerous people in and out of the government in Washington helped me gain access to data, develop hypotheses, and strengthen my arguments. While I cannot list them all here -- in part because it is not clear that many of them would wish to be associated with my research -- three people must be mentioned who helped me through the labyrinths of the Nuclear Regulatory Commission, the Federal Energy Regulatory Commission, and the telephone exchanges of electric utility companies respectively: James Delaney, Bernard Tanenbaum, and Joseph Knotts. I am grateful to them both for their help in accessing information and their remarkable, if unsuccessful, perseverance in trying to dissuade me of numerous misconceptions.

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Finally, I wish to thank my husband, George Jennings, for his continuous support and encouragement.

The opinions and errors in this thesis are my responsibility alone.

CONTENTS

CHAPTER 1

Public Participation in AEC Licensing

INTRODUCTION

Since World War II, the Nuclear Regulatory Commission (NRC) and its predecessor, the Atomic Energy Commission have been a focal point for controversy. Three interrelated aspects of public participation in the regulation and licensing of nuclear power plants have been discussed and debated in recent years. First, the claim is made that public participation -- at least to the extent allowed by the NRC -- causes undue delays in the licensing and construction of nuclear power plants, and is, therefore, instrumental in raising costs. Second, proponents of nuclear power assert that the NRC has established unnecessarily restrictive environmental and safety standards in response to uninformed public criticism. Third, the licensing process has supposedly contributed to a crisis in government legitimacy. According to Nelkin and Fallows, ". . . public opposition to nuclear power . . . reflects resentment and mistrust of government bureaucracy; . . . for many people, nuclear energy has become a symbol of the declining influence of the citizen in important policy areas," (11, p. 2).

Public participation in NRC licensing is legally mandated through the institution of intervention. According to the Atomic Energy Act (15), interested parties can participate in cases involving licenses to construct and operate nuclear power plants by applying for intervention status. While the public can participate in other ways,[1] the formal institution of intervention is of interest from a policy standpoint since it can be controlled by Congress. Indeed, legislation introduced in 1977 attempts to deal with the claim that the licensing process unnecessarily precludes further development and commercialization of nuclear power. One main thrust of the legislation is to curtail intervention by removing contested issues from licensing cases.

This chapter investigates the impact of intervention in NRC and AEC licensing cases since 1966. Relying primarily on the Regulatory Adjudication Issuances of the Commission,[2] a statistical analysis of the relation between intervention, contested issues, licensing delays, and the cost of nuclear power plants is performed.

The overall picture that emerges from this study shows that while intervention has a major effect on both the licensing process and the cost of power plants, the effect is not associated with any direct technical changes in the plants that are licensed in contested cases. Rather, the data indicate that intervenors are incapable of forcing any major changes in plant design through participation in licensing. However, certain types of intervention result in major delays in licensing, which induce cost premiums of up to 10 percent. The duration of the delay is dependent on the issues that are contested in the licensing cases, rather than on the mere presence of intervenors or the year of licensing.

The longest delays between 1966 and 1976 are associated with cases where intervenors contested the Commission's regulations involving power plant safety under emergency conditions. These regulations are subject to difficulties due to the lack of consensus on accident risks and uncertainties surrounding health effects of radiation exposure (13). Issues raised in the context of catastrophic accidents involve acceptable risk rather than power plant safety. Moreover, the issues are not within the jurisdiction of licensing boards to address in the individual licensing cases: as is shown in the next section, licensing boards in the years considered here consistently refused to address these issues.

These results indicate that the legislative plan to reduce licensing time by limiting the scope of review will not be successful. In order to reduce licensing delays, Congress must address the basic issue of acceptable risk.

The chapter is organized as follows. Section 1 contains summary information about the licensing cases. Information on issues, their resolutions, and intervenors in licensing cases are summarized. In Section 2, a model is presented relating issues, delays, and cost, and several equations are estimated. The cost equation allows discrimination between two impacts of delay: that due to building a power plant under identical conditions with or without licensing delay, and the cost changes due to yearly variations, e.g. different regulatory requirements and productivity changes. The evidence suggests that the Commission has successfully adjusted to some issues raised by intervenors. Although the sample size does not allow a definitive yearly study of issues, the data suggest that the delay effect of environmental intervention may be decreasing.

Section 1: Licensing Cases

A. An Introduction to the Licensing Process

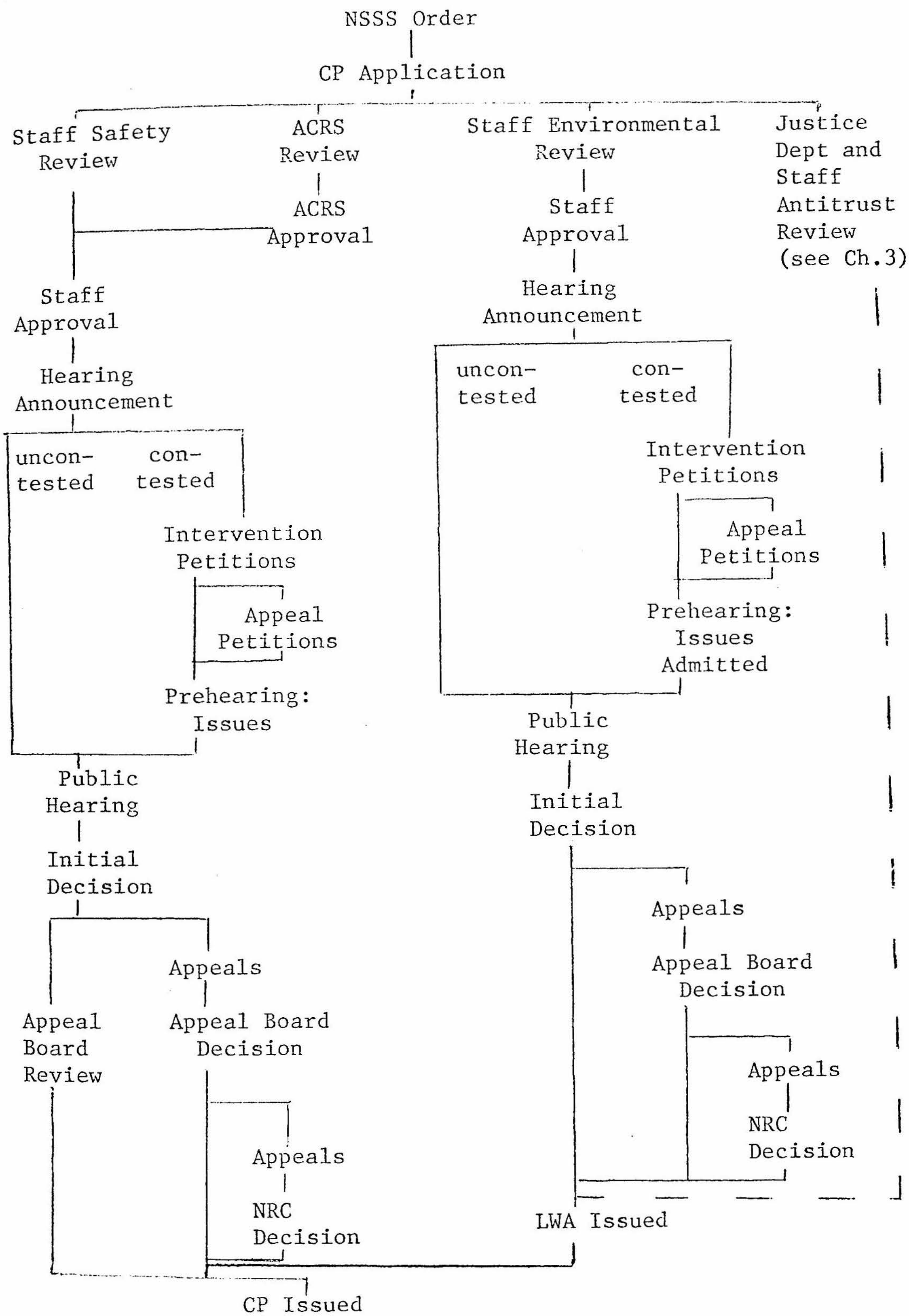
An applicant for a nuclear power plant Construction

Permit (CP) and Operating License (OL) goes through an extremely complex licensing process.[3] A description of this process is beyond the scope of this paper:[4] Figure 1 schematically summarizes the current NRC process, highlighting the opportunities for intervention.

Once the Applicant files a CP application,[5] four separate reviews are set in motion: an antitrust review,[6] an environmental review by the NRC staff, and two safety reviews, one by the NRC staff, and the other by the Advisory Committee on Reactor Safety.[7] Once the staff reviews are completed, hearing notices are issued. The Environmental and Safety Reviews are usually separate proceedings. The former leads to a Limited Work Authorization (LWA), permitting site preparation work and construction of equipment that does not involve the reactor. The safety proceeding typically lasts longer, and leads to Construction Permit issuance.

The environmental review is conducted to determine compliance with the National Environmental Policy Act. Compliance involves an Environmental Impact Statement (EIS), an Environmental Cost-Benefit Analysis, a "Need for Power" Analysis (7), proof that applicable environmental laws

FIGURE 1


NSSS Order
CP Application
Staff Safety Review
ACRS Review
ACRS Approval
Staff Environmental Review
Staff Approval
Justice Dept and Staff Antitrust Review (see Ch.3)
Staff Approval
Hearing Announcement
uncon- tested
con- tested
Intervention Petitions
Appeal Petitions
Prehearing: Issues
Public Hearing
Initial Decision
Appeal Board Review
Appeals
Appeal Board Decision
Appeals
NRC Decision
Hearing Announcement
uncon- tested
con- tested
Intervention Petitions
Appeal Petitions
Prehearing: Issues Admitted
Public Hearing
Initial Decision
Appeals
Appeal Board Decision
Appeals
NRC Decision
LWA Issued
CP Issued

regarding thermal and atmospheric pollution are satisfied and an overall finding that the proposed facility will not cause undue environmental harm. Detailed environmental reviews were first instituted after the 1971 Calvert Cliffs court decision.[8] Prior to 1972, applicants were issued exemptions allowing some construction prior to completion of the environmental review. Following another court case,[9] the Commission suspended this practice. Shortly thereafter the environmental and safety reviews were separated, with LWA's issued at the completion of the environmental review. This arrangement allowed a continuation of the practice of pre-CP construction.

The reviews have become increasingly complex, as a result of Court decisions and major Commissions actions. 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 (7). Inclusion of the environmental effects of so-called "Class 9 accidents" -- the very low probability-high consequence events which the Commission had previously ignored in the public part of licensing -- as an environmental cost in the cost-benefit analysis followed several years of controversy.

Safety reviews have been contested and fought over with an equal amount of vigor by intervenors. However, the Courts have consistently ruled that the Commission procedures are a reasonable reflection of the Commission's expertise. As a result, the reviews have addressed a consistent set of issues. Findings are made on the adequacy of plant location in terms of surrounding population and expected radioactive releases, on normal radioactive releases, on the consequences of the "maximum credible accident" and the integrity of the plant under other accident conditions. Additionally, the Licensing Board evaluates the applicant's construction quality-assurance program and radiological monitoring programs, and must find the plant not inimical to the common defence, security or safety of the public.

The public part of safety reviews essentially centers around a checklist of regulations. The regulations may not (except in very unusual circumstances[10]) be challenged in a licensing case. 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 and the "as-low-as-practicable" radiation release standards.[12]

Final determination of safety need not be made in a CP case. A number of features of the plants licensed in the period under consideration here were experimental, or depended on the behavior of other parts of the plant that could not be known before completion. Once the plant design is finalized the applicant applies for an Operating License. The staff then reviews the plant to assess previously unsettled issues, and compliance with the conditions and promises in the Construction Permit. The termination of OL cases is timed to coincide with actual completion of construction. Public hearings in OL cases have not been mandatory since 1971. However, a hearing will be held if someone intervenes. Prior to 1974, many OL cases incorporated environmental reviews.

B. The RAI Data

In order systematically to examine the issues and resolutions in licensing cases, a sample of 116 nuclear units was chosen. The sample consists of all the units for which applications were filed between 1966 and 1974, excluding those plants that are additional units at a single site and have identical license and construction histories as the initial unit. Applications filed prior to 1966 were mostly built under "turnkey" arrangements, so reliable cost data are absent.[13] The sample stops after 1974 since CP licensing history for the more recent plants is incomplete. Table 1 shows the number of CP applications, CP issuances, and OL issuances for units in this sample.

TABLE 1

LICENSE ISSUANCES

	CP APPLICATIONS	CP ISSUANCES	OL ISSUANCES
1966	9	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

The Regulatory Adjudication Issuances contain information on three key factors in public participation: the type of intervenor, the issues raised, and the resolution of issues in licensing.

C. Intervenors

Intervenors in CP and OL cases fall into essentially four categories. "Major Intervenors" include the well-organized, well-funded private groups who intervened with legal representation and became full parties to the case. "Minor Intervenors" are private individuals who live near the site of the nuclear plants. The Commission rules give any interested individual who files the appropriate papers intervention status. However, it is impossible to participate (as opposed simply to observe) unless the intervenors have expert witnesses, legal representation, and the ability to fill out and file endless interrogatories.

The expensive nature of intervention resulted in many requests for financial assistance from intervenors in 1974.[14] In the Vermont Yankee case, intervenors requested $25,000.00 so they could "minimally" participate in a subsidiary aspect of an OL case.[15] Full intervention in a CP case is estimated to cost in the hundreds of thousands of dollars.[16]

The fate of intervenors lacking legal counsel was dramatically demonstrated in a 1974 case involving the Carolina Environmental Study Group and Duke Power Co.[17] The intervenors - who later became highly sophisticated[18] -- stipulated to a special type of expedited hearing. A condition of the stipulation -- unknown to the intervenors at the time -- was that all evidence which is not accepted fact would be excluded from the hearing. As a result, the intervenors could not present any of the journal articles 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 against undertaking a complex administrative procedure without proper counsel.

The public intervenors in virtually all the cases in the sample are representatives of the states in which the plants are located. Some states participated vigorously, particularly in the environmental phases of the review. The earliest requests for considering thermal pollution came from state intervenors.[19] Other states in the sample were merely onlookers, intervening under a clause in the Atomic Energy Act allowing states observer status.[20]

The antitrust intervenors are wholesale customers of the applicant. Prior to 1970 they intervened requesting antitrust reviews. Following a change in the Atomic Energy Act in 1970 that made the review mandatory, the intervenors used the AEC review to sue the applicant for antitrust violations. Chapter 3 of this thesis treats the antitrust issue in detail.

When more than one intervenor appears in a licensing case it is difficult to distinguish who is raising what issues. Generally all the private intervenors consolidate and present one case. When public intervenors are opposing the license, private intervenors will frequently support them and vice-versa. The simplifying assumption is made here that whenever a major private intervenor is involved in a case, he is responsible for all issues. When both public and minor intervenors participate in a case, the public intervenor is responsible. This assumption will tend to overstate the importance of major intervenors.

Table 2 shows the distribution of intervenors by year of CP and OL issuance. An equivalent table for year of CP application is provided below. The number of uncontested CP cases dropped to zero in 1970, and has remained low.

TABLE 2

TYPES OF INTERVENORS

	MAJOR INTERV.	MINOR INTERV.	ANTI TRUST	PUBLIC INTERV.	NO INTERV.	TOTAL
CP						
1967	0(.00)	0(.00)	4(.57)	1(.14)	3(.43)	7
1968	2(.10)	3(.15)	4(.20)	6(.30)	8(.40)	20
1969	5(.63)	4(.50)	0(.00)	3(.38)	1(.13)	8
1970	1(.13)	2(.25)	2(.25)	1(.13)	3(.38)	8
1971	4(1.00)	3(.75)	1(.25)	1(.25)	0(.00)	4
1972	2(.22)	2(.22)	3(.33)	2(.22)	0(.00)	9
1973	6(.55)	5(.45)	3(.27)	1(.09)	0(.00)	11
1974	7(.41)	10(.59)	2(.12)	10(.59)	0(.00)	17
1975	1(.20)	0(.00)	3(.60)	0(.00)	2(.40)	5
1976	2(.67)	1(.33)	0(.00)	1(.33)	0(.00)	3
OL						
1971	1(1.00)	1(1.00)	0(.00)	0(.00)	0(.00)	1
1972	4(.67)	2(.33)	0(.00)	4(.67)	0(.00)	6
1973	4(.36)	3(.27)	0(.00)	6(.55)	4(.36)	11
1974	3(.25)	3(.25)	1(.08)	3(.25)	6(.50)	12
1975	2(.67)	0(.00)	0(.00)	2(.67)	1(.33)	3
1976	1(.50)	0(.00)	0(.00)	0(.00)	1(.50)	2
CP&OL						
1971	5(1.00)	4(.80)	1(.20)	1(.20)	0(.00)	5
1972	6(.40)	4(.27)	3(.20)	6(.40)	0(.00)	15
1973	10(.45)	8(.36)	3(.14)	7(.32)	4(.18)	22
1974	10(.34)	13(.45)	3(.10)	13(.45)	6(.21)	29
1975	3(.38)	0(.00)	3(.38)	2(.25)	3(.39)	8
1976	3(.60)	1(.20)	0(.00)	1(.20)	1(.20)	5
TOTAL ALL YRS	45(.35)	39(.31)	23(.18)	41(.32)	29(.23)	127

However, the number of uncontested cases overall has risen since 1973. While the number of cases in each cell is too small to test for statistical significance, the data suggest that the number of contested cases peaked immediately after the National Environmental Policy Act was passed and the Calvert Cliffs decision handed down. Rolph claims that intervenors currently are concentrating on a few major cases and rulemaking (12). Table 2 weakly supports the claim.

D. Issues

The issues raised in licensing are divided into seven categories here. In order to simplify the issue-situation to a tractable form, considerable license had to be taken with the RAI decisions. A detailed explanation of inclusions in issue-types is found in Appendix A. Tables 3 and 4 show the distribution of issues by year of CP application and year of CP issuance respectively. When more than one issue was raised in a single case multiple entries are shown.

The first two issues correspond to environmental reviews. ENVIRON: EIS, NEPA includes issues relating to the form of the environmental review and the requirements

TABLE 3

Issues: Year of CP Application and Intervenor Type

	1966	1967	1968	1969	1970	1971	1972	1973
Environ: EIS, NEPA								
Total	0	3	4	7	8	1	3	5
Major Int.	0	3	4	6	8	1	3	3
Public Int.	0	1	3	3	4	0	1	2
Environ: Cooling, Technical								
Total	1	5	2	5	6	0	0	4
Major Int.	0	2	2	5	6	0	0	3
Public Int.	1	5	1	3	2	0	0	2
Safety: Normal								
Total	2	1	4	6	5	0	3	10
Major Int.	1	1	4	6	5	0	3	5
Public Int.	0	1	3	3	2	0	1	8
Safety: Emergency								
Total	0	0	2	5	8	1	1	5
Major Int.	0	0	2	5	7	0	1	4
Public Int.	0	0	1	3	5	0	0	3
Safety: Accidents, Seismic								
Total	2	2	0	2	6	0	0	4
Major Int.	0	0	0	2	6	0	0	4
Public Int.	1	0	0	2	4	0	0	2
Process								
Total	4	6	6	7	10	0	3	10
Major Int.	1	3	4	6	9	0	3	6
Public Int.	1	2	3	3	4	0	1	6

TABLE 4

Issues Raised: Year CP Issuance

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Total
Environ: EIS, NEPA											
% Cont.	0	.08	.57	.4	1.0	.22	.55	.29	.33	.67	.35
% Total	0	.05	.5	.25	1.0	.22	.55	.29	.2	.67	.29
Number	0	1	4	2	4	2	6	6	1	2	27
Environ: Cooling, Technical											
% Cont.	.25	.33	.14	.2	.75	.22	.55	.12	0	.67	.24
% Total	.14	.2	.13	.13	.75	.22	.55	.12	0	.67	.23
Number	1	4	1	1	3	2	6	2	0	2	22
Safety: Normal											
% Cont.	0	.08	.57	.2	1.0	.22	.36	.41	.33	0	.31
% Total	0	.05	.5	.13	1.0	.22	.36	.41	.2	0	.26
Number	0	1	4	1	4	2	4	7	1	0	24
Safety: Accidents Seismic											
% Cont.	0	0	0	.2	.75	.22	.36	.35	.33	.33	.23
% Total	0	0	0	.13	.75	.22	.36	.35	.2	.33	.20
Number	0	0	0	1	3	2	4	6	1	1	18

cont....

TABLE 4 (cont.)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Total
QA, Plans	0	.25	.14	0	0	.22	.27	.17	0	.67	.18
Security											
% Cont.	0	.25	.14	0	0	.22	.27	.17	0	.67	.18
% Total	0	.15	.13	0	0	.22	.27	.17	0	.67	.15
Number	0	3	1	0	0	2	3	3	0	2	14
Antitrust											
% Cont.	1.0	.33	0	.4	.75	.56	.45	.53	1.0	.33	.47
% Total	.57	.2	0	.25	.75	.56	.45	.53	.6	.33	.39
Number	4	4	0	2	3	5	5	9	3	1	36
Process											
% Cont.	1.0	.25	.71	.8	1.0	.33	.55	.47	.33	.67	.49
% Total	.57	.15	.63	.5	1.0	.33	.55	.47	.2	.67	.41
Number	4	3	5	4	4	3	6	8	1	2	38

* % Cont. = Percent contested cases resolved in year.
% Total = Percent total cases resolved in year.

of NEPA. ENVIRON: 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, the second theoretically could result in a different plant design.

Safety issues are divided into three categories. The first relates to normal operations. Two examples are the appropriateness of the plant location in view of the population exposed to radioactive releases from normal plant operations, and the effectiveness of the plant's iodine-removal system. The second category contains issues relating to plant accidents, e.g., the emergency core cooling system and the validity of the Commission's accident assumption. The category includes issues relating to major accidents, that is, the very low-probability high-risk event. The third safety category includes the quality assurance (QA) program, evacuation plans, and security plans, The category is intended to include safety-related issues that are not matters of technical plant design.

Process issues are related to the licensing process rather than the plant. Examples are claims of licensing board bias, requests for extensions on the brief-filing dates, and arguments over the provision of evidence. Antitrust issues are treated in Chapter 3.

E. Resolutions

The licensing resolutions fall into roughly nine categories.[21] Table 5 shows the distribution of resolutions by intervenor and year of construction permit issuance. The first five categories are all variations on rejections. First, the issue can simply be rejected outright. This may occur when the intervenor disagrees with the other parties on a legitimate issue and the licensing board rules in favor of and other parties. Second, some issues are considered length and then rejected. If the intervenor wins in one of the appeal or licensing board hearings, but is ultimately rejected, this type of resolution is said to occur. Another category of resolutions falling into the "consider and reject" category is when the licensing board appears to have expended extra effort on an issue, e.g. by ordering extra hearings.

The third category is when the licensing board rules that an issue is not a legitimate issue for resolution in a licensing case. Most of the "not issue" issues are weeded

TABLE 5

RESOLUTIONS: TYPE OF INTERVENOR AND YEAR

	1967	1968	1969	1970	1971
REJECT					
MAJOR	0(.00)	1(.25)	5(.38)	0(.00)	7(.39)
PUBLIC	3(.50)	1(.14)	0(.00)	0(.00)	0(.00)
MINOR&PUBLIC	0(.00)	0(.00)	0(.00)	2(1.00)	0(.00)
CONSIDER&REJECT					
MAJOR	0(.00)	0(.00)	0(.00)	0(.00)	1(.06)
MINOR&PUBLIC	0(.00)	0(.00)	1(.50)	0(.00)	0(.00)
NOT ISSUE					
MAJOR	0(.00)	3(.75)	5(.38)	1(.20)	5(.28)
PUBLIC	1(.17)	1(.14)	0(.00)	0(.00)	0(.00)
MINOR&PUBLIC	0(.00)	2(1.00)	1(.50)	0(.00)	0(.00)
CONSIDER AT OL					
PUBLIC	0(.00)	1(.14)	0(.00)	0(.00)	0(.00)
OTHER FORUM					
MAJOR	0(.00)	0(.00)	0(.00)	1(.20)	1(.06)
PUBLIC	1(.17)	3(.43)	0(.00)	0(.00)	0(.00)
GRANT-MINOR					
PUBLIC	0(.00)	0(.00)	0(.00)	2(1.00)	0(.00)
MONITOR AND TEST					
MAJOR	0(.00)	0(.00)	1(.08)	1(.20)	2(.11)
GRANT-MAJOR					
MAJOR	0(.00)	0(.00)	0(.00)	1(.20)	0(.00)
MIXED-PROCESS					
MAJOR	0(.00)	0(.00)	2(.15)	1(.20)	2(.11)
PUBLIC	1(.17)	1(.14)	0(.00)	0(.00)	0(.00)

	1972	1973	1974	1975	TOTAL
REJECT					
MAJOR	4(.33)	9(.33)	6(.24)	1(.25)	33(.31)
PUBLIC	0(.00)	0(.00)	0(.00)	0(.00)	4(.24)
MINOR&PUBLIC	0(.00)	0(.00)	2(.40)	0(.00)	4(.36)
CONSIDER&REJECT					
MAJOR	0(.00)	3(.11)	3(.12)	1(.25)	8(.07)
MINOR&PUBLIC	0(.00)	0(.00)	0(.00)	0(.00)	1(.09)
NOT ISSUE					
MAJOR	4(.33)	8(.30)	7(.28)	2(.50)	35(.32)
PUBLIC	0(.00)	0(.00)	1(1.00)	0(.00)	3(.18)
MINOR&PUBLIC	0(.00)	0(.00)	1(.20)	0(.00)	4(.36)
CONSIDER AT OL					
PUBLIC	0(.00)	0(.00)	0(.00)	0(.00)	1(.06)
OTHER FORUM					
MAJOR	0(.00)	2(.07)	0(.00)	0(.00)	4(.04)
PUBLIC	0(.00)	0(.00)	0(.00)	0(.00)	4(.24)
MINOR&PUBLIC	0(.00)	0(.00)	2(.40)	0(.00)	2(.18)
GRANT-MINOR					
MAJOR		3(.11)	1(.04)	0(.00)	4(.04)
PUBLIC	0(.00)	0(.00)	0(.00)	0(.00)	2(.12)
MONITOR AND TEST					
MAJOR	2(.17)	0(.00)	1(.04)	0(.00)	7(.06)
GRANT-MAJOR					
MAJOR	0(.00)	0(.00)	3(.12)	0(.00)	4(.04)
MIXED-PROCESS					
MAJOR	2(.17)	2(.07)	4(.16)	0(.00)	13(.12)
PUBLIC	1(1.00)	0(.00)	0(.00)	0(.00)	3(.18)

out by the licensing board at the prehearing conference and never admitted into contention (see Figure 1). However, the AEC, faced with a long history of court appeals, is very careful to hear anything that might possibly develop into an issue. Direct attacks on Commission regulations are considered "generic" and cannot be an issue in licensing unless the intervenor presents evidence of immediate danger.[22] 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. Regulation 10 CFR section 20.105 states that, with certain qualifications,

> (a) There may be included in any application for a license . . . proposed limits upon levels of radiation . . . resulting from 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. . . .

In addition, section 20.1 states that

> (c) [licensee] 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 [sic] considerations, and in relation to the utilization of atomic energy in the public interest.

The 0.5 rem level of section 20.105 was established in a generic proceeding. 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 itself has the discretion to label an issue as "licensing" or "generic" when controversy persists.[23]

"Consider at OL" and "Other forum" resolutions moot the issue. "Other forum" typically means that the issue was settled by stipulation in conferences prior to the hearing. Occasionally the intervenor has settled the issue in a court so that no further action need be taken by the NRC.[24] The "Grant-Minor" resolution refers to small procedural changes that are not expected to have any influence on the plant. For instance, the successful inclusion of some point in the cost-benefit NEPA study falls into this category. "Grant-Major" applies when an issue is resolved in a manner that has a major effect on the plant. "Mixed-Process" is for cases with a multitude of minor procedural questions which are resolved both for and against the intervenor.

The distribution of issue resolutions leaves little doubt that intervenors are having a negligible effect on plant design through CP case participation. As is shown in Table 5, the "Grant-Major" resolution occurred in only 4 percent of the issues raised by major intervenors, and in none of the issues raised by minor intervenors or by public intervenors, absent the majors. Table 6 divides the resolution/year table to also indicate issues. Of the four "granted-major" issues, two involved procedural issues: the 1970 entry is for the Calvert Cliffs decision, the 1974 entry involves the Nine-Mile Point case in which the AEC ruled that econometric need-for-power studies were acceptable and the plant was put off for a year based on the intervenors'

TABLE 6

Issues and Resolutions: CP Issuance: 1967-1976

ENVIRON:EIS,NEPA

	7	8	9	0	1	2	3	4	5	6
REJECTED	0	0	2	1	1	2	3	1	0	2
CONSIDER& REJECT	0	0	0	0	1	0	1	2	1	0
NOT ISSUE	0	1	2	0	2	0	1	0	0	0
CONSIDER AT OL	0	0	0	0	0	0	0	0	0	0
OTHER FORUM	0	0	0	0	0	0	0	0	0	0
GRANTED MINOR	0	0	0	0	0	0	1	1	0	0
MONITOR& TESTING	0	0	0	0	0	0	0	0	0	0
GRANTED MAJOR	0	0	0	1	0	0	0	1	0	0
UNKNOWN	0	0	0	0	0	0	0	0	0	0
TOTAL	0	1	4	2	4	2	6	5	1	2

ENVIRON:TECHNICAL

	7	8	9	0	1	2	3	4	5	6
REJECTED	0	0	0	0	0	2	1	0	0	0
CONSIDER& REJECT	0	0	0	0	0	0	0	1	0	0
NOT ISSUE	1	1	1	0	0	0	0	0	0	0
CONSIDER AT OL	0	1	0	0	0	0	0	0	0	0
OTHER FORUM	0	2	0	0	1	0	2	0	0	1
GRANTED MINOR	0	0	0	0	0	0	1	0	0	0
MONITOR& TESTING	0	0	0	1	2	0	0	0	0	0
GRANTED MAJOR	0	0	0	0	0	0	0	1	0	1
UNKNOWN	0	0	0	0	0	0	2	0	0	0
TOTAL	1	4	1	1	3	2	6	2	0	2

SAFETY:NORMAL

	7	8	9	0	1	2	3	4	5	6
REJECTED	0	1	2	0	4	0	3	4	0	0
CONSIDER& REJECT	0	0	1	0	0	0	1	0	0	0
NOT ISSUE	0	0	0	0	0	0	0	0	1	0
CONSIDER AT OL	0	0	0	0	0	0	0	0	0	0
OTHER FORUM	0	0	0	1	0	0	0	2	0	0
GRANTED MINOR	0	0	0	0	0	0	0	0	0	0
MONITOR& TESTING	0	0	1	0	0	2	0	1	0	0
GRANTED MAJOR	0	0	0	0	0	0	0	0	0	0
UNKNOWN	0	0	0	0	0	0	0	0	0	0
TOTAL	0	1	4	1	4	2	4	7	1	0

SAFETY:EMERGENCY

	7	8	9	0	1	2	3	4	5	6
NOT ISSUE	0	0	0	1	3	2	4	6	1	1
104B CASE	0	0	0	0	0	0	0	0	0	0
OTHER FORUM	0	0	0	0	0	0	0	0	0	0
ANTITRUST	0	0	0	0	0	0	0	0	0	0
UNKNOWN	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	1	3	2	4	6	1	1

PLANS,QA,SECURITY

	7	8	9	0	1	2	3	4	5	6
NOT ISSUE	0	3	1	0	0	2	3	3	0	2
104B CASE	0	0	0	0	0	0	0	0	0	0
OTHER FORUM	0	0	0	0	0	0	0	0	0	0
ANTITRUST	0	0	0	0	0	0	0	0	0	0
UNKNOWN	0	0	0	0	0	0	0	0	0	0
TOTAL	0	3	1	0	0	2	3	3	0	2

ANTITRUST

	7	8	9	0	1	2	3	4	5	6
NOT ISSUE	0	0	0	0	0	0	0	0	0	0
104B CASE	3	3	0	2	0	0	0	0	0	0
OTHER FORUM	1	1	0	0	0	0	0	0	0	0
ANTITRUST	0	0	0	0	2	3	3	8	3	1
UNKNOWN	0	0	0	0	1	2	2	1	0	0
TOTAL	4	4	0	2	3	5	5	9	3	1

PROCEDURES

	7	8	9	0	1	2	3	4	5	6
REJECTED	3	1	1	1	2	0	2	3	1	2
CONSIDER& REJECT	0	0	0	0	0	0	1	0	0	0
NOT ISSUE	0	1	2	0	0	0	0	0	0	0
GRANTED MINOR	0	0	0	2	0	0	1	0	0	0
GRANTED MAJOR	0	0	0	0	0	0	0	1	0	0
MIXED-PROCESS	1	1	2	1	2	3	2	4	0	0

study. While the Calvert Cliffs decision in fact affected all plants, it produced a construction stay in the Calvert Cliffs plant. However, neither of these cases had a design impact on the particular plant in question. The two other entries both involve cooling systems: intervenors successfully forced installation of cooling towers. Tables 5 and 6 show that if intervenors are having an effect in these cases, it must be through delaying tactics. In the next section this proposition is investigated.

Section 2: A Model of Intervenor Impact

The potential impact of intervenors on nuclear licensing cases is through delays. Delay in CP issuance can be expected to raise the cost of nuclear plants, although construction begins prior to CP issuance. Since certain construction activities cannot start until after CP issuance, a delay is expensive. First, funds must be committed very early in the process for major components. Thus the applicant loses the opportunity cost of the funds. Second, many contracts must be entered into in advance, e.g. for hiring skilled labor. A delay then involves breaking contracts. Third, later investments will be subject to the effects of inflation. The inflationary effects are ignored here, because they can presumably be balanced by investment.[25]

A second set of delay-costs are related to the year of CP issuance. The applicant is subject to regulations applicable at the time the CP is issued.[26] A delay of a year will mean that the applicant must satisfy a different set of regulations, with different costs. Furthermore, the cost of delay reflects changes in the real price of nuclear power plant components that are purchased prior to CP issuance. Productivity increases result in benefits from delay. Changed regulations might also have a net negative impact on price.

Elapsed time from application to construction permit depends on the year of CP application rather than year of CP issuance. Additionally, the intervenors influence elapsed time. Two potential models are considered: first, intervenors affect elapsed time simply by the act of intervention, or according to type of intervenor; second, the type of issue raised determines elapsed time. The first model can be rejected on the basis of the regression results. Consider the following equations:

$$\text{Model 1:}\quad ELT_t = a_1 + \sum_{\tau=66}^{73} b_{1\tau} D_\tau + \sum_{i=1}^{3} c_i Int_i$$

Model 2: $$ELT_t = a_2 + \sum_{\tau=66}^{73} b_{2\tau} D_\tau + \sum_{j=1}^{6} c_j Iss_j$$

where

ELT_t = elapsed time

D_τ = dummy variables for year of CP application

$$D_\tau = \begin{cases} 1 \text{ if } \tau = t \\ 0 \text{ otherwise} \end{cases}$$

$$Int_i = \begin{cases} 1 \text{ if the case involves type i intervenor} \\ 0 \text{ otherwise} \end{cases}$$

$$Iss_j = \begin{cases} 1 \text{ if case involves issue j} \\ 0 \text{ otherwise.} \end{cases}$$

The regression results of Model 1 and Model 2 are contained in Tables 7 and 8.[27]

Table 9 contains the issues raised by year of CP application. If Model 1 is accurate then the coefficients for X8 and X13 should be large and positive, with those for X9-X12 smaller. However X11 and X12 account for most of the increase in elapsed time. Moreover, X14 and X15, dummy variables for highly contested cases, have insignificant coefficients. Hence the existence of intervenors alone as the determinant of increased elapsed time is misspecified.

TABLE 7

Model 1

Multiple R = 0.7118

Constant Term = 14.7562

Degrees of Freedom = 87

	Variable	Coefficient	Std. Err. of Coef.
1967	X1	- 3.3824	4.5440
1968	X2	3.8095	5.1996
1969	X3	9.1378	5.2814
1970	X4	15.7272	5.0047
1971	X5	18.7114	6.0493
1972	X6	2.1272	6.5270
1973	X7	16.2226	4.7953
Major Int.	X8	12.1943	2.6197

TABLE 8

Model 2

Multiple R = 0.8097

Constanct Term = 17.6967

Degrees of Freedom = 80

	Variable	Coefficient	Std. Err. of Coef.
1967	X1	6.6006	4.6753
1968	X2	17.4664	5.5286
1969	X3	19.2864	5.6547
1970	X4	23.3369	5.3705
1971	X5	28.6057	6.4915
1972	X6	16.3926	7.0548
1973	X7	27.6117	4.9364
NEPA, EIS	X8	6.8671	4.0050
Envir. Tech.	X9	- 4.0353	4.1226
Safety Norm.	X10	- 0.9514	3.9623
Safety Emerg.	X11	18.3183	5.8321
QA, Plans Security	X12	12.3642	4.2535
Process	X13	- 0.9921	3.6715
2 issues	X14	0.3026	4.4225
3 or more issues	X15	- 7.5355	8.4046

TABLE 9

Issues: Year CP Application (Major Intervenors Only)

	1966	1967	1968	1969	1970	1971	1972	1973	Total
Environ: EIS, NEPA	0	.75 (3)	1.0 (4)	1.0 (6)	.89 (8)	1.0 (1)	1.0 (3)	.5 (3)	.82
Environ: Cooling, Technical	0	.5 (2)	.5 (2)	.83 (5)	.67 (6)	0	0	.5 (3)	.53
Safety: Normal	1.0 (1)	.25 (1)	1.0 (4)	1.0 (6)	.56 (5)	0	1.0 (3)	.83 (5)	.74
Safety: Emergency Seismic	0	0	.5 (2)	.83 (5)	.78 (7)	0	.33 (1)	.67 (4)	.56
QA, Plans Security	0	0	0	.33 (2)	.67 (6)	0	0	.67 (4)	.35
Process	1.0 (1)	.75 (3)	1.0 (4)	1.0 (6)	1.0 (9)	0	1.0 (3)	1.0 (6)	.94
Total	1	4	4	6	9	1	3	6	34

The interpretation of results in model 2 is straightforward. A plant applied for in 1966 with no intervenors had an expected elapsed time to CP of 17.69 months. Subsequent year coefficients represent increases in time over 1966 due to a combination of a heavier case load and a more complex review. The increase from 1967 to 1968 is attributed to the Calvert Cliffs decision. The court decision required back reviews of plants licensed since 1970, and reviews prior to all subsequent CP issuances. The back review requirement affects units applied for in 1968 but not 1967. The high value of X5 is due to the enormous backlog of work produced by the Calvert Cliffs decision. The large coefficient for 1973 corresponds to the year with the largest number of CP applications since 1967.

The issue coefficients have important implications for policy making. The insignificant coefficients for X13, X14, and X15 indicate that intervenors do not cause large delays simply because of procedural jockeying.

NEPA reviews are shown to have a positive effect on licensing times, although substantive environmental issues do not. This corresponds with the view of the AEC as primarily a safety-regulatory agency. The Commission can be expected to expend minimum effort on issues not directly related to its central mandate. The high values of X11 and X12 confirm this model of an agency. The positive value for the coefficient of the procedural environmental issues, alternatively, correspond to the nearly continual judicial review of the AEC with regard to its handling of NEPA requirements.[28]

The high value on X11 is of particular importance. The issues coded as safety-emergency share the characteristic that the controversy is based on risk-assessment. This includes cases where the ECCS Criteria were challenged, where the Price-Anderson Act was challenged, where seismic issues were raised, and where assumptions underlying treatment of Class-9 accidents were controverted. As is shown in Table 7, in every one of these cases the licensing board ruled the issue to be extraneous: either a rulemaking hearing was in progress or the issue was a challenge to Commission regulations. That these issues eventually result in "not issue" rulings suggests that the current Congressional plan to remove issues from licensing cases by legislation may be ineffective insofar as delays are concerned.

The contrast between X10 (safety, normal) and X11 (safety, emergency) underscores the proposition that the a weakness of the AEC is in its mandate to rule on what constitutes acceptable risk of catastrophes rather than solely to determine an acceptable risk of normal low-level radioactive releases. The latter risk-assessment, while also subject to uncertainty, is comparable to the activities of numerous other agencies and companies.[29] However, independent estimates of the probability and consequences of a catastrophe differ by many orders of magnitude.[30] The data presented here indicate that jurisdiction over catastrophic events is a prime source of delay, and reflects a weakness of the NRC.

The high coefficient corresponding to QA, Plans and Security suggests that although these issues were also ruled "not an issue" (see Table 6), the applications may have been deficient as far as the issues were concerned. The RAIs show evidence in several cases of adjustments, particularly in quality assurance, prior to the public hearings.[31]

Tables 10 and 11 contain correlation coefficients for issues and years, and across issues. Because the frequency with which issues are raised is correlated with years, a desirable procedure is to measure the change in the impact of the issues across years. The analysis would allow a test of several hypotheses about regulatory behavior. First, the Joskow hypothesis, that agencies adjust procedures to minimize the delays caused by new issues,

TABLE 10

Correlation Coefficients: Issue, Year of CP Application

	1967	1968	1969	1970	1971	1972	1973
Environ: EIS, NEPA	-.218	.031	.241	.194	-.086	.139	-.029
Environ: Technical	-.016	-.049	.181	.162	-.145	-.132	-.005
Safety: Normal	-.314	.040	.181	.019	-.174	.145	.217
Safety: Emergency	-.297	-.041	.193	.311	-.038	-.016	.072
QA, Plans, Security	-.111	-.161	.015	.269	-.115	-.105	.085
Process	-.225	.048	.113	.162	-.248	.057	.101
2 issues	.094	-.136	-.037	-.163	-.098	-.089	.155
3 or more issues	-.297	-.041	.193	.311	-.141	-.016	.137

TABLE 11

Correlation Coefficients: Issues

	Environ: EIS, NEPA	Environ: Technical	Safety: Normal	Safety: Emergency	QA, Plans, Security	Process
Environ: Technical	.450					
Safety: Normal	.496	.411				
Safety: Emergency	.472	.449	.595			
QA, Plans, Security	.229	.207	.181	.355		
Process	.631	.390	.613	.469	.242	
2 Issues	.076	.083	.085	-.206	-.085	.205
3 or more Issues	.631	.623	.541	.823	.554	.568

could be tested (8). Second, the "smart intervenor" hypothesis could be tested. The latter holds that the intervenors in the AEC gained sophistication over the years and concentrated on issues on which they were most effective (12). Unfortunately, the sample-size is not large enough to generate statistically significant results. However in Table 12, the

TABLE 12

Multiple R = .8437
Constant Term = 24.0721
Degrees of Freedom = 15

	Variable	Coefficient	Std. Err. of Coef.
NEPA, EIS	X1	10.8622	5.3788
Environ: Tech.	X2	- 6.5891	6.4441
Safety: Norm.	X3	- 5.2384	5.6736
Safety: Emerg.	X4	21.5264	7.0981
QA, Plans, Security	X5	19.1436	6.9910

results of regressing all issues except procedures on pooled data from 1972 and 1973 are given. (Procedural issues occurred in 100 percent of the cases in the subsample.) While these results cannot be compared to the full sample with confidence, they suggest a shift downward in the relative importance of environmental-technical and safety-normal issues. The downward tendency in environmental issues since the Calvert Cliffs decision supports Joskow's hypothesis. However, the evidence does not support the smart intervenor hypothesis.

TABLE 13

	% of all contested cases	% of contested cases, 1972-73
Environ-Tech	.53	.33
Safety-Normal	.74	.89

The impact of intervention on cost is assessed by estimating cost as a function of the relevant variables and elapsed time. Since it was concluded in Section 1 that the intervenors do not have a direct effect on cost, the elapsed time equation and cost equation form a recursive system. Let

$$Y_t = \alpha e^{\sum_{\tau=68}^{78} \delta_\tau A_\tau + \sum_{i=1}^{N} \gamma_i D_i} X^\beta$$

be a production function, where

t = year of CP issuance

A_τ = a dummy variable,

$$A_\tau = \begin{cases} 1 \text{ if } t = \tau \\ 0 \text{ otherwise} \end{cases}$$

D_i = dummy variables for plant characteristics

N = number of plant characteristics

X = construction input.

Solving for X:

$$X = \frac{1}{\alpha} Y_t^{\frac{1}{\beta}} e^{\sum_{\tau=68}^{78} \delta_\tau A_\tau + \sum_{i=1}^{N} \gamma_i D_i} .$$

The cost of Y_t depends on X and elapsed time:

$$C(Y_t) = pXe^{\delta ELT}$$

Let p = 1. Then

$$C(Y_t) = \frac{1}{\alpha} Y_t^{\frac{1}{\beta}} e^{\sum_{\tau=1}^{78} \alpha_\tau A_\tau + \sum_{i=1}^{N} \gamma_i D_i + \delta ELT} .$$

Or:

$$\ln(C(Y_t)) = \ln(\frac{1}{\alpha}) + \frac{1}{\beta} \ln Y_t + \sum_{\tau=68}^{78} \alpha_\tau A_\tau + \sum_{i=1}^{N} \gamma_i D_i + \delta ELT.$$

In this model, $\frac{1}{\beta}$ measures construction scale economies, δ reflects the increased costs due to a licensing delay, and α_τ incorporates the changes in year τ in regulations and costs of inputs (in constant dollars).

The cost data pose serious difficulties for two reasons. First, the reported cost-per-megawatt data are not in constant dollars, and expenditures are made over the entire construction period. Thus the reported numbers reflect yearly inflation of input prices. Second, only about a third of the plants in the total sample are complete, and none of the plants applied for after 1969 are finished. Data for remaining plants are estimated costs. Historically, the estimates have been inaccurate.

It is impossible to exclude plants that are not finished. First, this confines the sample to plants ordered in the years prior to the bulk of intervenor activity. Second, the subsample would include only the plants that were constructed quickly - i.e. those cases that had no major difficulties or delays. A serious bias would be introduced into estimation. Tables B1 and B2 in Appendix B contain average cost data by year of CP application and elapsed time to OL issuance (Table B1) or presence and absence of major intervenors and operating licenses (Table B2).

Unfinished plants can be included in the sample on the basis of a single assumption: that the reported estimates are an accurate representation of the applicants' expectations. Errors in estimates will then arise only from deviation between the actual and expected inflation rate, and unanticipated construction delays. (Major productivity changes are already reflected in the estimates since the sample excludes plants applied for since 1973). Thus, if the estimates are deflated assuming a future 8 percent inflation rate (the historical average) and the applicants' expected completion date, the deflated cost will be accurate.[33]

Costs are deflated using the procedure outlined by Mooz (10). He estimates a cash flow curve, calculates the proportion spent in each unit of time, and deflates according to a deflator for that time unit. The estimates here are different from those of Mooz. He uses the Handy-Witman index as a deflator, which is incorrect because it is, first, an output rather than input index, and, second, it is heavily weighted by nuclear costs (9). Mooz' procedure thus assumes that in each year the proportion of the plant built satisfies regulatory and productivity requirements of plants coming on line in that year. The plants are usually built to the requirements in existence at the time of construction permit issuance and any changes will reflect current regulations rather than a combination of changes over past years.

The Engineering News Record Construction Cost Index is used here. The Index measures inflation in inputs per year (cement, lumber, steel and skilled labor) for fourteen cities. A regional index was constructed by averaging inflation in the cities in seven areas. The index and regions are reproduced in Table B3, Appendix B. Table B4 contains the reported and adjusted cost for plants in the sample.

Table 13 includes the results of the regression program. None of the plant characteristics are significant.[32] The plants in the sample show increasing returns to scale: according to this model a 10 percent increase in plant size reduces per-megawatt cost by 2.5 percent. The year-coefficients reflect changes occurring at the CP-issuance. Smaller coefficients in later years indicate actual (or expected) increases in productivity and/or less stringent regulatory requirements. High values for 1968-1970 correspond to retrofitted ECCS systems,[34] while coefficients in the early seventies reflect increased environmental standards. The

TABLE 13

Multiple R = .5831

Constant Term = 6.9130

Degrees of Freedom = 79

	Variable	Coefficient	Std. Err. of Coef.
1968	Y1	.2744	.1469
1969	Y2	.3185	.1775
1970	Y3	.3727	.1717
1971	Y4	.3490	.2236
1972	Y5	.4961	.1953
1973	Y6	.1718	.1945
1974	Y7	.3036	.1839
1975	Y8	.1053	.2409
1976	Y9	-.0879	.3775
1977	Y10	.1727	.2774
1978	Y11	.2030	.3224
AE = Bechtel	Y12	-.0081	.0843
AE = Utility	Y13	-.0344	.1035
Type = BWR	Y14	.0477	.0757
Megawatts	Y15	-.2650	.1883
Elapsed Time	Y16	.0086	.0040

$$\ln(C(Y_t)) = \ln(\frac{1}{\alpha}) + \frac{1}{\beta}\ln Y_t + \sum_{i=1}^{N} \gamma_i D_i + \delta ELT + \sum_{\tau=68}^{78} \alpha_\tau A_\tau + u$$

coefficients for 1973-1978 are not significant: this may be due to inaccuracies in the reported cost estimates.

The coefficient for elapsed time (measured in months) is positive and significant. Adjusting for the log model, the coefficient indicates that a one month increase in licensing time increases plant costs by a multiple of 1.008. Thus the safety-accidents issue increases real costs by about 16 percent. Table 14 shows percent cost increases for certain issues.

TABLE 14

	Estimated Delay (Model 1)	Cost
NEPA, EIS	6.86	5.64%
Safety Emerg.	18.32	15.78%
QA, Plans, Security	12.36	10.39%
Average Major Intervenor Delay (Model 2)	12.19	10.24%

The cost increases reported in Table 14 reflect the first set of costs discussed at the start of this section, i.e. lost sunk costs of startup. In addition, the delay means a plant is licensed in a later year than expected, and its cost thus reflects the changes in productivity and regulations over the years. While the 95 percent confidence intervals for all adjacent years in the sample overlap, the procedure below yields an indication of the percent increase in cost. The actual numbers must, of course, be viewed with suspicion. For instance, between 1971 and 1972 the CP issuance coefficient increases by .1471. A one year delay in CP issuance increases costs by 15.8 percent. Ignoring the correlation between issues and years (another suspect procedure), and extrapolating between years, the safety-emergency issue results in total cost changes reported in Table 15.

TABLE 15

Cost Increase, Safety-Emergency Issue

Year CP Issuance	% change, total cost
1970	25%
1971	15%
1972	21%
1973	- 3%
1974	12%

Section 3: Conclusions

This chapter investigates the impact of intervention in the Atomic Energy Commission. The study results in a number of important and interesting conclusions. First, the intervenors do not cause major delays merely because of their participation. Non-technical matters cannot be shown to hold up licensing significantly. However, certain issues that are concerned essentially with the process of the AEC reviews are important, e.g., in what depth the reviews are to be conducted, or what issues the reviews must address. Intervenors who brought up these issues held up licensing. Since licensing time is significantly related to plant costs, the intervenors succeeded in raising nuclear power plant costs by more than 10 percent.

One important implication of this finding is that the increased cost of licensing buys non-zero output. If delay was due to the "process" issues, a case could be made for excluding intervenors since they impose costs while contributing nothing to reactor safety. However, delay is related to safety and environmental issues, and hence occurs because the NRC is investigating these aspects of nuclear power plants in greater depth than the Commission would in the absence of intervenors. Consequently, the intervenors cannot be dismissed without assessing the value of increased conservatism in the NRC's reviews.

APPENDIX A: ISSUE CATEGORIES

Issue categories contain issues classified in the regulatory adjudication issuances under the following headings:

Environ: EIS, NEPA

environmental impact statement

cost-benefit analysis

need-for-power

cost of decommissioning

energy conservation

Environ: Cooling, Technical

environmental monitoring system

ground water environment

transmission system

cooling system

Safety: Normal

radiological emissions and ground water

iodine removal

siting: population

combined effects with fossil plants

unresolved issues after CP issuance

electrical system

pipes, fuel rods, closure studs, valves, ice-condenser, freezer-dryer, fuel condensation, cadwelding

Safety: Emergency

emergency core cooling system

atmosphere inerting

class-9 accidents

Price-Anderson Act

seismicity

QA, Plans, Security

radiological monitoring

radiological transport

quality assurance

plant security

evacuation plans

Process

documents -- evidence

pre-CP construction

board bias against intervenors

improper procedures

financial assistance

filing date delay and late petitions

petitions to intervene

APPENDIX B*

TABLE B1

YEAR OF CP APP	YEARS TO OL ISSUANCE 5	6	7	8	9	10	NO OL BY 1977
1966							
NUMBER	1.	1.	5.	1.	0.	1.	0.
AV.COST	169.00	159.00	317.20	251.00	0.00	619.00	0.00
AV.COST*	131.96	164.59	261.26	226.12	0.00	363.41	0.00
1967							
NUMBER	4.	6.	6.	1.	0.	0.	5.
AV.COST	310.75	346.50	352.33	408.00	0.00	0.00	446.60
AV.COST*	249.91	241.08	236.00	240.52	0.00	0.00	261.00
1968							
NUMBER	1.	5.	0.	0.	0.	0.	5.
AV.COST	471.00	450.00	0.00	0.00	0.00	0.00	508.60
AV.COST*	435.54	336.94	0.00	0.00	0.00	0.00	271.15
1969							
NUMBER	0.	2.	1.	0.	0.	0.	8.
AV.COST	0.00	449.00	593.00	0.00	0.00	0.00	767.63
AV.COST*	0.00	270.49	453.25	0.00	0.00	0.00	392.67
1970							
NUMBER	0.	0.	0.	0.	0.	0.	15.
AV.COST	0.00	0.00	0.00	0.00	0.00	0.00	638.13
AV.COST*	0.00	0.00	0.00	0.00	0.00	0.00	294.63
1971							
NUMBER	0.	0.	0.	0.	0.	0.	6.
AV.COST	0.00	0.00	0.00	0.00	0.00	0.00	694.00
AV.COST*	0.00	0.00	0.00	0.00	0.00	0.00	325.33
1972							
NUMBER	0.	0.	0.	0.	0.	0.	5.
AV.COST	0.00	0.00	0.00	0.00	0.00	0.00	643.00
AV.COST*	0.00	0.00	0.00	0.00	0.00	0.00	272.76
1973							
NUMBER	0.	0.	0.	0.	0.	0.	19.
AV.COST	0.00	0.00	0.00	0.00	0.00	0.00	649.53
AV.COST*	0.00	0.00	0.00	0.00	0.00	0.00	271.38
1974							
NUMBER	0.	0.	0.	0.	0.	0.	18.
AV.COST	0.00	0.00	0.00	0.00	0.00	0.00	780.33
AV.COST*	0.00	0.00	0.00	0.00	0.00	0.00	267.01

*Sources for Tables in Appendix B are described in Footnote 33.

TABLE B2

YEAR OF CP APPLICATION		INTERVENORS	NO INTERVENORS
1966	OL		
	NUMBER	1.	8.
	AVERAGE COST	694.00	261.25
	AVERAGE COST*	523.90	208.56
	NO OL		
	NUMBER	0.	0.
	AVERAGE COST	0.00	0.00
	AVERAGE COST*	0.00	0.00
1967	OL		
	NUMBER	2.	15.
	AVERAGE COST	457.00	328.67
	AVERAGE COST*	272.09	237.23
	NO OL		
	NUMBER	2.	3.
	AVERAGE COST	436.50	453.33
	AVERAGE COST*	227.09	283.61
1968	OL		
	NUMBER	1.	5.
	AVERAGE COST	414.00	461.40
	AVERAGE COST*	355.19	353.01
	NO OL		
	NUMBER	3.	2.
	AVERAGE COST	510.00	506.50
	AVERAGE COST*	267.64	276.41
1969	OL		
	NUMBER	1.	2.
	AVERAGE COST	396.00	547.50
	AVERAGE COST*	228.58	382.83
	NO OL		
	NUMBER	5.	3.
	AVERAGE COST	791.80	727.33
	AVERAGE COST*	390.14	396.89

TABLE B2 (cont.)

1970	INTERVENORS	NO INTERVENORS
OL		
NUMBER	0.	0.
AVERAGE COST	0.00	0.00
AVERAGE COST*	0.00	0.00
NO OL		
NUMBER	9.	6.
AVERAGE COST	610.78	679.17
AVERAGE COST*	271.17	329.83

1971	INTERVENORS	NO INTERVENORS
OL		
NUMBER	0.	0.
AVERAGE COST	0.00	0.00
AVERAGE COST*	0.00	0.00
NO OL		
NUMBER	1.	5.
AVERAGE COST	1001.00	632.60
AVERAGE COST*	474.17	295.56

1972	INTERVENORS	NO INTERVENORS
OL		
NUMBER	0.	0.
AVERAGE COST	0.00	0.00
AVERAGE COST*	0.00	0.00
NO OL		
NUMBER	3.	2.
AVERAGE COST	698.33	560.00
AVERAGE COST*	273.26	272.03

1973	INTERVENORS	NO INTERVENORS
OL		
NUMBER	0.	0.
AVERAGE COST	0.00	0.00
AVERAGE COST*	0.00	0.00
NO OL		
NUMBER	6.	12.
AVERAGE COST	791.33	549.25
AVERAGE COST*	319.57	234.76

1974	INTERVENORS	NO INTERVENORS
OL		
NUMBER	0.	0.
AVERAGE COST	0.00	0.00
AVERAGE COST*	0.00	0.00
NO OL		
NUMBER	6.	13.
AVERAGE COST	785.50	768.92
AVERAGE COST*	254.53	271.32

TABLE B3

REGIONAL DEFLATORS

	1	2	3	4	5	6	7
1966	1.229	.948	.946	.881	.970	1.350	.879
1967	1.199	.906	.923	.842	.924	1.284	.845
1968	1.089	.795	.862	.779	.863	1.192	.787
1969	1.009	.710	.830	.830	.793	.998	.710
1970	.968	.699	.673	.654	.690	.924	.677
1971	.820	.601	.654	.539	.609	.842	.631
1972	.732	.536	.573	.524	.586	.710	.558
1973	.655	.489	.509	.479	.512	.662	.502
1974	.624	.453	.491	.457	.501	.605	.478
1975	.572	.422	.447	.416	.434	.582	.418
1976	.524	.392	.424	.388	.402	.542	.371

1. South: Atlanta, Baltimore, Birmingham, New Orleans
2. Atlantic: New York, Philadelphia, Pittsburgh
3. New England: Boston
4. North-Central: Chicago, Cincinnati, Cleveland, Detroit, Minneapolis
5. Central: Denver, Kansas City, St. Louis
6. Texas: Dallas
7. West: Los Angeles, San Francisco, Seattle

TABLE 34

Unit, Reported Estimated Costs and Adjusted Cost

UNIT NAME	COST	ADCOS	8%
ALAN BARTON 1	1271.00	0.00	579.52
ALLENS CREEK 1	528.00	0.00	230.27
ALVIN VOGTLE 1	488.00	0.00	222.03
ARKANSAS ONE UNIT 2	417.00	0.00	252.32
ATLANTIC 1	1087.00	0.00	303.78
BAILLY	693.00	0.00	270.13
BEAVER VALLEY 1	649.00	0.00	362.84
BEAVER VALLEY 2	931.00	0.00	342.13
BELLEFONTE 1	397.00	0.00	221.03
BELLEFONTE 2	397.00	0.00	221.03
BLUE HILLS 1	659.00	0.00	235.79
BRAIDWOOD 1	479.00	0.00	174.87
BROWNS FERRY3	246.00	0.00	188.03
BROWNSFERRY1	227.00	215.91	0.00
BROWNSFERRY2	251.00	226.12	0.00
BRUNSWICK 1	471.00	435.54	0.00
BRUNSWICK 2	471.00	382.27	0.00
BYRON 1	466.00	0.00	176.46
CALLAWAY 1	714.00	0.00	250.33
CALVERTS CLIFFS 1	414.00	355.19	0.00
CALVERTS CLIFFS 2	297.00	0.00	227.01
CATAWBA 1	470.00	0.00	232.47
CHEROKEE 1	672.00	0.00	283.46
COMANCHE PEAK 1	309.00	0.00	163.37
COMANCHE PEAK 2	309.00	0.00	151.21
COOPER NUCLEAR	406.00	261.90	0.00
CRYSTAL RIVER3	509.00	0.00	369.30
DAVIS BESSE 1	588.00	0.00	289.43
DAVIS BESSE 2	746.00	0.00	232.92
DIABLO CANYON 1	461.00	0.00	250.87
DIABLO CANYON 2	384.00	0.00	181.39
DONALD COOK 1	506.00	303.66	0.00
DONALD COOK 2	412.00	0.00	203.31
DOUGLAS POINT 1	1002.00	0.00	421.68
DOUGLAS POINT 1	1002.00	0.00	421.68
DUANE ARNOLD	518.00	317.95	0.00
EDWIN HATCH 1	480.00	411.81	0.00
EDWIN HATCH 2	645.00	0.00	390.28
ENRICO FERMI 2	823.00	0.00	360.92
FORKED RIVER	649.00	0.00	256.69
FORT CALHOUN 1	383.00	275.06	0.00
FORTSTVRAIN	694.00	523.90	0.00
GRAND GULF 1	560.00	0.00	288.71
GRAND GULF 2	560.00	0.00	255.34
GREENWOOD 2	611.00	0.00	247.10
HARTSVILLE 1	488.00	0.00	231.70
HOPE CREEK 1	1172.00	0.00	445.70

TABLE B4 (cont.)

Unit Name	Cost	ADCOS	8%
INDIAN POINT 3	408.00	240.52	0.00
JAMES FITZPATRICK	367.00	217.47	0.00
JAMESPORT 1	882.00	0.00	219.45
JOSEPH FARLEY 1	710.00	0.00	466.92
JOSEPH FARLEY 2	575.00	0.00	362.62
KEWAUNEE	372.00	239.77	0.00
KOSHKONONG 1	722.00	0.00	234.60
LASALLE 1	417.00	0.00	177.15
LASALLE 2	417.00	0.00	170.32
LIMERICK 1	1138.00	0.00	467.69
LIMERICK 2	506.00	0.00	192.10
MAINE YANKEE	253.00	185.82	0.00
MIDLAND 1	1528.00	0.00	644.68
MIDLAND 2	866.00	0.00	379.77
MILLSTONE 2	502.00	312.40	0.00
MILLSTONE 3	874.00	0.00	275.37
MONTAGUE 1	697.00	0.00	195.47
NINE MILE POINT 2	694.00	0.00	245.17
NORTH ANNA 1	631.00	0.00	435.99
NORTH ANNA 2	346.00	0.00	200.82
NORTH ANNA 3	720.00	0.00	341.06
OCONEE1	184.00	175.01	0.00
OCONEE2	181.00	172.16	0.00
OCONEE3	187.00	160.43	0.00
PALISADES	169.00	131.96	0.00
PALO VERDE 1	788.00	0.00	266.47
PEACH BOTTOM 2	495.00	339.35	0.00
PEBBLE SPRINGS 1	710.00	0.00	203.84
PERRY 1	642.00	0.00	234.37
PILGRIM 2	735.00	0.00	249.92
PILGRIM1	183.00	147.81	0.00
PRAIRIE ISLAND 1	377.00	243.00	0.00
PRAIRIE ISLAND 2	377.00	226.24	0.00
RANCHO SECO1	370.00	233.82	0.00
RIVER BEND 1	637.00	0.00	299.70
RUSSELVILLENUCLEAR	268.00	229.93	0.00
SALEM1	619.00	363.41	0.00
SALEM2	605.00	0.00	293.50
SAN ONOFRE 2	1038.00	0.00	423.53
SEABROOK 1	507.00	0.00	193.92

TABLE B4 (cont.)

Unit Name	Cost	ADCOS	8%
SEQUOYAH 1	317.00	0.00	199.71
SHEARON HARRIS 1	1001.00	0.00	474.17
SHOREHAM	849.00	0.00	394.53
SKAGIT 1	771.00	0.00	230.43
SOUTH TEXAS 1	541.00	0.00	276.63
ST LUCIE 1	593.00	453.25	0.00
ST LUCIE 2	765.00	0.00	363.22
STERLING	698.00	0.00	229.15
SURRY 3	1251.00	0.00	570.40
SURRY1	309.00	308.50	0.00
SURRY2	189.00	179.77	0.00
SUSQUEHANNA	997.00	0.00	444.08
THREE MILE ISLAND 1	498.00	357.51	0.00
THREE MILE ISLAND 2	696.00	0.00	353.11
TROJAN	396.00	228.58	0.00
TURKEYPOINT3	159.00	164.59	0.00
TYRONE 1	783.00	0.00	234.93
VERMONTYANKEE	300.00	219.33	0.00
VIRGIL SUMMER	394.00	0.00	220.15
WATERFORD 3	638.00	0.00	355.21
WATTS BAR 1	332.00	0.00	192.70
WILLIAM MCGUIRE 1	325.00	0.00	188.17
WILLIAM MCGUIRE 2	325.00	0.00	196.23
WILLIAM ZIMMER 1	617.00	0.00	271.38
WOLF CREEK	817.00	0.00	286.44
WPPSS-2	720.00	0.00	279.83
WPPSS-3	1000.00	0.00	311.24
WPPSS1	942.00	0.00	318.56
ZION1	263.00	169.52	0.00

ADCOS = Adjusted cost of completed cost.

8% = Adjusted cost for unfinished plants assuming 8% inflation rate for 1977 on.

FOOTNOTES TO CHAPTER 1

1. The public also participates in individual licensing cases through State proceedings and ACRS reviews (see fn. 7), and in general licensing through NRC rulemaking hearings and Congress. See (11), (12).

2. The AEC and NRC Regulatory Adjudication Issuances (RAI) contain decisions and memoranda of the Atomic Safety and Licensing Boards, the Atomic Safety and Licensing Appeal Boards, and the Commission. Under the direction of Professor Roger Noll, Margaret Bates, Brian Binger, George Fox, David Montgomery, Darwin Niekerk, Roger Noll, James Quirk and myself summarized all the RAI decisions through 1975. The information on issues and resolutions in this paper derives from the RAI summaries.

3. An official at the Southern California Edison Company claimed in 1977 that the company would need approval from over 76 different local, state, and federal agencies in order to construct and operate a nuclear power plant (personal correspondence with author). See (15).

4. See (12).

5. See Figure 1. The CP applications typically run to many volumes. They include proposed plant designs, proof of compliance with NRC regulations, financial statements, and preliminary environmental impact statements.

6. Antitrust is treated in Chapter 3 of this dissertation.

7. The Advisory Committee on Reactor Safeguards is composed of 18 experts in nuclear engineering, usually academics. The ACRS reviews all CP and OL applications.

8. The Calvert Cliffs decision required pre-CP environmental impact statements (EIS) for all plants subsequently licensed. It also required EIS preparation for all plants licensed since 1970, although construction could proceed on these plants pending EIS completion, provided a hearing was held to determine whether interim construction would result in excessive environmental damage. Calvert Cliffs Coordinating Committee Inc., et al., v. USA EC, CA D of C, 449 F.2d 1109 No. 24, 389 and 24, 871, July 23, 1971.

9. Coalition on Safe Nuclear Power v. US Atomic Energy Commission et al., CA - D C No. 71-1396, April 7, 1972.

10. A Commission regulation can be challenged if the intervenor presents substantial evidence of harm to health and safety of the public or on procedural and discretionary grounds. No intervenor has met this standard. See 4AEC: AEC decision in the Calvert Cliffs case, August 8, 1967.

11. See (6).

12. "As low as practicable" refers to the Commission rules regarding radioactive releases from normal plant operations.

13. "Turnkey" plants refer to plants bought under contracts whereby the NSSS supplier agreed to construct the plant for a fixed cost and "turn the key" over to the utility on a specified date. See (3).

14. A rulemaking hearing was opened on the financial assistance issue in 1975. It has not yet been concluded.

15. RAI - 74 - 6, ALAB-211, June 13, 1974.

16. See (2).

17. RAI-74-4, LBP-74-22, April 9, 1974.

18. Duke Power Co. et al. v. Carolina Environmental Study Group, Sup. Ct. Decision, June 1978. See Chapter 2 of this dissertation.

19. New Hampshire v. USAEC et al., 406 F.2d 170 CA-1, January 13, 1969.

20. The Atomic Energy Act of 1954, PL83-703, and amendments, section 2.714 et seq.

21. Frequently several issues in licensing fall into the same category used in coding here. As a consequence, numerous resolutions exist. The procedure followed here was to take the final resolution of the most important issue falling in each category.

22. See fn. 10.

23. Morningside Renewal Council, Inc. et al., v. USAEC et al., CA-2, No. 72-2093, 484 F.2d 234, 94 S. Ct. 3080, July 5, 1973.

24. E.g., Municipal Electric Association of Massachusetts, et al., v. SEC, U.S. Court of Appeals for the D.C. District, March 26, 1969.

25. The implicit assumption is that the utility can realize gains commensurate to the inflation rate on investment. Thus the investment returns on funds that would be spent on the reactor absent delay will offset inflation of reactor component prices over the delay period.

26. The Commission has the authority to order "retrofits," or plant changes, after CP issuance. It exercises this authority only when it perceives important safety consequences of not ordering the retrofit. See 10 CFR 50.109 and Power Reactor Development Corp. v. Electrical Workers, 367 US 396, 1961.

27. The regressions are performed on a subsample of plants applying for CPs between 1966 and 1973, excluding several plants that were subsequently cancelled. The procedure is necessary as most plants applied for in 1974 did not receive CPs by the beginning of 1978.

28. See (1).

29. See (5).

30. See (13), (16).

31. See, for instance, the Midlands cases (USAEC Docket Nos. 50-329, 50-330).

32. In other regressions the significance of other plant factors -- division type, architect-engineer, NSSS supplier -- were tested. None of these factors was found to be significant. Similarly, other types of intervenors could not be shown to significantly affect licensing time. The lack of significance may reflect an insufficiently large sample size. An additive cost model was tested in addition to the log model. The results are reproduced here (variables correspond to Table 13).

Multiple R = .5803
Constant Term = 225.9900

Variable	Coefficient	Std. Err. of Coef.
X1	60.0910	44.2210
X2	65.7642	53.3289
X3	89.0461	51.5949
X4	74.2789	67.6358
X5	123.3425	58.6852
X6	33.2479	59.8995
X7	72.2775	57.0621
X8	13.3151	74.7966
X9	-43.8742	115.2071
X10	13.0170	84.3028
X11	28.6666	99.5114
X12	- .2536	25.3352
X13	-14.2630	32.0148
X14	6.0667	22.7445
X15	- .1057	.0738
X16	2.8713	1.2192

33. The statistics come from (9) and (14). Completion date estimates rely on (14), when possible, and (4).

34. Emergency Core Cooling System retrofits were ordered for plants licensed in the 1960s. See fn. 26.

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CHAPTER 2

Optimal Compensation Systems: The Case of The Price-Anderson Act

INTRODUCTION

Public debate has surrounded the regulation of nuclear safety since Congress passed the Atomic Energy Act of 1954 and found that nuclear technology, "must be regulated to . . . protect the health and safety of the public."[1] While the basis for the disputes may be reactor safety per se, the debates before the Courts, the Atomic Energy Commission, the Nuclear Regulatory Commission, and Congress are usually concerned with the implications of regulatory programs for reactor safety. This paper is concerned with one of the most long-standing foci of controversy: the program for compensating victims of major nuclear accidents. The compensation plan is contained in Public Law 85-256, popularly known as the Price-Anderson Act.[2]

First passed in 1957 to encourage development of commercial nuclear power, the Price-Anderson Act has a stated dual purpose. The development goal is reached by removing all public liability arising out of nuclear accidents from the suppliers of the nuclear plants, and indemnifying the owners of the plant from any liability in excess of the maximum available ("reasonably priced") insurance. The essence of these provisions is to remove the risk of a high-consequence event from private parties involved in the provision of nuclear power. Second, the Act guarantees some compensation to victims of a major accident by the establishment of a fund, and provides guidelines for disbursing the fund in the event of an accident.

The guidelines contain directions for withholding part of the fund for belated claims. A bankruptcy court disburses the remainder under approximate bankruptcy lines: victims receive a fraction of the fund that is proportionate to their share of total damages. Additionally, the Act states that "in the event of a nuclear incident involving damages in excess of that amount of aggregate liability (the above-mentioned fund), the Congress will thoroughly review the particular incident and will take whatever action is deemed necessary and appropriate to protect the public from the consequences of a disaster of such magnitude."[3]

While the compensation fund is a substitute for standard public liability by nuclear plant owners or operators, the bulk of the fund financing currently comes from general tax revenues rather than from the parties to the risk -- e.g. the potential victims or utility owners. The Act is thus distinguished from a federal insurance program, which involves premium payments, or a simple limit on liability of a nuclear power plant owner. Absence of direct premiums or penalties from the beneficiaries is the major identifying characteristic of a compensation system as defined in this paper. The mechanism for incentive control in insurance systems is thus absent from a compensation program. Although the program may be supported by the beneficiaries via taxes, no control of incentives through premium manipulation or rate-setting is possible.

Critics of the Act attack both the indemnification and the compensation programs. Indemnification, they claim, leads to reduced incentives for safety on the part of the owners, operators and contractors of nuclear power plants.[4] The rationale is straight forward: owners, etc., are assumed to expend resources on any safety measures which are worthwhile in terms of protecting their investments or averting potential liability. Since the government has removed the risk of very large accidents, some safety measures are not "worthwhile" which otherwise would have been. Two factors provide a countervailing influence. First, as the utilities point out, no one can be held liable for damages in excess of his assets.[5] Thus the utilities could not be held liable for all the damages of a major nuclear accident in any event. Second, as Marshall and Lieb discuss[6], direct safety regulation by the Federal Government results in the utilities being forced to install safety devices regardless of liability. Marshall and Lieb conclude that the overall impact of the Price-Anderson Act indemnification provisions on safety is ambiguous.

Criticisms of the compensation program focus on provisions relating to the guaranteed compensation fund. The Price-Anderson Act establishes a $560 million fund for total payments arising from a single accident. The compensation mechanism indicates that after a major accident victims are only guaranteed partial compensation. Critics claim that since the legislature, by indemnifying power plant owners, denied victims their common law remedy, partial compensation is a "taking of private property" and a violation of the due process rights of victims or potential victims.[7] Furthermore, the proportion of the victim's damages that is compensated depends on the total damages of all victims. The greater total damages are, the smaller the proportion of individual losses that are compensated. Critics object that this is both irrational and inequitable.

The compensation provisions of the Price-Anderson Act gained prominence in 1977 as a result of a suit brought by the Carolina Environmental Study Group against the Duke Power Company and the Nuclear Regulatory Commission.[8] The District Court Judge ruled in favor of the Carolina Environmental Study Group, declaring the Price-Anderson Act unconstitutional for reasons summarized above. In June, 1978, the Supreme Court reversed the ruling. Chief

Justice Burger's decision states that the Price-Anderson Act, "bears a rational relationship to Congress's concern for stimulating the involvement of private enterprise in the production of electric energy through the use of atomic power." Moreover, "the Price-Anderson Act not only provides a reasonable, prompt and equitable mechanism for compensating victims of a catastrophic nuclear accident, it also guarantees a level of net compensation generally exceeding that recoverable in private litigation."[9]

The bulk of the Supreme Court decision concerns legal issues that are not specific to nuclear safety.[10] The Court ruled, however, that the Act falls within the range of legislative discretion with respect to compensation. The Court did not address the issue of alternative methods of achieving legislative goals, an issue within the province of Congress. However, as the Carolina Environmental Study Group notes in its brief to the Supreme Court, the indemnification and compensation programs contained in the Price-Anderson Act are separable.[11] Thus Congress could achieve the promotional goal by keeping the indemnification provisions while modifying the compensation system.

The research in this paper is motivated by the Carolina Environmental Study Group suggestion. The characteristics of alternative potential compensation systems are evaluated in the following sections, in an attempt to determine whether an optimal system exists, or whether some system other than that of the Price-Anderson Act might be preferable. The first problem is to formulate a method for evaluating compensation systems. In Section 2, criteria are developed -- e.g., workable definitions of "efficiency", "equity" and so on. Section 3 contains a simple model of compensation systems, and the relationship between the various goals and information is examined.

Second, the Price-Anderson Act and other related compensation systems are evaluated. Numerous systems are found in both the public and private sectors today. A striking example is federal disaster relief. In the following section, various relevant compensation systems are summarized. The purpose of this summary is to put the Price-Anderson Act into perspective in light of similar programs, and to identify viable alternatives. The last section constitutes an evaluation of these systems, along with some additional compensation systems, that, while not currently employed, may be preferable in some circumstances to the present arrangements.

Section 1: The Institutional Setting

The concept of government compensation for victims of accidents, especially for those people who have no control over the accident and who are left uncompensated by the tort system, has gained popularity over the years. For instance, Rosenthal, Korn, and Lubman decry the case of accidents involving government-contracted products.[12] They address the problem embodied in the Texas City disaster of 1947. A quantity of ammonium nitrate, earmarked for the Marshall Plan, exploded, killing or injuring several thousand people. Even after two acts of Congress and over a dozen years, the victims remained undercompensated.[13] Writing in 1963, Rosenthal et al claim that collecting for accidents involving, say rocket fuel transportation, is difficult or even impossible. Plaintiffs must identify the appropriate person to sue in situations that involve dozens of contractors and other businesses. Plaintiffs then incur problems of proof, and given an event of catastrophic proportions, the defendants may simply not have enough money for adequate relief.[14] The authors' solution is an explicit assumption of limited liability by the Federal Government. They suggest a broad form of social insurance for such accidents.

Dacy and Kunreuther go through a similar exercise for natural disasters.[15] They too point to the Federal Government as the only entity with sufficient funds to pay for damages incurred in a natural disaster. They argue that forcing the victims of natural disasters to bear the entire burden of the losses is in some sense unfair, or socially undesirable. The social injustice sentiment is also present in Franklin's writing on tort law. "I do not see why, as an initial proposition, today's law should care how a limb was broken, whether by an intentional wrongdoer, a negligent automobile driver, a non-negligent driver, a wall toppled by an earthquake, or a fall in the bathtub."[16] His solution is social insurance, with provisions to deter accidents.

The Federal Government has responded generously to increased compensation demands. Perhaps the most dramatic evidence of the increased federal activity in the liability area is in the field of natural disasters.[17] The 1950 Disaster Relief Act[18] provided for federal aid in the limited form of allowing federal agencies to authorize the use of their resources -- equipment, supplies, and personnel -- by the States. In 1964 and 1965 Congress responded to a series of major disasters by passing special Acts designed to compensate the victims of specific disasters.[19] A major new provision of the Acts was the liberalization of the Small Business Administration's and the Federal Housing Administration's loan policies. Low interest rate, long-term loans became available to victims of the disasters. PL 89-769 provided for a maximum loan forgiveness of $1800.

These provisions were modified and made generally applicable to disasters in the Disaster Relief Act of 1969. The bill extended the provisions of the original Disaster Relief Act in other ways, most notably by authorizing the Federal Government to pay for up to 50 percent of the cost of repairing, restoring or reconstructing State or local flood control, navigation, irrigation, reclamation, public power, sewage treatment, watershed development, and airport construction projects. The Federal Disaster Relief Act Amendments of 1974 increase the federal share dramatically.[20] Thus, it directs the Government to pay for up to 100 percent of the cost of replacing a State or local facility, which includes, in addition to the above projects, "any other public building or system including those used for educational or recreational purposes, any park,"[21] and up to 90 percent on the value of any such facility if it is not reconstructed. In addition, the Federal Government can give money to the States for the purpose of compensating needy individuals. The federal share of this program is 75 percent, provided the State pays the additional 25 percent, up to an amount not exceeding $5000 per individual or per family. The Federal Government can lend the State the additional 25 percent. Other aid to private individuals is accomplished by payments in kind: food stamps, relocation and employment services, crisis counseling, etc.

Trends in disaster relief include larger allocations, greater coverage, greater consolidation, and limited attempts to control excessive speculative or risky investments. More generosity is reflected in the change from the 1966 to the 1974 Acts. While previously the Government agreed to pay back municipalities for 50 percent of damages, it now compensates 90 or 100 percent. The $5000 grant to families is one example of increased coverage. Consolidation attempts are seen by the replacement of specific Acts with generally applicable Acts. Kunreuther[22] attributes this tendency partly to the unexpected expense of specific Acts. However, as later Acts incorporated many provisions of the specific Acts, this explanation is not sufficient. Antispeculation measures, with one important exception, take the form of forbidding certain practices. For instance, the SBA will not extend a loan to a business that previously received a disaster loan and used it to reconstruct the business in the same location.[23] The exception involves the flood program, which will be discussed below. Otherwise, the Government has not responded to underinvestment in defenses by manipulating the structure of its programs.

The Government's program of natural disaster relief contains a number of compensation formulae. When total damages exceed $560 million, the Price-Anderson Act can be characterized as a bankruptcy system. Individual compensation is computed according to the following formula:

$$\text{Compensation} = \$560 \text{ million} \times \frac{\text{Personal Damages}}{\text{Total Damages}}$$

The Disaster Relief Act's aid-in-services to municipalities follows a similar procedure. For instance, the Federal Government owns a fixed number of fire-trucks in any given locale. These can be lent to different precincts, with priority determined by need.[24] The same principle is involved in the Trans-Alaskan Pipeline Authorization Act, which covers oil spills from vessels carrying Alaskan oil.[25] A fund of one hundred million dollars has been established, and in the event that claims from a single oil spill exceed the ceiling, all payments are adjusted proportionately downward.

The compensation system in the Disaster Relief Act's aid to families, and the SBA's loan forgiveness clauses, are lump-sum payment programs. Under these systems, once individual damages exceed a limit -- $5,000 in the case of the Disaster Relief Act -- the individual receives that sum of money regardless of either total personal damages or total disaster damages. The lump-sum formula also applies to compensation from airplane accidents. According to one provision of the Warsaw Convention, crash-victims from international airplane flights that either originate or stop in the United States, are eligible for a maximum compensation of $100,000. If damages exceed the limit the remainder is uncompensated.[26]

The third standard type of compensation formula is the flat percentage rate. The Disaster Relief Act aid to public agencies provides for compensation of formerly 50 percent, and currently 90 or 100 percent of the damages suffered. SBA loans are similar. Individuals receive loans to cover damages, of which some fraction is properly considered a grant. The fraction depends on the difference between the interest rate charged by the SBA (1 to 3 percent) and the inflation rate. A flat percentage rate is also embodied in the tax provisions. Currently, uncompensated disaster damages in excess of $100 can be deducted from taxable income under the "theft and casualty" clause.[27] Compensation then depends on the individual's tax rate.

This discussion indicates that the formula used in determining compensation under the Price-Anderson Act is only one of a number of compensation formulae. Furthermore, compensation for events over which the individual has no control is very widespread. As such programs have become common, criticism of them on wastefulness and inefficiency grounds has increased. In the next section, the basis of the criticisms is discussed.

Section 2: Equity and Efficiency

Efficiency in catastrophe situations is analogous to efficiency in more mundane scenarios. Theoretically, costs can be assigned to the consequences of a disaster, and to precautionary tactics invested in beforehand. Efficiency results when the marginal investment in disaster defenses is equal to the marginal expected savings in disaster consequences. This simple analysis provides a useful conceptual framework, although actual estimation may be precluded insofar as disaster costs include, e.g., loss of life. The analysis here is limited to damages that are potentially compensable, or transferrable.[28]

In the nuclear case, defensive activities for potential accident victims are limited. The major tactic is locational: risk exposure depends on how close -- meteorological conditions aside -- one is to the nuclear power plant.[29] More latitude exists for other kinds of disasters. For instance, buildings can be erected different distances from earthquake faults, can be different heights, can be built in general to varying degrees of seismic resistivity. Additionally, an earthquake-prone community can invest to different degrees in organizations which mitigate the damaging aftereffects of an earthquake (e.g., fire departments, search and rescue crews). All of these activities constitute investments in disaster defenses. The person in a flood prone area can build varying distances from the river, can construct a house with different degrees of flood resistance, can -- in an extreme case, erect dikes or dams.

Absence of any compensation plans would result in optimal investment in disaster defenses in an ideal, full-information world.[30] Knowledge of accident risks is conspicuously absent in the major nuclear accident case. However, the existence of a compensation plan will not correct for non-optimal investment due to incorrect estimates of the probability of disaster, except in the event of a lucky coincidence. Compensation will tend to change the individuals optimal investment strategy so as to produce excessive damages.

The following quote contains a recognition of potential distortion of incentives due to compensation. Although a separate point was being argued, Judge McMillan, the District Court Judge in the Carolina Environmental Study Group case, acknowledges the impact of compensation:

> The Act violates the equal protection provision that is included within the Due Process clause of the Fifth Amendment because it provides for what Congress deemed to be a benefit to the whole society (the encouragement of the generation of nuclear power), but places the cost of that benefit on an arbitrarily chosen segment of society, those injured by nuclear catastrophe . . . [because] 1. The statute unreasonably places the risk of major nuclear accident upon people who happen to live in the areas which may be touched by radioactive debris. . . . 2. The Act irrationally and unreasonably places a greater burden upon people damaged by nuclear accident than upon people damaged by other types of accidents. . . . 3. The Act . . . places that loss upon people injured by such accidents who are by definition least able to stand such losses. . . .[31]

Neoclassical economic analysis indicates that risk will be internalized in property values, and the losses envisioned by the Judge are offset by prices. However, McMillan's decision indicates that compensation will tend to distort any risk internalization that would otherwise exist. Flood compensation increases the value of flood-prone land, inducing greater investment than would otherwise exist. The result is greater total costs of the disaster, or moral hazard. Although commonly associated with insurance,[33] moral hazard refers to any situation when a system induces incentives for inefficient investment. Incentive difficulties generally result when the different actors (e.g., the government and victims) have different information, different preferences, and different degrees of control over the activity. In the case at hand, the government may wish to minimize overall costs of a disaster, while victims are only concerned with their individual losses. The victims control these losses, to some extent, while the government must pay out compensation without exact knowledge of whether or not the victims invested in an optimal level of defenses. Only the victim can know what the optimal level of defense expenditures is, since he has the most information about his personal risk and his defense-losses technology.

Excessive damages from compensation-induced moral hazard have been noted by a number of authors. Dacy and Kunreuther attack federal disaster relief programs as encouraging speculation and inducing greater damages than would exist in their absence.

> Federal policy frequently rewards the gambler at the expense of the prudent or cautious individual. Special disaster policies, such as mortgage forgiveness in Alaska and an $1800 forgiveness clause on SBA loans following Hurricane Betsy, tend to encourage economic investment that an individual would most likely consider unsound under normal circumstances. . . . The most disturbing aspect of federal relief is that it does nothing to discourage individuals from moving into disaster-prone regions (e.g. flood plains) thus perpetuating the need for more loans and grants in the future.[34]

Hirschleiffer treats the more fanciful case of war damage. In a 1953 paper, he argues for the institution of a war damage insurance program to encourage people to internalize the risk of war damage.

> [I]n the absence of an insurance program, it will be politically impossible for the government not to compensate for damage. Simple compensation without insurance tends to discourage private efforts designed to reduce vulnerability, since those making the expenditures involved do not gain relative to those in a highly vulnerable condition. In fact, simple compensation will encourage the abandonment of any protective measures of non-zero cost as already exist.[35]

Cost-minimization is adversely affected by compensation programs, as compensation may provide incentives for moral hazard. In Sections 3 and 4, it is shown that different systems yield different amounts of moral hazard, that is, the victim's optimal investment strategy will differ under different compensation systems. However, the individual's optimal investment strategy may not be socially optimal. First, individual losses impose externalities on the society. Second, compensation furthers social goals characterized here as "equity." "Equity" arguments fall into several categories: all provide rationales for instituting compensation at the expense of optimal levels of defense investment.

The defense expenditures of other people may confer a positive externality on the individual. In a disaster, so much capital may be destroyed that a discrete shift in the capital-labor ratio occurs. The value of the individual's labor will decrease after the disaster. The combined influence of defense expenditures might reduce the change in this ratio, and the value of a given individual's productive resources is correspondingly increased. In particular, if a capital investment is made disaster-proof, after the event the marginal productivity of labor will be higher.

Additionally, the capital-labor shift can be reduced by a large influx of federal funds into the disaster area, reducing the cost of disaster recovery. The implication of this observation is that a compensation system that provides larger total amounts of aid for those disasters that result in greater total damages is preferable to a system that keeps total compensation constant. This is reflected in Title I of the Federal Disaster Relief Act of 1974:

> Sec. 101 (a) The Congress hereby finds and declares that -- (1) because disasters often cause loss of life, human suffering, loss of income, and property loss and damage; and (2) because disasters often disrupt the normal functioning of governments and communities, and adversely affect individuals and families with great severity; special measures, designed to assist the efforts of the affected States in expediting the rendering of aid, assistance, and emergency services and the reconstructing and rehabilitation of devastated areas are necessary. (b) It is the intent of the Congress, by this Act, to provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from such disasters. . . .[36]

Second, compensation is a form of risk spreading. A standard result from the study of insurance contracts specifies the Pareto Optimal cost sharing agreement -- assuming no moral hazard -- between two parties, when one of the parties is risk neutral and the other risk-averse.[37] The risk-neutral party should absorb all the risk, or cost variations, in different possible states of the world, while the risk-averse parties should always receive the same payment.

Moral hazard modifies the optimal insurance contract. In this case the risk-neutral party absorbs a fraction of the other party's risk: at some point the increased losses due to moral hazard outweigh the benefits from risk-spreading.[38] The insurance models have only limited applicability to the problem addressed in this paper. The models deal with inter-actions between two parties, rather than between a government and numerous victims. The informational requirements of insurance models become untenable in the latter case. However, the insurance contract results suggest that an appropriate guideline for compensation systems is for the government to assume the maximum risk possible in view of probable moral hazard. The resulting guideline for design of compensation systems can be stated as follows: if moral hazard is identical under two compensation systems, the system that compensates a greater proportion of the victim's damages is preferred.

The third rationale for compensation is altruism. The idea is simply that, above arguments aside, some minimum level of support ought to be provided when losses are due to an external event. Several papers have attempted to formalize this point; however rational economic explanations are unnecessary.[39] In terms of compensation, the requirement is that victims of accidents ought to receive compensation -- and the greater the level of compensation, the better.

Each of these factors indicates the desirability of compensation, and furthermore, a compensation system that is responsive to levels of damage. The ideas and propositions are formalized in Sections 3 and 4.

A body of literature concerned with problems that are closely related to the issue addressed in this paper concerns the study of optimal tort systems. The problem of tort system design was formulated by Calabresi.[40] It is useful to review his analysis, since compensation systems have similarities to tort systems and are relevant to tort analysis. Calabresi defines the goal of accident law to be reducing the cost of accidents. He refines this into three overlapping goals: reducing the number and severity of accidents (primary costs); reducing societal costs resulting from accidents (secondary costs); and reducing the cost of administering the system (tertiary costs). He suggests assigning liability to the "best cost avoider", or the party to the accident who is in the cheapest position to mitigate the risk of or damage from the accident. Calabresi's work was modified and extended by Brown, Diamond and others[41] who, through a "generalized liability rule" concept incorporated the notion of incomplete compensation into the model. However, the basis for incomplete compensation in their models is due care, or the defense activities of the parties to the accident, rather than an exogenously set formula, like the Price-Anderson Act.

Calabresi's primary and tertiary costs are what are called "efficiency" here, and secondary costs reflect both equity concerns and the externalities discussed above. However, the similarity of the compensation problem and the tort analysis is limited to this conceptualization. The "best cost avoider" is always the disaster victim. Improvements suggested by Brown, relating incomplete compensation to standard of care, is not immediately available to compensation. It requires the government to possess an extraordinary quantity of information, and to examine each victim of the disaster separately. As Marshall points out in an excellent review of this literature, informational requirements may lessen the usefulness of these proposals even in the tort area.[42]

Although the government now compensates individuals for a wide range of activities, it generally does so through a compensation or grant system, rather than an insurance program, as recommended by many of the authors referenced in the previous section. While possibly reflecting the precept that a disaster is an exogenous event, the Government reflects underinvestment possibilities in its programs only marginally.

Dacy and Kunreuther, and Kunreuther in a later work,[43] recommend the institution of insurance programs that incorporate specific anti-risk-taking provisions. Although such provisions are important, it is demonstrated in the following sections that investment in disaster defenses can be encouraged through choice of formula, that is, by manipulating the basic structure of the compensation system. Furthermore, this might be more consonant with the third of Calabresi's goals: reducing the cost of administering the system.

In the remainder of this paper, "efficiency" is defined narrowly, to refer only to minimization of the sum of individual damages and individual defense expenditures. Thus, any increase in moral hazard will decrease efficiency. All of the above rationales for compensation are lumped together under the "equity" heading.

"Equity" refers here to all of the rationales becuase it cannot be proven that compensation is desirable (in the Pareto sense) on the basis of the risk-spreading or externality rationales. The risk-spreading result holds when there are only two parties: a principal, who assumes some of the risk, and an agent, whose actions determine the outcome. The Pareto result depends on the principal knowing what the agent's attitude towards risk is. In order to generalize the result to the case of many agents, first, the principal must know what each agent's attitude towards risk is. Second, unless each agent is subject to a personalized compensation program, the principal must be able to aggregate the agents' preferences, e.g., via a social welfare function. The same two conditions are prerequisite to proving the desirability of compensation on the basis of the externality argument. Consequently, although compensation can be rationalized in terms of risk spreading or externalities, it cannot be shown to result in a Pareto superior result.

Section 3: Modeling Compensation Systems

The basic features of a compensation system are modelled in this section. The strategy used is to formalize a compensation system so that first, the variables that contribute to equity can be isolated, and second, a measure of efficiency derived. Since the ultimate goal of such analysis is policy, the equity variables must be manipulable by the government. Viability of different systems in terms of information about risk and the defense technology is considered. Information about attitudes towards risk is deliberately omitted from the analysis: even if such attitudes can be measured, they differ from individual to individual. The variance in attitudes precludes use of them as a variable that is relevant to the government.

The formal analysis is restricted to the simplified case where all victims are risk-neutral. The choice of simplification is rationalized by two facets of the analysis. First, it is clear that the exact amount of risk aversion must be known in order to determine the exact amount of underinvestment in disaster defenses, since risk-aversion negates the effect of a compensation system. However, the effect is one of degree: thus different systems can be ranked without regard to risk-aversion. Second, as is mentioned above, the concern here is not with attitudes towards risk. Thus risk-aversion will only complicate the analysis unnecessarily. This approach is distinguished from the insurance literature: essentially the results of the literature are taken as goals (e.g., risk spreading), rather than results.

Let p be the exogenously determined probability of a disaster. Define:

β = the cost of all defense expenditures of a single individual,

$f(\beta)$ = the individual's damage function.

The defense expenditures of the other victims can give either positive or negative externalities to the individual, as was noted in the previous section.

We assume that these defense expenditures are exogenously set, and are reflected in the damage function $f(\beta)$.

Let:

K = total damages less those of the individual (i.e., total damages = $f(\beta) + K$),

$M(f(\beta), K, \alpha)$ = the individual's compensation rate (compensation = $M(f(\beta),K,\alpha) \cdot f(\beta)$).

α is a shift parameter, where $\frac{\partial M}{\partial \alpha} = 1$. It measures the "generosity" of the program. Thus, if the system is a flat percentage system, individuals receive α percent of damages in compensation. For most of this section $M(f(\beta), K, \alpha)$ will be denoted by $M(f(\beta),K)$ or by M. K enters into the individual's compensation function since the level of support depends on total damages. For instance, the Disaster Relief Act compensation depends on a presidential declaration of a National Disaster Area. The Price-Anderson Act is not activated unless the Nuclear Regulatory Commission announces an "extraordinary nuclear occurrence." While this indicates boundary conditions, we assume here that the disaster which occurs with probability p is sufficiently large to activate the compensation program, despite any defense expenditures.

Compensation cannot exceed damages, i.e., $M \leq f(\beta) + K$. Positive returns result from defense expenditures, but they exhibit decreasing marginal returns:

$$\frac{\partial f}{\partial \beta} \leq 0 \quad , \quad \frac{\partial^2 f}{\partial \beta^2} \geq 0 \; .$$

Define ξ to be the damage elasticity of M:

$$\xi = \frac{\partial M}{\partial f} \cdot \frac{f}{M} .$$

ξ measures the "responsiveness" of the system.

Different values of ξ yield different compensation formulae. If $\xi = 0$, then $\frac{\partial M}{\partial f} = 0$. Thus the compensation rate $M(f(\beta),K,\alpha)$ is only dependent on K and α, and so far as the individual is concerned, is a fixed-percentage system.

$$\text{If } \xi = -1, \text{ then } \frac{\partial M}{\partial f} = -\frac{M}{f}, \text{ or } M = \frac{C(K,\beta)}{f(\beta)} .$$

Thus, compensation is $\frac{C(K,\alpha)}{f(\beta)} \cdot f(\beta) = C(K,\alpha)$. In this case, compensation is independent of individual damages. For the individual, the program constitutes a lump-sum system. The bankruptcy system is equivalent to $\xi = \frac{-f(\beta)}{f(\beta) + K}$.

The Acts discussed in the previous section are typically combinations of these systems. For instance, under the Warsaw Convention, if $f(\beta) \geq \$100{,}000$, then the lump sum applies, with $\xi = -1$ and $M \cdot f(\beta) = \$100{,}000$. If $f(\beta) \leq \$100{,}000$, then the flat percentage system applies, with $C(K,\alpha) = 1$.

Minimization of damages is accomplished by minimizing:

$$\sum_{\text{(all individuals)}} (\beta + p \cdot f(\beta)),$$

with first order condition:

(1) $$\frac{df}{d\beta} = \frac{-1}{p}.$$

Each individual can have a different function $f(\beta)$. The individual's problem, however, is to minimize:

(2) $$\beta + p\, f(\beta)\ (1 - M).$$

The first order condition implies that:

(3) $$\frac{df}{d\beta} = \frac{-1}{p(1 - M - f(\beta)\frac{\partial M}{\partial f})} = \frac{-1}{p(1 - M(1 + \xi)}.$$

As long as M does not depend directly on the state of the world, these results extend easily to a multi-disaster case, or to the case where there is uncertainty over damages $f(\beta)$. Let

$$g(\beta,\theta)$$

be damages given θ and investment β. The analogy to the minimization in (2) is:

(2') minimize $E_\theta\ \{\beta + g(\beta,\theta)\ (1 - M)\} = \beta + h(\beta)(1 - M)$

where

$$h(\beta) = E_\theta[g(\beta,\theta)].$$

$h(\beta)$ must have the same properties as $f(\beta)$. Second order conditions for existence of a regular minimum are that:

(4) $$-1 \leq \xi \leq 0\ , \quad M \leq 1\ , \qquad \frac{\partial^2 M}{\partial f^2} < \frac{-2\frac{\partial M}{\partial f}}{f}.$$

α and ξ are the potential government policy variables in the system. Letting M be constant,

$$(5)\quad \frac{d\beta}{d\xi} = \frac{(1+\xi)\dfrac{df}{d\beta}}{(1-M(1+\xi)\dfrac{d^2f}{d\beta^2})} \quad < \quad 0.$$

Allowing M to vary:

$$(6)\quad \frac{d\beta}{d\alpha} = \frac{\dfrac{df}{d\beta}\left(-1 - f\dfrac{\partial^2 M}{\partial f \partial\alpha}\right)}{\dfrac{d^2f}{d\beta^2}(1 - M(1+\xi)) + \dfrac{df}{d\beta}\left(-2\dfrac{\partial M}{\partial f} - \dfrac{\partial^2 M}{\partial f^2} f\right)} \, .$$

If $\frac{\partial^2 M}{\partial f \partial \alpha} \leq 0$, then $\frac{d\beta}{d\alpha} < 0$.

If ξ remains constant when α varies, (e.g., a shift from a fixed rate of C percent to $(C + \varepsilon)$ percent) then

$$(7)\quad \frac{d\beta}{d\alpha} = \frac{M\dfrac{df}{d\beta}}{(1 - M(1+\xi))\dfrac{d^2f}{d\beta^2}} \quad < \quad 0.$$

A comparison of (1) and (3) indicates that unless $\alpha = 0$ (which implies that $M = 0$) or $\xi = -1$ (the lump-sum system), compensation will result in underinvestment in defenses. Equations (5) and (7) imply that an increase in either "responsiveness" or "generosity" leads to a decrease in defense expenditures --

which are already suboptimally low, as is seen by comparing (1) and (3). However, equation (3) shows that different combinations of α and ξ will result in different values of $f(\beta)$, and thus in different values of β.

Certain equity principles were posited in the previous sections. These are summarized here.

(a) If an alternate system causes damages to decrease while payment remains constant, then equity does not decrease.

(b) If total damanges increase, then a compensation system affording greater total compensation is preferable to a system yielding identical total payments.

(c) If individual damages increase, a system yielding identical or larger payments is preferable to a system yielding lower payments.

The following Table demonstrates principle (a): how different compensation systems induce different defense expenditures without adversely affecting equity. A specific functional form for $f(\beta)$ is assumed for demonstrative purposes.

TABLE 1

Comparison of Alternative Systems When $f(\beta) = e^{-\gamma\beta}$. ($\gamma > 0$)

$M = \alpha$ = compensation rate	ξ	f = damages	$M \cdot f$ = compensation
$\frac{5}{13}$	0	$\frac{26}{16\gamma p}$	$\frac{5}{8\gamma p}$
$\frac{2}{5}$	-.1	$\frac{25}{16\gamma p}$	$\frac{5}{8\gamma p}$
$\frac{1}{2}$	-.6	$\frac{20}{16\gamma p}$	$\frac{5}{8\gamma p}$
$\frac{5}{8}$	-1.0	$\frac{1}{\gamma p}$	$\frac{5}{8\gamma p}$

The percent of damages attributable to the compensation system is described by combining (1) and (3):

(8)

$$\frac{\dfrac{-1}{p(1 - M(1+\xi))} - (\dfrac{-1}{p})}{\dfrac{-1}{p(1 - M(1+\xi))}} = M(1 +\xi).$$

$M(1 +\xi)$ measures the percent decrease in $\frac{\partial f}{\partial \beta}$, the derivative of damages with respect to defenses. If damages are elastic in defenses, compensation systems induce moral hazard in quantities that are monotonically related to the expression $M(1 +\xi)$. Thus the expression yields a basis for evaluating the efficiency of a compensation system. Let us define $M(1 +\xi)$ as the measure of moral hazard. Decreasing $M(1 + \xi)$ will decrease the proportionate amount of underinvestment. This yields one basis for evaluating a compensation system. A fixed percent system which allocates C percent has a measure of C. The bankruptcy system with a ceiling of D has a measure of $\frac{D \cdot K}{(f(\beta) + K)^2}$. If compensation is fortuitously equivalent under both systems -- i.e., $C = \frac{D}{f(\beta) + K}$, then induced damages will be less under the bankruptcy system. This measure is considered further in the last section.

Equations (5) and (7), taken together, yield:

$$(9) \qquad \frac{d\beta}{d\xi} \cdot \frac{\xi}{\beta} = \frac{\xi}{1 + \xi} \left(\frac{d\beta}{d\alpha} \cdot \frac{\alpha}{\beta} \right).$$

If ξ is less than $-\frac{1}{2}$, a percent increase in α causes less underinvestment than a percent increase in ξ, while if ξ is greater than $-\frac{1}{2}$, a percent increase in ξ causes less underinvestment than a percent increase in α.

Although the switching point of $-\frac{1}{2}$ is, of course, dependent on the risk-neutrality assumption, risk-aversion will only change the exact point, not the result. The significance of such a tradeoff derives from the interpretations assigned to α and ξ. Both are connected to equity. However, the implication of equation (9) is that increases in efficiency need not always be made at the expense of responsiveness -- for fairly unresponsive systems, a reduction in the absolute level of compensation is more effective.

When the defense-damage technology is known, the government can set a "fair" level of compensation based on the government's knowledge of what damages are if the individual invests in the optimal level of defenses. The system is totally unresponsive. However, if damages, or appropriate damages, are not known with certainty beforehand, efficiency must be sacrificed to ensure the same compensation level. Consequently, attainment of equity necessitates a responsive system of compensation.

An intermediate case is when the government can set bounds on the total damages. In such an event, a partially responsive system is possible. Information is a valuable activity in terms of efficiency, so long as damages are not perfectly inelastic in defenses.

In the next section, these results are applied to the compensation systems considered earlier.

Section 4: Discussion

The Acts discussed in Sections 1 and 2 can be evaluated through a combined use of the full-information model and a consideration of the uncertainties involved. In essence, the

Government should formulate a compensation program which minimizes $M(1 + \xi)$ insofar as possible while satisfying equity goals. A high generosity level can be offset by unresponsiveness. Uncertainty considerations will limit the ability to have an equitable unresponsive compensation program.

The Price-Anderson Act addresses a disaster situation infamous for uncertainty over damage estimates. Expected total damage estimates range over several orders of magnitude. Yellin[44] suggests that part of the reason for the discrepancy is the tendency of the Nuclear Regulatory Commission to average accident consequences from the same accident-type over different reactors.[45] However, damages are highly dependent on the nuclear reactor site.

The averaging tendency is reflected in the Price-Anderson Act, where a single ceiling is established for all accidents. This was criticized by Judge McMillan, as quoted in Section 1. The framework in Section 3 yields understanding of the concern. Given a large variance, more responsiveness is needed. In the terminology of the previous Section, the personal responsiveness factor is

$$\xi = \frac{-f(\beta)}{f(\beta) + K} \quad .$$

If K is very large, ξ tends to zero. However, the total responsiveness of the system is given by:

$$\frac{\partial M}{\partial(f(\beta) + K} \cdot \frac{(f(\beta) + K)}{M} = \frac{-5.6 \cdot 10^8}{5.6 \cdot 10^8} = -1.$$

Since expected damages are subject to large uncertainty, the unresponsive nature of the program indicates a lack of equity. Furthermore, since the magnitude of individual damages is correlated to the number of people hurt, absolute compensation decreases when damages increase.

An equivalent controversy does not exist over oil spill damages, nor over the Trans Alaska Pipeline Authorization Act. This can be interpreted as a situation involving less uncertainty, and in which the ceiling bears more relation to the maximum expected magnitude of total damages.

The Disaster Relief Act incorporates nearly all the systems discussed in Section 2. The combination of the various provisions is supported by the analysis. The tax deduction system results in victims in higher income brackets receiving a larger percentage rate of compensation.

The Disaster Relief Act provides lump-sum grants and other payments in kind to victims who have suffered great damages, possibly mitigating the apparent inequity of the tax-relief system. Partitioning of compensation programs may result in less underinvestment, if individuals with different wealth behave in different manners (e.g., if relative-risk aversion increases).

However, the Disaster Relief Act fails to distinguish between different types of events. The evolution of the current Disaster Relief Act was discussed in Section 2. The Act represents an attempt by Congress to provide a general bill -- that is, to cover all natural disasters by a single compensation program. Consolidation leads to greater variance in expected damages, since the Act applies to a multitude of different kinds of events. Not only do these events lead to different expected damages -- which results in unnecessary variance over $f(\beta)$ in the full information case -- but each event is subject to different amounts of uncertainty. If an event that is well-documented is tied to an event about whose consequences little is known, then the compensation system will have to be based on the latter event. Individuals who face the risk of the "certain" disaster unnecessarily underinvest in defenses. The analysis in Section 3 indicates that greater partitioning is a better approach. Since more is known about certain types of natural disasters than others, separate formulae are appropriate.

Furthermore, if the Government expended resources in collecting information about the consequences of disasters, more defense investment could be induced through a compensation system. More knowledge about disaster consequences would enable unresponsive compensation programs. The Disaster Relief Act provides for disaster warning and planning programs, but concentrates mainly on ex-post activities. Certain other Government agencies, such as the National Oceanographic and Atmospheric Administration, evaluate the risks of various disasters. The collection of information is central to optimal system design, and as such the Government could save excess damages by investing in data collection rather than compensation.

One type of natural disaster was recently split off from the general coverage of the Disaster Relief Act. A flood insurance program has been established.[46] One of the first activities under the flood insurance program has been the detailed collection of risk and damage information. While the success of the program as an actuarially-based insurance plan is uncertain,[47] this type of Act still reflects two of the primary recommendations of the previous analysis, partitioning and information collection.

In Section 3 several "equity" principles were stated. Presumably a system which increases compensation for increased damages is preferable to a system yielding constant compensation. However, this implies a greater responsiveness in the system. Existing compensation programs reflect extremes -- e.g., bankruptcy, as discussed above, lump-sums with a measure (defined in the previous section) of zero, or fixed percentages, where $\xi = 0$, and all incentive control must be manifested by lowering the generosity level, that is, the rate of compensation. One alternative to these systems which may be preferable in certain situations is the "average damage lump-sum" system. The system allows compensation to vary with average damages. If individual damages strongly correlate to average damages, then the system will provide a good approximation of the fixed percentage type of compensation. Correlation can be enhanced by separating the victims into subgroups.

The system is preferable to a lump-sum system, since compensation increases with increased damages. Moreover, it presents the individual with reverse prisoner's dilemma incentives: he is best off when other people's damages are high and his own are low. Importantly, the system does not require the Government to accurately predict damages beforehand.

Formally, let n be the number of victims, C be a constant less than 1, and define β, $f(\beta)$, K and M as in the previous section. M is given by:

$$\frac{C(f(\beta) + K)}{nf(\beta)}.$$

Compensation is then $\frac{C(f(\beta) + K)}{n}$. The measure of the system developed in Section 3 is:

$$M(1 + \xi).$$

For this system, $\xi = \frac{-K}{f(\beta) + K}$, so $M(1 + \xi) = \frac{C}{n}$. This compares favorably with the flat percent system (an equivalent compensation yields a measure of C) or bankruptcy system (with measure $\frac{CK}{f(\beta) + K}$).

Another compensation system that is based on the averaging principle but allows for a fixed overall system is the following. Let X be the absolute ceiling. $g(f(\beta) + K)$ is a function such that

$$\frac{dg}{d(f(\beta) + K)} < 0, \quad g(f(\beta) + K) \underset{f(\beta)+K\to\infty}{\to} 0,$$

$$M(f(\beta),K) = \frac{X - g(f(\beta) + K)}{nf(\beta)}.$$

Then compensation is:

$$\frac{X - g(f(\beta) + K)}{n}$$

while

$$M(1 + \xi) = \frac{\frac{-dg}{d(f(\beta) + K)}}{n}.$$

This system compares favorably with the Price-Anderson system.

In conclusion, the Government has a wide variety of available options for reducing underinvestment in disaster defense expenditures without resorting to an actuarially-based insurance system. Although optimal systems require the same degree of knowledge that insurance requires in order to set premiums, alternatives such as the "average damage lump sum" system can approximate an optimal system, while requiring less information.

FOOTNOTES TO CHAPTER 2

1. PL 83-703, 42 USC 2012.

2. PL 85-256, 71 Stat 576 (1974).

3. PL 85-256, 1976 amendments.

4. Harold Green, "Nuclear Power: Risk, Liability and Indemnity," Michigan Law Review 71 (1973):479.

5. This problem pervades much of the catastrophic accident work, and leads to "de facto limits on liability." See Kenneth Solomon and David Okrent, "Catastrophic Events Leading to De Facto Limits on Liability," mimeo, the RAND Corp, 1977.

6. An excellent discussion of the premium system and its economic implications is contained in J. M. Marshall and L. I. Lieb, "Liability and Safety in Nuclear Power Plants," UCLA - ENG - 7724, University of California at Los Angeles, February 1977.

7. Carolina Environmental Study Group Inc. et al. v. United States Nuclear Regulatory Commission et al., United States District Court for the Western District of North Carolina, Charlotte Division C-C-73-139, filed March 31, 1977.

8. Carolina Environmental Study Group Inc. et al. v. USNRC, 1977.

9. Duke Power Co. et al. v. Carolina Environmental Study Group, Supreme Court decision, June 1978.

10. See related articles in the New York Times (June 23, 1978, p. 1) and Environmental Reporter (July 3, 1971, p. 1).

11. Brief filed December 1977.

12. Rosenthal, Korn, and Lubman, Catastrophic Accidents in Government Programs: Report of the Legislative Drafting Fund of Columbia University for the National Industrial Association, National Industrial Association, 1963.

13. Rosenthal et al, 1963, pp. 3-4.

14. Solomon and Okrent, 1977.

15. Douglas Dacy and Howard Kunreuther, The Economics of Natural Disasters (New York: The Free Press, 1969).

16. Marc Franklin, "Replacing the Negligence Lottery: Compensation and Selective Reimbursement," in Robert Rabin, ed., Perspectives on Tort Law (Boston: Little, Brown and Co., 1976), p. 288.

17. For a general discussion of the changes in natural disaster compensation programs, see Howard Kunreuther, Recovery from Natural Disasters (Washington, D.C.: American Enterprise Institute, 1973).

18. PL 81-875.

19. E.g., The Alaska Omnibus Act, PL 88-415, 78 Stat 505; The Pacific Northwest Relief Act of 1965, PL 89-41, 79 Stat 131; The Southwest Hurricane Disaster Relief Act of 1965, PL 89-768, 80 Stat 1316.

20. PL 89-769 Sec. 9.

21. PL 93-288.

22. Kunreuther, 1973.

23. Kunreuther, 1973.

24. For a discussion of postdisaster relief programs, see Linda Cohen, Roger Noll and Barry Weingast, "Responses to Disaster: Planning for a Great Earthquake in California," California Institute of Technology, Social Science Working Paper No. 131, April 1977.

25. PL 93-153 Sec. 204, 87 Stat 586, November 16, 1973.

26. "Symposium on the Warsaw Convention," Journal of Air Law and Commerce 33 (1967):579-688.

27. 1977 Federal Tax Code.

28. The existence of noncompensable damages, e.g. loss of life, complicates liability rule analyses considerably. See, e.g. P. Diamond and J. Mirrlees, "On the Assignment of Liability: The Uniform Case," Bell Journal of Economics 5, no. 2(Autumn 1974b):366-406.

29. Joel Yellin, "The Nuclear Regulatory Commission's Reactor Safety Study," Bell Journal of Economics (Spring 1976); and United States Nuclear Regulatory Commission, "Reactor Safety Study," NUREG - 75/014 WASH - 1400, October 1975.

30. This statement relies on absence of externalities or transaction costs. See, e.g. Ronald Coase, "The Problem of Social Cost," Journal of Law and Economics (October 1960).

31. Carolina Environmental Study Group et al. v. USNRC, 1977.

32. Howard Kunreuther, 1973; and Howard Kunreuther, "Limited Knowledge and Insurance Protection," Public Policy 24(Spring 1976):227.

33. A definition and discussion or moral hazard is contained in Kenneth Arrow, "Uncertainty and the Economics of Medical Care," AER 53, no. 5 (December 1963):941-973.

34. Dacy and Kunreuther, 1969:229-230.

35. Jack Hirshleiffer, "War Damage Insurance," Review of Economics and Statistics 35 (May 1953):146-147.

36. PL 93-288, 42 USC 5121.

37. Michael Spence and Richard Zeckhauser, "Insurance, Information, and Individual Action," American Economic Review Proceedings (May 1971).

38. Spence and Zeckhauser, 1971.

39. Bruce Bolnick, "Post-Disaster Cooperation: Utility Dependence, Prices and Beyond," Duke University, Durham, N.C., mimeo, 1978, and references in Bolnick.

40. Guido Calabresi, The Cost of Accidents (New Haven: Yale University Press, 1970).

41. John Marshall, "The Safety-Incentive Theory of Liability," UCLA-ENG-7770, University of California at Los Angeles, November 1977, and references in Marshall.

42. John Marshall, 1977.

43. Dacy and Kunreuther, 1969; Kunreuther, 1973.

44. Yellin, 1976.

45. WASH - 1400, 1975.

46. PL 93-158 Sec. 204, 87 Stat 584.

47. Kunreuther, 1976, evaluates the flood program and concludes that people do not buy a high enough level of insurance. He speculates that the difficulty lies in evaluating probabilities of low-frequency events and that individuals do not behave according to the expected utility hypothesis. However, the study fails to incorporate existence of other forms of "free" compensation into the model. As long as compensation is still available for flood victims, they need not buy any insurance at nonzero cost. The Federal Government has recognized this problem, and stated in more recent amendments that individuals eligible for flood insurance cannot collect alternate compensation.

CHAPTER 3

An Analysis of Antitrust Reviews by the Atomic Energy Commission

INTRODUCTION

Section 105c of the Atomic Energy Act of 1954, as amended, states that all applicants for nuclear power plant construction permits must submit to an antitrust review by the Justice Department and, if necessary, the Atomic Energy Commission.[1] Since Congress amended the 1954 Act in 1970 to institute mandatory prelicensing antitrust review, nearly all major private power companies have come under the scrutiny of the Justice Department's Antitrust Division. Reviews under this law progressed so rapidly that by 1974 a popular journal reported: "The Atomic Energy Commission has been the scene of the most intensive and probably the most successful activity by the Antitrust Division lawyers of the Justice Department" (7; p. 88).

Opinions differ about the effectiveness and desirability of the antitrust reviews. The Justice Department enthusiastically claims that the reviews constitute extremely effective antitrust enforcement. Private utility companies claim that the reviews are blackmail, and bias investment decisions away from nuclear plants. Other sources dismiss them as boondoggles for publicly-owed electric utility companies (37), (40).

The central issue addressed here is the rationality and success of antitrust review by the Atomic Energy Commission. Current evidence indicates that the reviews are not a success. First, proposed remedies are at variance with development of competitive potential within the industry. Second, the enforcement record is poor: some license conditions are either ignored or enforced so as to further cartelization in the industry instead of the stated competitive intent.

These conclusions indicate that, despite the enthusiasm generated for the reviews, AEC oversight may have limited value and even be possibly counterproductive. It is argued that the reviews contribute to cartelization and stability in the industry, and that these results are neither necessary nor desirable.

Since the reviews have only been pursued for eight years, much of the evidence presented below is incomplete. This difficulty is compounded because the 105c reviews coincide with a period of increased judicial antitrust activity in the regulated industries. Consequently, not only is a historical analogy lacking, but distinguishing between judicial and administrative actions is problematical. The conclusions here necessarily rely in part on indirect evidence and speculation.

The chapter is organized as follows. Section 1 contains a brief history of the events leading up to the 1970 Atomic Energy Act amendments. Included partly for completeness, the history clarifies certain agency models which predict the observed ambivalent outcome of the reviews. In Section 2, certain features of the electric utility industry are reviewed. This allows an assessment of the extent of scale economies in the industry and an evaluation of the antitrust policy inherent in the section 105c reviews. Section 3 reviews actions taken in response to the NRC's antitrust mandate, and the concluding section evaluates the evidence in view of the results of Section 2.

Section 1: History of the 1970 Amendments

The 1970 amendments derived from a history of interaction between the Atomic Energy Commission, the powerful Joint Congressional Committee on Atomic Energy, and the electric utility industry. The events surrounding the advent of antitrust review support the observations of Joskow (16) on the response of public utility commissions to the environmental movement in the late 1960s and early 1970s, e.g., that the AEC's antitrust requirement is a compromise regulatory solution. As a result, enforcement designed to further the

the previously competing interests -- e.g., mutually beneficial cartelization of private and public power companies -- can be expected, rather than vigorous pro-competitive policies.

The original 1954 Atomic Energy Act contained a section similar to the current section 105c. However, the authorizing section in the original AEA was never enforced. The 1954 Atomic Energy Act stated that licenses could either be awarded under section 103 (commercial) or section 104b (research and development). Section 103 licensees were subject to antitrust reviews under then section 105c. Section 103 licenses differed from section 104b licenses in other important ways. The latter were eligible for a number of subsidies denied section 103 license holders, e.g., waiver of charges from consumption of special nuclear fuel and Power Reactor Development Program financial assistance.

The entire thrust of commercial licensing, and particularly antitrust review, was blunted by Section 102. It stated that in order for a reactor to be licensed under section 103, a statutory finding that the reactor type has practical value must be made. Up until 1970, the AEC refused to make the requisite finding.

During the first 13 years after the passage of the 1954 Atomic Energy Act, the antitrust provisions were ignored. Atomic energy, however, developed into a commercial success.

The first two objectives from AEC's 1962 Report to the President are:

> 1. the demonstration of economic nuclear power by assuring the construction of plants incorporating the presently most competitive reactor type;
>
> 2. the early establishment of a self-sufficient and growing nuclear power industry that will assume an increasing share of the development cost (48).

Research and development of light water reactors progressed far more rapidly than had been anticipated. In 1963 Jersey Central Power and Light Company announced that it planned to build a nuclear plant without any government subsidies and that its decision to build the plant was based on the comparative economics of different available types of power generation. The 1962 AEC goals had apparently been met within a year.

The National Coal Association was likewise convinced of the economic competitiveness of nuclear power plants (42; p. 6). In an attempt to remove the section 104b subsidies and thereby reduce the apparent competitive advantage of nuclear plants over coal, the National Coal Policy Conference, Inc., the National Coal Association and the United Mine Workers formally petitioned the Commission to issue a finding of practical value on May 14, 1967. A rulemaking hearing was held, and the Commission denied the petition. The same organizations petitioned for a statutory finding of practical value in 1966 and it was again denied (50). However, by 1966 most of the section 104b subsidies had been discontinued.

In September 1967, a number of municipal power companies and the Power Planning Committee of the Municipal Electric Association of Massachusetts ("the Massachusetts Municipals") petitioned to intervene in the Vermont Yankee construction permit proceedings. They contended that the AEC had to license Vermont Yankee under section 103 instead of 104b, because it was clearly a commercial plant, and the Licensing Board should thus consider antitrust issues. (4AEC21; 4AEC71) The Massachusetts Municipals' backup contention -- which was eventually supported by a circuit court -- was that the Licensing Board could not make the requisite findings on the Applicant's financial qualifications, because the financial structure of the Vermont Yankee Corporation was illegal. The petitioners requested that the AEC order the Vermont Yankee Corporation to sell stock in the Vermont Yankee plant to them.

During the next two years similar cases were brought in the Duke Power (Oconee) cases (petition filed 8/10/67); Philadelphia Electric (Peach Bottom -- 12/5/67); Boston Edison (Pilgrim -- 5/29/58); Maine Yankee (9/16/68); Florida Power Corporation (Crystal River 3 -- 9/24/68); and the Carolina

Power and Light cases (Brunswick -- 10/7/69; 11/19/69). While the specific contentions differed from case to case, all involved some kind of attack on issuing licenses under 104b, and were thinly veiled attempts at enforcing an antitrust review. The Commission formulated principles for handling these petitions in the Duke Power Company case, and applied them thereafter (4AEC21; 4AEC57; 4AEC71):

1. Intervention was granted to municipalities who were customers of the applicant. They had a "valid economic interest" in the plant. Intervention was denied other organizations, such as power planning cooperatives. In the Duke case, intervention was denied an organization of municipal companies, the Piedmont Cities Power Supply, Inc. It had planned to buy part of the Oconee plant and sell it at cost to the cities (4AEC57). From an antitrust standpoint, it makes more sense to admit groups like the Piedmont Cities Power Supply, Inc. As Weiss and Hughes explain, size differential between private and public companies is one of the greatest impediments to coordinated operations between them (35). Hughes recommends the formation of public power cooperatives (14).

2. Licensing Boards would accept evidence on whether the plant can be licensed under 104b -- but only on whether the applicant satisfied the requirements of such licensing. Requirements include, e.g., insuring the safety of the public. Absence of antitrust violations is not required.

3. A finding of practical value cannot be made in an individual licensing case. It must be done in rule-making. Before any finding can be made, some of the large units will have to be operating and show practical value.

4. The "research and development" aspect of 104b licensees includes building a plant to demonstrate economic competitiveness. Thus a plant identical to some other unit is still "research and development."

The "Duke" reasoning carefully affords all parties procedural due process but effectively reduces the role of the intervenors to that of powerless bystanders. In the Maine Yankee case, the Board initially denied the petition to intervene, saying the issue was "illusory and extraneous" and served "no useful purpose," (4AEC163; 4AEC312). The decision was overturned by the Commission on the basis of the Duke reasoning. The Atomic Safety and Licensing Boards rejected the intervenors' contentions in all of the cases.

Setting the pattern for later intervenors, the municipalities went to Court. In City of Statesville et al. v. AEC, U.S. Ct. App., D.C. Cir., 12/5/69 (re Duke Power Co.); Power Planning Committee et al. v. AEC (Vermont Yankee -- later consolidated with Statesville); and Easton Utilities Comm. v. AEC, 424 F. 2d 847 (D.C. Cir., 1970) (re Philadelphia Electric Co.) the intervenors challenged the ability of the AEC to license large, clearly commercial reactors under section 104b. The Courts affirmed the AEC. However, the decisions indicated that the section 104b licensing anomaly could not continue indefinitely. In the Statesville case (which became the precedent), the Court questioned whether 104b construction permits could be converted into operating licenses without antitrust review.

In 1970, Congress resolved the impasse and licensing delays caused by practical value intervenors (44), (45). Congress' concern with the late 1960s controversy is evident in the sections of the amendments that treat grandfathering. The 1970 amendments state that reviews are required before issuance past 1970 of Contruction Permits. Previous construction permits are grandfathered, except that reviews are held prior to an Operating License issuance if requested by a party who had previously intervened on the 104b licensing controversy. In addition, Congress specified that joint ownership of the nuclear plant between private and public companies -- the central issue in the section 104b interventions -- is an expected outcome of the reviews.

The remainder of this paper treats the enforcement record. As will be seen, enforcement of section 105c is a logical outgrowth of the section 104b controversy. Conforming to Joskow's model of a regulatory agency (16), the reviews have forestalled lengthy litigation between the Commission and power companies by resulting in a mutually beneficial arrangement to both private and public utility companies.

Section 2: The Electric Utility Industry

The usual prescription for antitrust policy in regulated industries is to promote competition to the extent compatible with the scale economies in the industry (1), (23). Consequently, an evaluation of antitrust policy must rest on an understanding of industry structure. In this section, current thought on the potential for competition in the electric utility industry is reviewed. For a more detailed treatment, the reader is referred to (35), (23), or (22).

The electric utility industry is conveniently viewed as comprised of three sectors: distribution, transmission, and generation. Transmission is the transportation of power over high voltage lines from generating units to local sellers of power. Local sellers then use distribution networks to connect final users to the transmission lines. The electric utility industry in the United States is dominated by large, vertically integrated firms that generate, transmit, and distribute power within an extended geographical area. Each of the geographical areas also contains some local distribution systems, who purchase most of their power from the dominant firm in the area.

Several economists have attempted to estimate the extent of scale economies in the electric utility industry. Hughes investigates the relationship between unit power costs and firm size, and find unexploited scale economies in all but the largest firms (14). His conclusion -- which is supported by later studies (6) -- is that in order to capture all economies of scale, the country must be divided into twenty to thirty "planning units." By planning unit Hughes refers to either a single firm or multiple firms that closely coordinate investment planning and operations.

The policy of promoting power pools, pursued by the Federal Power Commission since the mid-1960s, is in accord with these results. However, the econometric results are an artifact of current industry practices, particularly those governing wholesales of power to local distributors. In this section, two related claims are discussed: first, that estimated scale economies are largely associated with generation systems rather than with individual generation plants; and second, that the system scale economies derive from organizational attributes of the current system. In particular, alternative organizations are feasible that allow for more competition and yet do not lose the efficiency associated with the current integrated industry structure. In order to support these claims, an introduction to the generation sector of the industry is necessary.

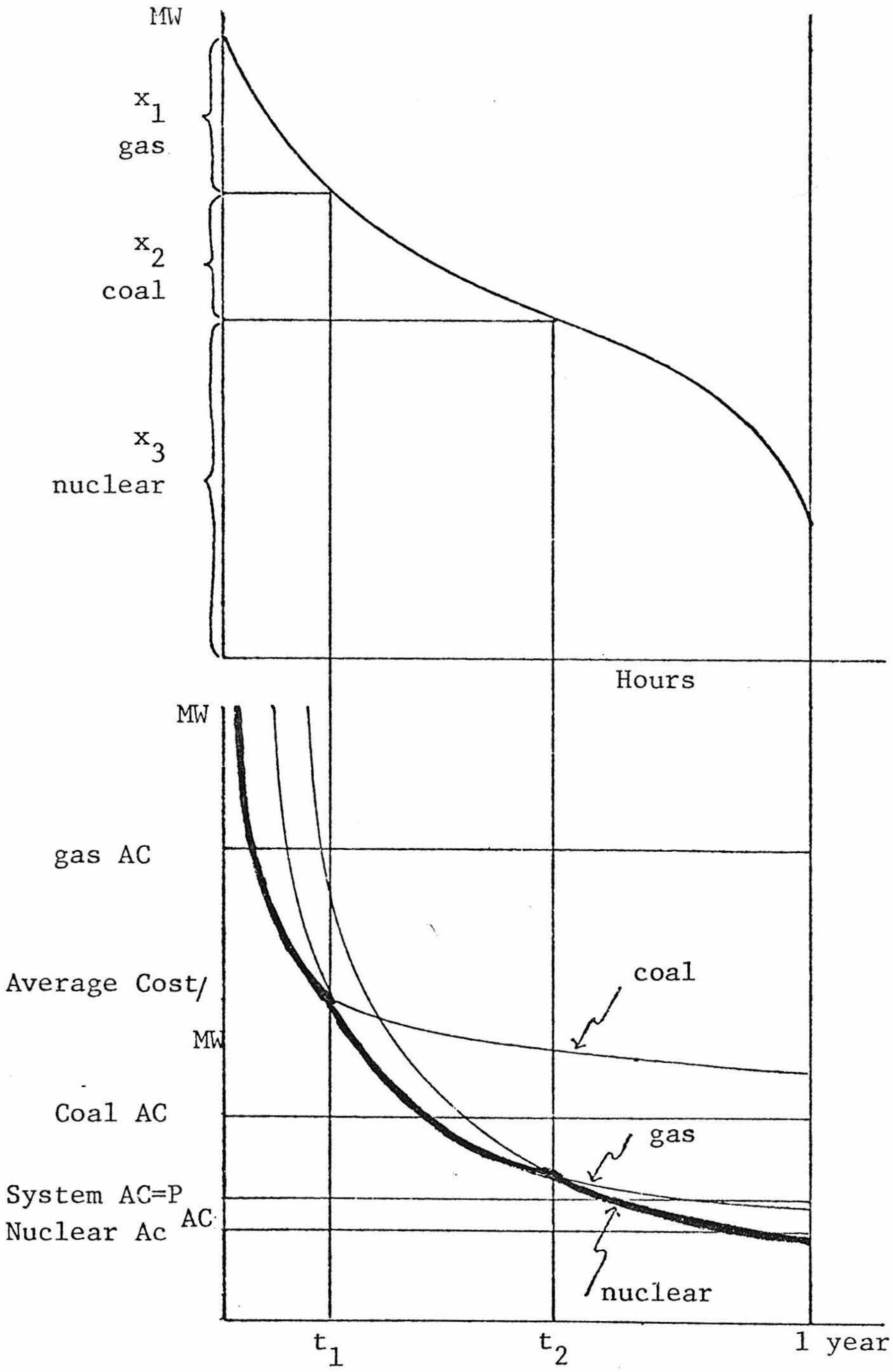
The generation sector is complicated by the nature of both the final demand for electricity and the generating technology. The demand for power varies substantially over the course of a year, a month, or even a day, while power can be inventoried only at costs that are very high relative to generation costs. As a result, for efficient operations, electrical output must constantly adjust to meet the changing instantaneous demand.[2] Consequently, much of the generating capacity is only used for a fraction of each year.

Different types of power plants have different relative costs, depending, among other things, on the proportion of the year during which they are operating.[3] The "generation sector" of the industry is the set of power plants (the "generation mix") whose combined output satisfies the electrical requirement of a distribution network.

Figure 1 represents an idealized distribution and generation system. The top figure shows the maximum demand for power as a function of the proportion of the year. The lower figure shows the average cost per watt of power generated in three different types of power plants as a function of the number of hours during the year in which the plants are operating.

Figures such as these are used in the industry to calculate the optimal generation mix. Power that is demanded during most of the year is met by "base-load" plants, while the additional varying demand is met by "peak-load" plants. For the idealized system represented in Figure 1, the optimal generation mix is composed of x_1 units of "gas-turbine" plant, x_2 units of "coal" plant and x_3 units of "nuclear" plant.[4] Additionally, the generation mix includes "reserve" plants, which are used to generate power when one or more of the other

Figure 1


MW
x_1
gas
x_2
coal
x_3
nuclear
Hours
MW
gas AC
Average Cost/
MW
coal
Coal AC
gas
System AC=P
AC
Nuclear Ac
nuclear
t_1
t_2
1 year

plants are not operational because of either breakdowns or normal maintenance. Calculating the required number of reserve plants, or "reserve capacity," is traditionally based on a consideration of the effects of a shutdown of the generation entity's largest plant and on some portion (10-15 percent) of the maximum load, or demand for power of the entity.[5] Reserve capacity increases when a larger proportion of total load is met by a single generation plant.

The final determining factor of generation mix investment (for the purposes of this section) is uncertainties of demand forecasting. When demand cannot be accurately forecast, the generation system installs a greater proportion of peak-load plants to base-load plants. The difference in investment is mainly because base-load plants typically take up to ten years to plan and construct, while peak-load plants require much shorter lead times. Because the base-load plants are only economical when run at full capacity for most of the year, they will not be installed unless the generation entity is convinced that future growth in demand will support the added units. If increased demand actually materializes, it must be met with the more quickly constructed base-load plants.

Scale economies in the generation sector of the industry derive from each of the factors mentioned above.

When a single firm (or "planning unit," in the terminology of Hughes) serves a larger area, the load-duration curve (see Figure 1) becomes flatter. Demand varies less because peak times differ in different parts of the service area. Moreover, the firm can spread the risk of increased demand over its greater number of customers. Consequently, the firm can increase the proportion of base-load to peak-load plants. Furthermore, for the larger firm each plant is less important to the total system due to its greater number of generating units. As a result, the larger firm can reduce its proportion of reserve plants.[6]

The case for vertically integrated, monopolistic firms rests on the assumption that the generation mix with the least per-unit electricity cost can only be achieved by coordinated effort. However, numerous economists have argued that incentives could exist for decentralized achievement of the optimal generation mix. The incentives depend on universal access to transmission systems and on a more complex pricing system.

If the electric utility industry is composed of numerous autonomous local distribution and generation entities, all the generation entities can compete for distribution customers only if all the parties -- in a sufficiently large area --

have access to transmission lines. Because the transmission sector demonstrates the classic properties of a natural monopoly, the lines must have common carrier status. Currently, integrated firms use their monopoly over transmission to impede local distributors within the dominant firms' service area from purchasing power from alternate sources. The "bottleneck" of transmission is discussed by Weiss (35) and has been recognized by the federal judicial system in the Otter Tail case.[7]

The role of prices can be explicated by a comparison of average cost and marginal cost pricing. In Figure 1 the system average cost is marked P_{AC}. If generation firms are constrained to charge average cost, a single company cannot profitably operate the "coal" or "gas" units, or more generally, peak-load and reserve plants. However, as is shown in Figure 1, the system is inefficient when all power is produced by base-load plants: the mix resulting from numerous small companies constrained to average cost pricing is a predominance of peak-load plants. If the industry is comprised of several firms, its prices create inefficient investment incentives for individual generation entities that can be overcome only through some form of coordinated, cartel-like behavior. For the reasons listed above, optimal generation mix will be obtained only if a single entity generates power for the entire relevant geographic area.

Marginal cost pricing, on the other hand, creates appropriate incentives for individual generation entities. Individual firms can operate a single or small group of generation plants, and provide part of the power requirements for a large service area rather than all the power for a smaller area. Marginal cost pricing allows some firms to operate only expensive plants, while other firms supply base-load power. Thus, system reliability will be achieved without sacrificing operation of the optimal mix of generation plants. Thus, constructing an efficient, competitive alternative to vertical integration requires time-dependent, marginal cost, wholesale pricing of power.[9] This entails more expensive methods for metering power, but variable pricing methods appear to be increasingly practicable as energy costs continue to rise (22).

The observations in this section imply that far more competition is feasible in the electric utility industry than currently exists. An alternative, pro-competitive industry structure that takes advantage of all scale economies would have numerous generation firms, distribution firms that are local monopolies, and a transmission system with common carrier status. Competition is induced among generation firms for sales to distribution customers.[10]

Section 3: 105c Review

When a utility applies for a construction permit at the NRC, it submits information relating to potential antitrust difficulties: wholesale and retail contracts, the market shares of different firms for bulk-load power, peak-load power, and other electricity markets, power-pooling agreements and so on. This information is sent to the antitrust division of the Justice Department. The Justice Department consults with the NRC staff and the relevant utilities -- e.g. the applicant and its wholesale customers -- and decides whether action must be taken. In most of the cases up to 1978 the Justice Department formulated settlements. The settlements are attached to the construction permit. If a settlement is not reached, the NRC holds an evidentiary hearing resulting in an Initial Decision. The Initial Decision is subject to appeals, as in other Commission reviews (see Chapter 1). The 105c reviews thus fall into two categories: those resolved by Justice Department settlements and those resolved through litigation at the NRC.

By the end of 1975, the Antitrust Division had re-viewed sixty-nine of the hundred largest utilities (51). These companies produced over 76 percent of the total 1974 kilowatt hour sales. The AEC had conditioned twenty-four applications, involving twenty-one different primary applicants. All were private companies. While the remaining licenses were not conditioned, in fifteen cases the applicants entered some kind of agreement with smaller utilities and the Antitrust Division as a result of the reviews. Litigation was pending on eight applications.

In 1976 and 1977 Atomic Safety and Licensing Boards issued three Initial Decisions. One Appeal Decision was handed down in December 1977. However, none of the issues before the NRC have yet been terminated. Due to the slow agency progression, most evidence to date is from the Justice Department reviews.

In this section the evidence from 105c reviews is examined examined. Justic Department reviews are considered first: the distribution of and rationale for license conditions are reviewed, and then the enforcement record is examined. Next, the NRC reviews are discussed. An evaluation of the evidence is contained in the following section.

The Justice Department Reviews

Justic Department-negotiated settlements are formally similar to other consent decrees. The applicant stipulates that no antitrust inconsistencies exist, and the Justice

Department stipulates that further action (i.e., NRC review) is undertaken if the conditions are not enforced.

The position of the Justice Department is that "activities under the license" include virtually every aspect of the companies' business. In 1972, Joseph Saunders, the Chief of the Public Counsel and Legislative Section of the Antitrust Division rationalized the broad interpretation:

> The output of the nuclear plant would be marketed as "firm power" by combining the plant, through the company's high voltage transmission lines, with other generating units owned by the company: the company's system will rely on the nuclear unit and vice versa to provide reserves against the risk of forced outage; the nuclear units would not be feasible but for their use in conjunction with the remainder of the company's system; and the nuclear units will therefore support and enhance the interconnection and coordination not only of the company's own generating units but also of the other systems with which the company is interconnected and coordinated. . . . A "bricks and mortar only" approach would certainly gut the antitrust review provisions of the Atomic Energy Act, (30, p. 214).

License conditions imposed to date fall into four general categories: unit access, transmission, coordination of operations and planning, and contracts. These conditions have been required of nearly all utilities undergoing 105c review. Unit access conditions require the applicant to sell a share of the nuclear power plant to municipal companies, power cooperatives or others, either contracting to provide a block of power at the cost of the nuclear power plant generation, or by selling a share in the power plant itself. Variations on this condition include selling shares in the current and future nuclear units, in only future units, or in some other generating unit owned by the applicant.

Transmission service conditions state that the applicant must allow small companies to gain access to the applicant's high voltage transmission lines. Again, there are many variations: some conditions require the applicant to "wheel" power between the various plaintiffs and other utilities within the applicant's service area, other conditions require the applicant to transmit power from a generating source outside the applicant's service area to the small distributors within its service area. Transmission service conditions are sometimes limited to the nuclear unit power sales: the applicant agrees to wheel power from the nuclear plant to the municipal (or other company) system.

The coordination conditions require the applicants to share with the small utilities some of the benefits of power pools. While the small companies rarely gain access to the pools, the conditions require that to some degree the different utilities will coordinate construction of generating units, reserve-sharing, or operating practices. One significance of coordinated operation between large utilities and small customers is due to current pricing conventions. As the Appeal Board explains in the Midland case (53), the price of emergency power under a reserve sharing agreement is less than the same power under a wholesale agreement by perhaps a factor of ten. Reserve sharing is possible only when the utilities are coordinating operations.

The contract conditions ban anti-competitive clauses in electricity sales contracts. Examples of such clauses are restrictions on resale of power, agreements not to sue the applicant for antitrust as a condition for bulk power sales, or agreements not to compete with the applicant for new wholesale customers. With the exception of unit access, the license conditions required by the Justice Department are not innovative, but fall into established judicial lines. If, as the following discussion suggests, the Justice Department follows the court precedents, no major industry innovations can be expected to ensue from the Justice Department reviews.

Contracts

Although the electric utility industry has been relatively free of antitrust prosecution, it is not formally exempt from any antitrust law which does not conflict with "overriding public interest requirements." While a legal history is beyond the scope of this paper, Areeda (1), Hubel (13) and Meeks (23) document important precedents.

The legal background is relevant to contract conditions, because the types of actions that the conditions seek to forestall are generally per se illegal under the Sherman Act, section 1 or section 2. For instance, territorial market-sharing agreements in the electric utility industry were held to be illegal collusion under section 1 in U.S. v. Florida Power Corp. and Tampa Electric Co. (USDC, Middle District of Florida, Tampa Division, Civil No. 68-297-T, settled in consent degree, 1971 Trade Cases, sec. 73, 637 (8/19/71)). Resale restrictions or agreements not to sue engender little or no controversy in court cases.

Coordination

If a group of companies coordinate to their mutual benefit but to the exclusion of other companies, and if the exclusion is motivated by predatory design, then the companies are in violation of section 1 of the Sherman Act. This principle was tested and upheld for electric utilities in the 1971 Supreme Court case involving the Gainesville Utilities. (Gainesville Utilities Department v. Florida Power Corp., 402 U.S. 515 (1971)).

Transmission Services

The legal rationale for requiring a utility to wheel for another utility comes under the "bottleneck" rationale. This doctrine essentially claims that natural monopolies are public utilities, and have common carrier status, i.e. access at a reasonable fee cannot be denied. Wheeling was first required of an electric utility in 1973, in the now famous Otter Tail Power Co. v. United States (410 U.S. 366(1973)). While the Supreme Court stopped short of declaring that transmission lines are common carriers, at least one legal scholar has interpreted the case and background precedents as unquestionably implying that they are common carriers ((33); p. 127 *et seq.*).

The importance of the case, and the reliance of the Justice Department on judicial guidelines, is confirmed in Table 5. The Otter Tail case divides licenses requiring transmission services and those not requiring transmission services. The division is significant using a chi-squared test at the .05 level.

TABLE 5 (51)

	Transmission	No Transmission
conditioned before Otter Tail	2 (14 percent)	12 (86 percent)
conditioned after Otter Tail	19 (46 percent)	22 (54 percent)

The enforcement record of Justice Department settlements suggests that the Department (or the NRC) lacks the power to enforce conditions that are not supported by the applicant. However, the evidence is sketchy and must be regarded as speculative rather than conclusive. The results of transmission and unit access conditions are considered here.

<u>Transmission</u>: Sixteen utilities were ordered to wheel power between 1971 and 1975 (51). The most recent Federal Energy Regulatory Commission (FERC) Index, supposedly complete at least through 1976, failed to indicate that any of these utilities had filed a general wheeling rate (55).[11] A cross-check is provided by the utilities Annual Reports that are filed at the FERC. 1977 Annual Reports for the sixteen companies confirmed non-existence of general wheeling services during 1977. Four Southern companies wheel South East Power Authority (SEPA) power under agreements that pre-date the AEC settlements (Georgia Power Co., Florida Power Corp., Virginia Electric Power Co., and Duke Power Co.). Public Service of Indiana wheels power for the Hoosier Energy Division, also under an old agreement. Arizona Public Service Co., Carolina Power and Light Co., and Southern California Edison all listed some transmission services. Of these, only the Southern California Edison service appeared to be related to the AEC settlement.[12] Five utilities listed no transmission

services in their Annual Reports: Detroit Edison, Illinois Power Co., Louisiana Power and Light, Mississippi Power and Light, and Wisconsin Electric Power Co. Gulf States reported wheeling for the Cajun Electric Power Cooperative. As Cajun was a party to the Gulf States case, it is likely that the wheeling service follows from the NRC settlement.

In order to clarify the situation, an attempt was made to contact representatives in the different utilities. Table 2 summarizes the combined results of the FERC information, polling industry and representative lawyers, and discussions with several antitrust lawyers who represent the municipalities in these cases.

The distinction between a general wheeling rate and the other arrangements is important. Once a general rate is filed at the FERC, any municipality can take advantage of it to transmit any purchased power (if transmission space is available). Utilities not currently seeking the service can obtain it in the future under the same terms. Alternatively, the specific rates, or rates tied to named generation units, are not flexible. As will be argued below, the latter manifestation of wheeling will not aid wholesale competition.

Unit Access

Between 1970 and 1976 nineteen applications had unit access conditions (51). By August 1977, five of the conditioned

TABLE 2: Status of Wheeling

1. further litigation	4
2. the rate has not been agreed upon	1 or 2
3. no rate was requested	
a) the nuclear plant or other wholesale supply is not yet available	2 or 3
b) specific rates applying only to named utilities and certain services exist	2 or 3
c) different arrangement reached between applicant and plaintiffs*	1
4. nuclear unit cancelled+	1
5. unknown	2
TOTAL	16

* Georgia Power Corp is offering Integrated Transmission Systems Agreements (ITSA's), in which smaller systems purchase a proportion of GPC's generation and transmission system. The ultimate goal of the ITSA policy, undertaken in response to GPC's capital raising crisis in 1974, is for each customer to own assets proportionate to the customer's peak demand. None of the customers has substituted outside power for GPC's power yet, although substitution is conceivable.

\+ The NRC settlements are only binding in conjunction with a Construction Permit. Wisconsin Electric Power Co. cancelled its application for the Koshkonong Plant before a CP was issued.

licenses indicated joint ownership with small utilities (52). Of the conditioned licenses, only four stated that unit access was to be accomplished by ownership. One of these plants had small owners; the remaining three did not. The discrepancy can be explained in several ways. First, some of the plants have been cancelled or delayed since the antitrust agreement was reached. Second, the small utilities may have decided to take advantage of the unit power purchase option rather than ownership. Third, the cost of nuclear plants has been unexpectedly high (23). The small utilities possibly reconsidered their position on ownership.

The Justice Department reviewed seventy plants prior to May 1976. Of these cases, 25 projects (36 percent) included small utility participants (52).

Joint ventures in large generating units have become increasingly popular. The trend is explained in terms of the financial situation of most major utility companies. Since 1974, the utilities' situation has varied between poor and desperate (38). Joint projects are attractive for several reasons. First (and foremost) is the issue of capital raising: municipalities have been able to contribute to cheap sources of money through their ability to float bond issues. Second, joint ventures allow risk-spreading. Small utilities absorb some of the risks of inflating construction costs, changing environmental requirements, and demand prediction. Another contributing factor is that the large utilities are exposed to deteriorating public relations. Unable to secure sites for additional plants or obtain rate-increases from public utility commissions, the utilities' reserves have been dropping (38). An extreme response is that of the Georgia Power Company. Through Integrated Transmission Systems Agreements, GPC has been shedding its municipal company load. The load previously comprised about twenty percent of the Georgia Power Company's total load.[13]

The discussion implies that unit access would probably be offered in nuclear units, antitrust reviews aside. Table 3 compares joint ventures with small utilities in nuclear plants subject to Section 105 review, to similar ownership in fossil units over 500 Mwe that are scheduled to begin operation in 1978-1980. No significant difference is found at the .05 confidence level using a chi-squared test.

TABLE 3

	without small owners	with small owners
nuclear	45 (64 percent)	25 (36 percent)
fossil*	53 (79 percent)	14 (21 percent)

* Data come from correlating an article in Electric World (39) with a FERC list of units ordered (56). The number of fossil units with small owners is larger if the Electric World table is incomplete.

Table 4 compares the number of nuclear plants with small owners that were reviewed under Section 105 with those that were not reviewed. Of the unreviewed joint venture plants, six had either been contested in other courts (e.g., the Yankee units) or would have been subject to Section 105 reviews had the primary applicant not settled with the small utilities.

TABLE 4

	w/o small owners	w/ small owners
nuclear with review	45 (64 percent)	25 (36 percent)
nuclear without review	31 (80 percent)	8 (20 percent)

The only conclusion that can be drawn from the ownership survey is that 105 reviews may have facilitated or speeded up the trend towards joint ventures. However, the reviews do not appear to have resulted in a significantly different pattern of ownership than would have existed in their absence.

The NRC Reviews

The AEC has three levels of adjudicatory panels: the Atomic Safety and Licensing Boards (a trial level), the Atomic Safety and Licensing Appeal Boards, and the Commission. By 1977, the Commission had issued only a few important antitrust policy statements, in connection with Louisiana Power and Light Company's Waterford 3 plant (NRC docket number 50-382A). The trial boards have issued Initial Decisions on antitrust in three cases: Consumers Power Company's Midland Plant (docket numbers 50-39A, 50-330A), Alabama Power Company's Farley Plant (docket numbers 50-348A, 50-364A), and the Davis-Besse and Perry plants, owned by the Toledo Edison Company and four other utilities (docket numbers 50-364 et al.). All three initial decisions were appealed to the Appeal Board. In December, 1977 the Appeal Board reversed and remanded the Midland Initial Decision. By January, 1978, no substantive appeal decisions had been issued in the other two cases.

While the Justice Department has a clear modus operandi in 105c cases -- i.e. requiring the conditions discussed above -- the Commission has not yet developed generic guidelines for Licensing Boards in antitrust cases. Consequently, Initial Decisions are ambiguous, confusing and conflicting. The most important conflicts relate to questions of the NRC's review jurisdiction and the settlement requirements. Additionally the Initial Decisions reach conflicting conclusions about what acts are to be considered in violation of section 105c.

Jurisdiction refers to the aspects of the industry that are reviewed under section 105c. The Commission considers these questions under the general heading of "nexus."

The Commissions's 1973 Waterford decision contains the most complete policy statement to date (6AEC620; CLI-73-25).

[T]he requirement in Section 105 for prelicensing antitrust review reflects a basic Congressional concern over access to power produced by nuclear facilities. The Commission's antitrust responsibilities represent *inter alia* a Congressional recognition that the nuclear industry originated as a Government monopoly and is in great measure the product of public funds. It was the intent of Congress . . . that access to nuclear facilities be as widespread as possible. . . .

At the same time, however, we must emphasize that the specific standard which Congress required for antitrust reviews -- "whether the activities under the license would create or maintain a situation inconsistent with the antitrust laws . . ." -- has inherent boundaries. It does not authorize an unlimited inquiry into all alleged anticompetitive practices in the utility industry as a whole. . . .

Delineating the scope of the above quoted standard is not a simple matter; . . . the statutory phrase does not necessarily include all the applicant's generation, transmission, and distribution of electricity. Neither is that phrase automatically limited to the construction and operation of the facility to be licensed.

In our view, the proper scope of antitrust review turns on the circumstances of each case. The relationship of the specific nuclear facility to the applicant's total system or power pool should be evaluated in every case. Denial of access to transmission systems would be more appropriate for consideration where the systems were built in connection with a nuclear unit than where the systems solely linked non-nuclear facilities and had been constructed long before application for an AEC license. While the propriety of pooling arrangements and physical interconnections could certainly be considered in appropriate cases, such matters in most circumstances could not be dealt with by this Commission where no meaningful tie exists.

. . . The Board found that, "power from Waterford will be comingled [sic] with the power from other LP & L generating facilities" (decision, p. 6). That is a truism applicable to all cases; power is not isolated. Such a finding should not be utilized to support the view that an application to construct one nuclear plant somehow authorizes an inquiry into all alleged anticompetitive practices in the electric utility industry. As we have said, alleged

> anticompetitive practices -- however serious -- which have no substantial connection with the nuclear facility, are beyond the scope of antitrust review under the Atomic Energy Act.

While this statement rejects the Justice Department's position, it fails to give clear alternative advice. The Licensing Board in the Midland case, referencing the Waterford Decision, said:

> Nexus exists between otherwise lawful activities under a license or proposed license and a situation inconsistent with the antitrust laws if, and only if, the said activities are misused so as to be a material element and substantial factor in a scheme or conspiracy, the purpose or effect of which is to cause the creation or maintenance of said situation. (NRCI-75/7 at p. 55)

Among issues that the Board dound to lack nexus are: attempts to monopolize the entire retail and wholesale markets; conspiracies to limit retail competition; and issues relating to the regional power exchange market.

The Board in the Davis-Besse/Perry case recognized that the issues excluded by the Midlands Board are the only issues ex ante that could indicate problems with the proposed nuclear power plant.

> [t]he principal issue in these proceedings is whether dominant electric companies in a relevant market area which do not compete with one another may make competitive benefits, including coordination and pooling, available to each other while denying these benefits to smaller actual or potential competitive entities within the market. This issue becomes of statutory concern to the Nuclear Regulatory Commission when the benefits to be shared or denied include power generated from proposed nuclear stations which power will have a substantial competitive impact upon the delivery and sale of electric energy in the relevant market. ((54), p. 9)

The Board then listed actions in previous years by the Applicants that were designed to eliminate small wholesale or retail competitors in their service areas. This was considered proof of a situation inconsistent with the antitrust laws.

In the Farley case, the Board decided that in view of its own jurisdiction and the nexus requirement, the relevant market was the market for wholesale power. Because of this distinction, access to the nuclear plant was only deemed necessary for the wholesale intervenor, the Alabama Electric Cooperative, since the Cooperative was the only wholesale competitor of the Applicant. Potential competitors -- e.g. other municipal companies -- were denied unit access.

> To go beyond this might be considered an unwarranted attempt to restructure the power industry at the retail distribution level, rather than fulfilling the statutory mandate of antitrust review under Section 105c. (5NRC804, at p. 961)

The midland Appeal Board reversed the Licensing Board's Initial Decision. The Appeal Board in essence finessed the issue of nexus altogether. Rather than initially limiting the scope of inquiry through establishment of nexus, the Appeal Board looked first for activities that ran counter to policies underlying the antitrust laws. The Appeal Board argued that such activities were made possible by the applicant's monopoly power in the relevant market, and that "activities under the license" -- i.e., the sole ownership and operation of the

Midland nuclear power plants -- would strengthn the applicant's monopoly position:

> We have no difficulty making the requisite finding . . . fair access to efficient, dependable and economical baseload generation is at the heart of the competitive situattion before us -- actions by Consumers have effectively prevented the small systems -- Consumers' competitors in many instances -- from turning to the most efficient sources of baseload power. The result is to give Consumers a competitive edge over the small utilities -- an edge attributable not to that company's efficient operations but to its exercise of monopoly power.
>
> Now Consumers wishes to increase its efficiency by installing large nuclear powered generating units. Manifestly, this will exacerbate the anticompetitive situations. (53, pp. 420-422)

Lack of generic guidelines raises obvious problems for litigants. Retail distributors are precluded by definition according to the Farley philosophy, while they obtained substantial relief in the Davis-Besse proceedings. Both retail and wholesale distributors failed to establish antitrust violations which met the stringent nexus test required by the Midland Board.

The inconsistencies are more marked in the attitude the Boards took towards relief. The Midland Board ruled that unit access was unnecessary for two reasons. First, the Board noted that the Applicant's 75 megawatt Big Rock nuclear power plant produces cheap power, and concluded that, "[t]here is no substantial evidence in the record of this proceeding that the smaller utilities are precluded from building their own nuclear power facilities because of size limitations." (NRCI-75/7; p. 111) Second, the Board reconciled this with the legislative desire to share nuclear power as far as possible by finding that "nuclear power is provided to both the citizens and competing utilities by the sale of power by Applicant at its retail and wholesale rates." (NRCI-75/7; p. 112) The Appeal Board overruled this decision. First, the Appeal Board stated as a matter of fact that nuclear plants are not economical in small sizes. Second, the Appeal Board found clear rationale for unit access in the legislative history of the Atomic Energy Act 1970 amendments.

The Davis-Besse decision reflected the Appeal Board's opinion, but went further to find unit access desirable as a matter of competition. License condition 9a states: "applicants shall make available to entities in the CCCT access to the Davis-Besse 1, 2 and 3 and the Perry 1 and 2 nuclear units and any other nuclear units for which Applicants of any of them shall apply for. . . . Such access . . . shall be an ownership share or unit participation . . ." ((54), p. 226). This condition was in addition to other conditions insuring that the utilities in CCCT (CAPCO Company Territories) had access to other wholesale power sales from CAPCO members.

The Midland Appeal Board did not issue license conditions. Instead, it remanded the case to the Licensing Board. In contrast to the Davis-Besse remedies and to the Appeal Board's own broad nexus definition, the Appeal Board offered ambivalent advice to the Licensing Board:

> In fashioning a remedy, we offer the Licensing Board one further caution. We believe that no type of license condition -- be it a requirement for wheeling, coordination, unit power access, or sale of an interest in the plant itself -- is necessarily foreclosed as a possible form of relief. Section 105c imposes no limits in this respect; it gives the Commission "authority . . . to issue a license with such conditions as it deems appropriate." But as broadly as it is framed, that discretion is not carte blanche. The authority to act may not be divorced from the purposes of the legislation. The Congressional goals as we understand them are these: to insure the smaller utilities a fair access to nuclear power under conditions which permit them a reasonable opportunity to make effective use of its potential, and to see that activities undertaken pursuant to Consumers' licenses neither create nor maintain an anticompetitive situation.
>
> Section 105c is one provision in a statute that regulates the use of nuclear power. Nothing on the face of the section or in its legislative history suggests that, except as reasonably necessary to achieve the goals just outlined, it may be employed as an implement to restructure the electric utility industry. In formulating "appropriate" license conditions, the Licensing Board should proceed accordingly. (53, pp. 431-432)

NRC antitrust review decisions are also inconsistent in their interpretations of the relevant laws. The Midland Board ruled that a situation inconsistent with the antitrust laws means anticompetitive conduct. It argued that a utility has no need to play Good Samaritan and that "unilateral refusals to enter voluntarily into coordination agreements with competitors per se is not illegal," (NRCI-75/7, p. 73). The Farley Board found that, "[i]nsofar as it bears upon a situation inconsistent with the antitrust laws, the 'business justification' argument of promotion of self-interest is not sufficient to immunize otherwise illegal condust," (5NRC804 at 808) including "persistent refusals to offer fair interconnection and coordination" with the municipal intervenors, (5NRC 804 at 925). The Davis-Besse Board contradicted the Midland decision by finding that "willful maintenance of monopoly power can be established by showing that 'transactions neutral on their face' have an exclusionary effect on the market, without a specific showing of anticompetitive motivation," (54, pp. 24-25). The Midland Appeal Board, again overturning the Licensing Board, argued that the 105c standard in any event addresses policies behind the antitrust laws rather than violations of the laws, and that the "per se" standard is not unique (53; pp. 35-45).

Section 4: Discussion

In the previous pages the results of different facets of the section 105c antitrust reviews were summarized. In this section it is concluded that selective enforcement suggests that the NRC is not an appropriate forum for antitrust enforcement. Rather than a pro-competitive restructuring of the industry, further consolidation is occurring. However, second best outcomes are unnecessary: as was discussed in Section 2, the industry is not a natural monopoly.

Two general conclusions can be drawn from the mass of legal jargon that comprises the NRC decisions. First, the Licensing Boards suffer from lack of expertise with the electric utility industry and the antitrust laws. Second, the review process suffers because the agency is incapable of reconciling its jurisdiction over nuclear power plant licensing with the fact that antitrust violations encompass the entire electric utility industry.

The lack-of-expertise criticism applies to the Midland Licensing Board. This Board had special problems as the chairman was killed before the Initial Decision was issued. As a result, the Board was left with a patent lawyer and an engineer. While Farley and Davis-Besse Decisions are more consonent with current legal thought on the antitrust laws, the Nuclear Regulatory Commission is essentially concerned with safety issues relating to nuclear power plants, rather than the structure of the electric utility industry. The NRC lacks expertise and the desire to enforce antitrust laws. Several conclusions follow from this observation. First, the NRC can be expected to have difficulty formulating an antitrust policy, as it tries to reconcile an industry problem with one piece of the industry. Second, the NRC can be expected to enforce section 105c so as to engender the least amount of controversy. One manifestation is the delegation of antitrust authority by the Commission to the Justice Department. The second manifestation -- which applies to the Justice Department as well -- is that vigorous antitrust enforcement is not pursued when it is counter to the interests of the applicants and municipal utilities.

The latter claim is reflected in lax enforcement of conditions, as discussed in the previous section. More importantly, the supposed conditions also support this claim. In this section the Justice Department settlement conditions are analyzed in view of the industry discussion in Section 2.

Transmission

Access by distributors to transmission networks is vital for competition at the wholesale power level of the industry. If such access is available and multiple generators exist within a small enough area, then distributors can shop around for wholesale power suppliers. Thus a general wheeling condition is not only pro-competitive, but vital for a competitively-structured industry. Limited transmission requirements do not contribute to competition as effectively.

When the applicant is only required to wheel power from the nuclear plant to the distributor, the distributor gains access to only one plant, and one that is in any event controlled by the applicant. The applicant thus remains in a monopoly position with respect to wholesale purchases. The applicant is not placed in the position of competing with other efficient generation systems for municipal or other wholesale customers.

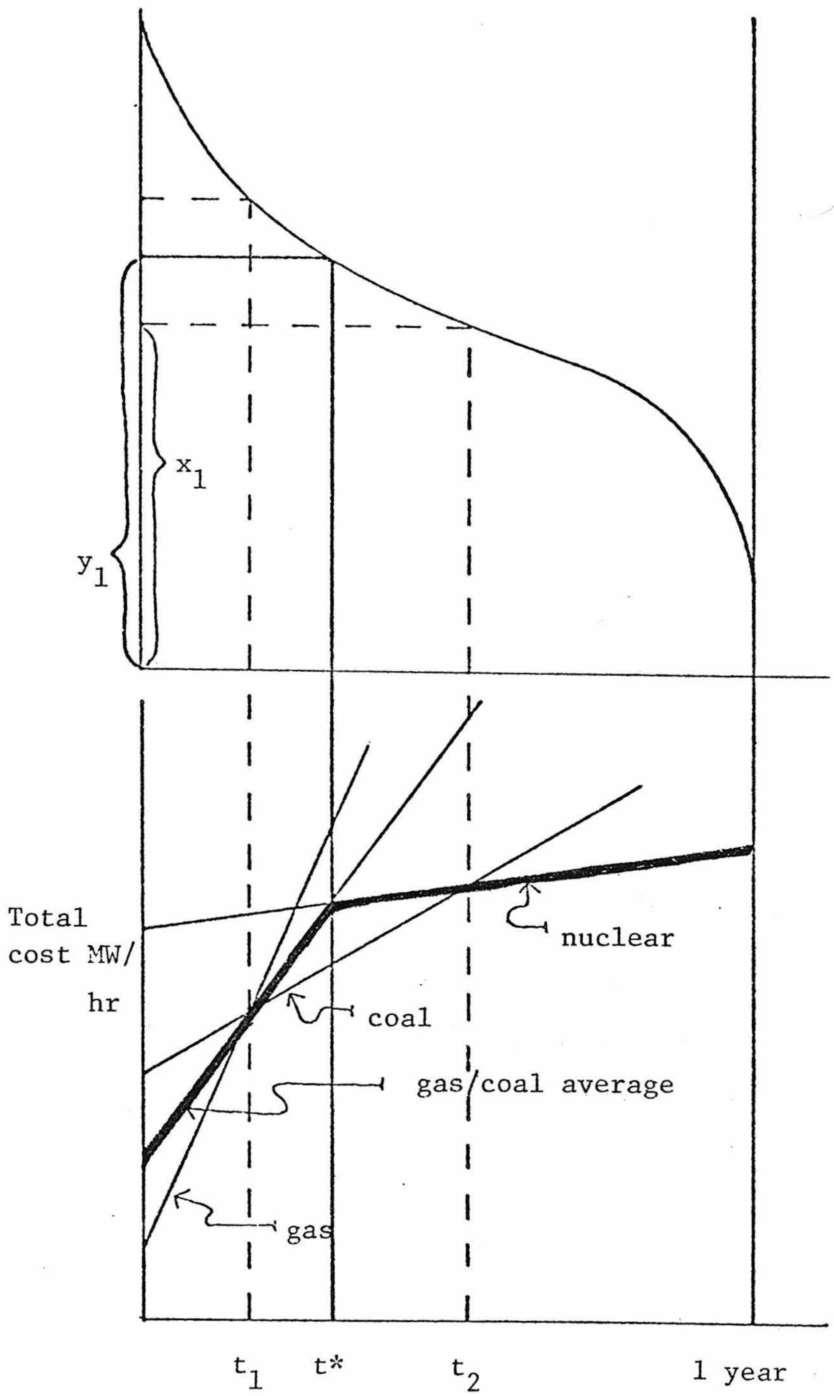
Interconnecting numerous small systems has a mixed result. If the small systems are interconnected they can coordinate operations, share reserves, and perhaps jointly construct a generating unit that captures some base-load scale economies. The small systems can then compete more effectively with the applicant. However, interconnection has at least two anticompetitive effects. First, it allows small systems to form a cartel-like organization. The extent of cartelization depends on how completely the systems pool resources. Although competition is not efficient at the distribution level -- so the systems are not "potential competitors" in the legal sense -- numerous independent distributors allow what is called yardstick competition. The performance of one distributor can be evaluated by comparison to other distributors. Cartelization removes the yardstick competition measure, which is valuable to public utility commissions and other price-setting agencies (17). Second, interconnection facilitates vertical integration by small systems. Once they have built their own generating units they no longer have the incentive to purchase such power from other companies.

In the previous section it was shown that the transmission agreements now in effect in the industry are of the second, limited type. Whether this result was intended by the Justice Department or not is irrelevant: the NRC is currently satisfied with limited transmission service offers.

Unit Access

The unit access philosophy is subject to additional criticisms. The unit access option is advantageous to small utilities. In addition to obtaining cost advantages from paying marginal cost of the least expensive bulk power option, the small utility has an assured source of power, since short-term contracts are subject to price and availability uncertainties. However, if the small utility faces a cost structure of paying marginal cost for power from nuclear generation units and system average cost for additional power, the utility has an incentive to use an inefficient generation mix. Figure 2 characterizes the situation for the system caricatured in the previous section. The extent of overinvestment ($y_1 - x_1$) in nuclear power depends on the impact nuclear has on the system

FIGURE 2



x_1
y_1
Total cost MW/ hr
nuclear
coal
gas/coal average
gas
t_1
t^*
t_2
1 year

average cost. Pro-nuclear bias is intensified since unit access affords small companies control over the source of power.

The ownership-share type of unit access condition encompasses coordination between the applicant and its wholesale customers. Thus, competition between the small and large utilities is lessened. Finally, unit access ownership arrangements afford the small utilities a direct entree into the generation sector of the industry. The total of the impacts from the unit access condition is removal of the basis for increased competition in the electric utility industry. The long term effect of shrinking the class of distribution systems is to decrease pressure for competitive generation systems.

Coordination conditions -- insofar as they go beyond pricing conventions -- contribute to decreased competitive potential for the same reasons as unit access conditions. Thus, the combined effect of the license conditions is to stabilize the current structure of the industry. While small systems are technically preserved from immediate bankruptcy, the industry remains lacking in competition.

Because the NRC is a safety regulatory agency, its interests are served by enforcing section 105c so as to further safety goals. Stabilizing the industry and increasing the attractiveness of nuclear projects further the goals. One result of the reviews is the small utilities are proponents of nuclear power. For instance, in the recent Supreme Court case, Duke Power Co. et al. v. the Carolina Environmental Study Group (57), both the American Public Power Association and the National Association of Rural Cooperatives filed friend-of-the-court briefs in support of the AEC position (58).

The NRC policy is desirable if the industry exhibits significant scale economies. However, it is argued in Section 2 that the generation sector of the industry is not a natural monopoly. Hence, preliminary evidence indicates that section 105c reviews are counterproductive to the evolution of a maximally competitive electric utility industry.

The 105c reviews currently dominate Justice Department antitrust enforcement of the electric utility industry (7). As the following story demonstrates there are indications that the reviews' impact extends beyond nuclear plants. In 1977, the California State Energy Resources Conservation and Development Commission reconsidered the demand by utilities for geothermal power leases. Previously, most geothermal power in Northern California was bought by the Pacific Gas and Electric Company, because of its monpoly control of transmission lines. But as the State Commission report notes,

> recent developments can be expected to significantly increase the number of entitites seeking to purchase geothermal energy for electric generation. These developments include: Antitrust Stipulations made by major California utilities during recent NRC power plant licensing procedures. . . . (47)

A conclusive assessment of the section 105c reviews must await future developments. However, the implications of the evidence reported in this chapter are that the reviews will at most result in stabilization of current industry structure, cartelization and perhaps investment inefficiencies. A restructured competitive industry is hindered by the current policies.

FOOTNOTES TO CHAPTER 3

1. The Energy Reorganization Act of 1974 (42 U.S.C.A. sec. 5801 et set. (1975)), established the Nuclear Regulatory Commission and assigned to it the regulatory functions previously executed by the Atomic Energy Commission. Among these functions is antitrust review. The titles "Nuclear Regulatory Commission" and "Atomic Energy Commission" are used interchangeably in this paper.

2. The alternative is power blackouts. The discussion here assumes that the "reliability" constraint imposed by government regulatory agencies is paramount, so that suppliers try to satisfy demand at all times.

3. The relative costs also depend on whether the plants are run at full or partial capacity, and how quickly they must be started up. Some plant types require a lengthy warm-up period before they can generate power efficiently. "Efficiency" of power plants is judged on the basis of watts output per BTU of fuel input. See (21).

4. Primeaux (29), a lone objector to this assessment, claims that even the obvious monopoly aspects of distribution are offset in terms of consumer prices by competition. He marshalls convincing evidence to support the claim.

5. Actual calculation procedures of reserve capacity are very complicated. See (3).

6. Oil and gas-burning steam generation units exhibit decreasing per unit electricity costs until they reach around 500 to 700 megawatts. Coal plants and nuclear plants have been built in yet larger sizes -- over 1,000 megawatts. The scale economies of the large plants have yet to be demonstrated (12), (19), but positing their existence, the plant sizes are small compared to total capacity of generating systems in the U.S. For instance, many of the firms in the Christianson-Greene sample that still have unexploited scale economies have installed nuclear units.

7. The Otter Tail case is discussed in Section 3.

8. The electricity situation is complicated by demand uncertainty. However, prices can be structured to mitigate this difficulty by allowing changes in supply, as well as demand, to effect prices. See (22).

9. Time-dependent retail prices also contribute to efficiency but are not necessary for the development of a competitive generation sector. At issue here are transactions between generation firms and local distributors.

10. The viability of such a system is demonstrated by the structure of the electric utility industry in other countries. In 1971, Philip Sporn wrote that Sweden "had integrated . . . existing and new technologies to a remarkably successful degree" (31, p. 24). He describes the Swedish electricity industry as follows:

> In Sweden about 45 percent of the annual power production is the responsibility of the State Power Board, about 40 percent is in private hands (the private power utilities of importance are about 10 in number), and the remaining 15 percent is provided by municipalities. Power exchange between all utilities is arranged on a voluntary basis and is now very far advanced. In spite of the mixed system of state, municipal, and private companies, the technical and economic operation of the system works in the same way as if there were only one utility. The state has not influenced the structure of the production and distribution systems toward any special kind of organization or to create a monopoly. The only departure from the free market system is that the state has given the Power Board the exclusive right to build and own the trunk line (i.e. transmission) systems for voltages of 230 kw and above. [31, p. 22]

11. One of the affected utilities -- Texas Utilities -- is not regulated by the FERC and is not included in any FERC filings.

12. An antitrust lawyer involved with the municipal customers of Southern California Edison told me that Southern California Edison is being sued in a judicial court for antitrust. Some of the issues are the same as those previously negotiated before the AEC. However, the parties to the new suit have stipulated against reopening the AEC settlement.

13. Personal correspondence with Milton Carlton, Esq., of Troutman, Sanders and Lockerman, Atlanta, Georgia. See also the notes to Table 1.

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