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Financial Qualifications Review of Applicants for Nuclear Power Plant Construction Permits

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Pacific Northwest Laboratory
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ABSTRACT

The NRC and its predecessor the AEC have had a regulatory requirement since 1956 that utilities seeking a construction permit for a nuclear power plant be financially qualified to construct and operate the plant. Several amendments to the requirements were made over the years including an attempt in 1982 to drop financial qualification review for electric utilities. This attempt was subsequently found invalid by a federal court. Nevertheless, financial qualification reviews consume significant amounts of NRC staff time and time at Atomic Safety and Licensing Board hearings. The analysis reported in this study was conducted to determine whether there is any empirical evidence of a relationship between a utility's financial health at the time of its construction permit application and the subsequent safety performance of the operating plant. The principal financial measures used to test for this relationship were bond rating, interest coverage ratio, debt/asset ratio, debt/equity ratio, and rate of return on equity. The principal safety measure was the long-term average of the scores assigned the utility in four key areas by the NRC under the Systematic Assessment of Licensee Performance program. The results of the analysis showed no evidence of a relationship between financial health at the time of the construction permit and subsequent safety performance.

SUMMARY

Since 1956, applicants for a construction permit (CP) to build a nuclear power plant have been required to demonstrate that they are financially qualified to construct the plant and meet related fuel cycle costs. The specific requirement appears at 10 CFR 50.33(f). Guidelines on the financial data and related information needed to establish financial qualifications for a CP are provided in Appendix C to 10 CFR 50. The information submitted by the applicant is reviewed and analyzed by U.S. Nuclear Regulatory Commission (NRC) staff prior to issuance of the CP.

In 1978, NRC initiated a rulemaking that eventually culminated in a final rule in 1982 that, among other things, eliminated financial qualification reviews for electric utility CP applicants. That rule was challenged in court and the requirement for financial qualifications review for CP applicants was ultimately reinstated pending further study. One of the issues to be examined was whether there is a demonstrable link between financial qualifications of CP applicants and plant safety.

The principal objective of the study documented in this report is to empirically investigate whether there is a relationship between the financial qualifications of a utility at the time of CP application and the subsequent safety performance of the plant.

TECHNICAL APPROACH

Three questions had to be answered in the analysis:

1. How should financial qualifications be measured?

2. How should safety performance be measured?

3. Is there a statistical relationship between the financial measures and the safety measures?

To address the first question, the financial analysis literature was reviewed and a large number of potential candidate measures of financial qualifications were identified. Potential sources of financial data were also reviewed to determine the availability of data to construct the various measures. Comprehensive data on a large number of financial parameters were then collected from two principal sources: Moody's Public Utility Manual and Standard & Poor's Compustat Services. Based on the financial analysis literature and the available data, five financial measures were selected for detailed analysis: bond ratings, interest coverage ratio (a measure of a utility's ability to repay its debt), debt/asset ratio, debt/equity ratio, and rate of return on equity.

To address the second question, prior work on quantitative measurement of safety performance was reviewed, and again a large number of candidate measures were identified. Data were obtained for such measures as:

- Systematic Assessment of Licensee Performance (SALP) scores assigned to licensees by NRC
- civil penalties assessed by NRC for safety violations
- licensee event reports (LERs)
- safety violations recorded in the NRC 766 File
- performance indicators adopted under NRC's Performance Indicator Program.

A large number of other measures such as construction deficiency reports and allegations were also considered, but were found to be unworkable within the scope of this study.

To address the third question, statistical analyses were performed to explore possible relationships between financial qualifications at the CP stage, as reflected by the five financial measures, and safety performance, as reflected by the safety measures. Average SALP scores were the primary safety measures used in the analyses.

RESULTS AND CONCLUSIONS

No evidence was found of a relationship between financial qualifications at the CP stage and subsequent safety performance. Several qualifications apply to this conclusion, however.

First, although the safety and financial measures considered in this study are the best available within the scope of this work, they are only approximate. It is conceivable that other measures could be developed in the future that might give a different result. This is considered unlikely, but the possibility cannot be completely ruled out.

Second, the population of plants and utilities considered in this study was limited. No applicant for a CP has ever been denied a permit because of inadequate financial qualifications. All of the utilities that have built nuclear plants in the U.S. have had relatively strong financial qualifications at the time of the CP. The data set used in this study included no utilities with a bond rating at the time of CP application lower than Ba based on Moody's rating system. Thus, on the basis of this study, little inference can be made about the relationship between financial qualifications and safety for utilities with weaker financial qualifications.

Third, the relationship may be obscured by other factors that have more direct or more important influence on safety, e.g., utility management or plant maintenance.

The issue of whether the financial health of a license applicant or licensee is related to safety performance is a longstanding one at the Commission. By empirically examining the relationship between financial qualifications at the CP stage and subsequent safety performance, this study addresses a portion of the issue.

ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
CFR	Code of Federal Regulations
Commission	The NRC, AEC, or both as the context requires
CP	Construction Permit
DAR	Debt/Asset Ratio
DER	Debt/Equity Ratio
DOE	U.S. Department of Energy
FR	Federal Register
GAO	U.S. General Accounting Office
ICR	Interest Coverage Ratio
IOU	Investor-Owned Utility
LER	Licensee Event Report
NRC	U.S. Nuclear Regulatory Commission
OL	Operating License
PI	Performance Indicator
PNL	Pacific Northwest Laboratory
POU	Publicly Owned Utility
RRE	Rate of Return on Equity
SALP	Systematic Assessment of Licensee Performance
TVA	Tennessee Valley Authority
USC	United States Code

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1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) and its predecessor the U.S. Atomic Energy Commission (AEC) have had a regulatory requirement since 1956 that applicants for a construction permit (CP) to build a nuclear power plant be financially qualified. An independent analysis of each applicant's financial qualifications to construct and operate the plant has been conducted by Commission staff. The principal objective of the study documented in this report is to empirically examine whether there is a relationship between the financial qualifications of a utility at the time of CP application and the subsequent safety performance of the plant.

There are two possible ways in which financial health at the CP stage may influence subsequent safety performance. The first is that poor financial health might create incentives for a utility to "cut corners" on plant construction, resulting in safety problems later. The second is that a utility in poor financial health at the CP stage may remain in poor financial condition not only during construction but also during subsequent plant operation and may have incentives to cut corners during plant operations. This condition could also affect safety.

There are also, of course, many factors that influence utilities to operate their nuclear power plants safely regardless of the utilities' financial condition. One important factor is the economic implications if a plant is forced to close because of safety problems. Closure can result in significant maintenance and repair costs and the need to purchase replacement power. If a state public utility commission determines that the closure was caused by imprudent actions by the utility, these costs may only be partially recoverable from ratepayers. Utilities would also receive unfavorable publicity from such a closure that could affect such things as their bond ratings. Finally, the NRC inspection program is designed to detect and prevent unsafe operating practices regardless of a licensee's financial position.

NRC is nevertheless interested in the question of whether there is a demonstrable relationship between financial qualification at the CP stage and subsequent safety performance for several reasons. First, if a correlation is found, the NRC may choose to devote additional resources to investigating the financial qualifications of future CP applicants[(a)] to better meet the Commission's obligation under the Atomic Energy Act to protect the health and safety of the public. Second, if no correlation is found, NRC may choose to reinitiate a rulemaking to eliminate financial qualification review for future utility CP applicants and thereby reduce the administrative time and cost of

(a) Currently there are no pending CP applications for nuclear power plants. NRC 1986 Annual Report, NUREG-1145, Vol. 3, p. 14, June 1987. (Hereafter cited as "NRC 1986.")

processing CPs.[a] The time and cost of financial qualifications review can be extensive. In the application to construct the two-unit Seabrook nuclear power station, for example, six days of testimony involving ten expert witnesses were devoted to the financial qualification issue. The transcript for this portion of the hearings contains more than 1300 pages.[b] Third, the financial qualification issue relates to a broader question of concern to NRC--whether the financial health of a utility is related to its safety performance. There are several examples of this concern. NRC has sent letters to utilities in poor financial condition expressing concern over how the condition would affect the safe operation of the utilities' nuclear plants on several occasions.[c] In addition, NRC has recently amended its regulations to require that licensees notify the appropriate Regional NRC Administrator in the event that the licensee is involved in bankruptcy proceedings. In its discussion of the rule, the Commission noted that "a licensee who is experiencing severe economic hardship may not be capable of carrying out licensed activities in a manner which protects public health and safety."[d] Finally, the NRC has expressed concern that performance incentive programs operated by public utility commissions in various states might "encourage, directly or indirectly, the adoption of actions designed to maximize measured performance at the expense of plant safety."[e] As of November 1987, performance incentives covered the construction or operation of approximately 45 nuclear power reactors owned by 30 utilities in 17 states.[f] The techniques and data developed in this report are potentially applicable to these broader concerns about the relationship between financial health and safety performance.

(a) Financial qualification review of CP applicants was eliminated in March 1982, but a February 1984 court decision invalidated the elimination. See Section 2.1.

(b) In the Matter of Public Service Co. of New Hampshire et al. (Seabrook Station, Units 1 and 2), 7 NRC 1 (1978). Nuclear Regulation Reports, Commerce Clearing House, paragraph 30,264.06 at p. 28,399.

(c) An August 17, 1987 letter, for example, was sent to the Public Service Co. of New Hampshire regarding low power testing at the Seabrook reactor. Nucleonics Week, McGraw-Hill, New York, N.Y., p. 3, September 3, 1987. A November 24, 1986 letter was sent to Gulf States Utilities Co. concerning its River Bend unit. Inside NRC, McGraw-Hill, New York, N.Y., p. 11, December 8, 1986. A letter was also sent to subsidiary companies of Middle South Utilities regarding their nuclear power plants. Inside NRC, p. 3, October 14, 1985.

(d) 52 Federal Register 1292, January 12, 1987.

(e) J. C. Peterson, Incentive Regulation of Nuclear Power Plants by State Public Utility Commissions, NUREG-1256 Vol. 1, p. 3, December 1987.

(f) Ibid., p. 1.

The specific NRC requirement that applicants for permits to construct a production or utilization facility[a] demonstrate to the Commission sufficient financial qualification to carry out construction is at 10 CFR 50.33(f). An applicant must demonstrate that it either has the necessary funds to cover estimated construction costs and related fuel cycle costs or has reasonable assurance of obtaining the necessary funds.[b] There are special requirements if the applicant is a newly-formed entity.[c] Guidelines for what financial data and related information are needed to establish financial qualifications for a CP are provided in Appendix C to 10 CFR 50. Applicants for an OL, other than electric utilities seeking an OL for a utilization facility, must demonstrate sufficient financial qualifications to operate the facility and permanently shut it down.[d] An application to transfer a license or a portion of an interest under a license must also include financial qualification information about the prospective transferee to the extent such information would be needed for the original license.[e] The evaluation of financial qualifications is conducted by the NRC Office of Nuclear Reactor Regulation.[f]

Section 189 of the Atomic Energy Act of 1954 (42 USC 2239) requires that a public hearing be held on every CP application. Hearings are conducted by Atomic Safety and Licensing Boards as authorized by Section 191 of the Act. One issue the Boards are to consider is "whether the applicant is financially qualified to design and construct the proposed facility,"[g] Similarly, a standard for issuance of a CP is a finding that the applicant is "financially qualified to engage in the proposed activity in accordance with (NRC) regulations."[h]

NRC eliminated financial qualification review for electric utilities at both the CP and OL stage in 1982.[i] The U.S. Court of Appeals for the District of Columbia, however, found that the amendment to the NRC regulations eliminating financial qualification review was not supported by the

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(a) The terms "production facility," "utilization facility," and "special nuclear material," are defined in the Atomic Energy Act of 1954 (42 USC 2014) and in the NRC regulations (10 CFR 50.2). Briefly, a production facility is a facility capable of producing quantities of special nuclear material of significance to the common defense and security. A utilization facility is a facility that is capable of using special nuclear material in quantities significant to the common defense and security. Special nuclear material is plutonium and uranium enriched in the isotope 233 or 235. A nuclear power reactor is a utilization facility.
(b) 10 CFR 50.33(f)(1).
(c) 10 CFR 50.33(f)(3).
(d) 10 CFR 50.33 (f)(2).
(e) 10 CFR 50.80(b).
(f) 10 CFR 1.61.
(g) 10 CFR 2.104(b)(i)(iii). 10 CFR 2, Appendix A (VI)(c)(iii).
(h) 10 CFR 50.40(b).
(i) 47 Federal Register 13750, March 31, 1982.

accompanying statement of basis and purpose.[a] NRC subsequently adopted a revised amendment to the regulations eliminating the requirement for electric utilities to demonstrate financial qualification for an OL.[b]

Two sections in the Atomic Energy Act provide the statutory basis for financial qualification review. Section 182(a) [42 USC 2232(a)] of the Act is the principal section dealing with the issue. It provides that:

> Each application for a license ... shall specifically state such information as the Commission, by rule or regulation, may determine to be necessary to decide such of the technical and financial qualifications of the applicant, ... or any other qualifications of the applicant as the Commission may deem appropriate for the license.

Section 103(b) [42 USC 2133(b)] is also applicable. It provides that the Commission shall issue licenses to persons:

> (2) who are equipped to observe ... such safety standards to protect health and to minimize danger to life or property as the Commission may by rule establish.

Together, these sections appear to allow the Commission the option of requesting such financial qualification information as it deems necessary to evaluate a license application.[c] The legislative history of the Atomic Energy Act provides little additional information on the intent of Congress regarding financial qualification review.[d] Two authors writing on the history of nuclear regulation, however, state that the section covering information on financial qualification was added to the Act because members of the Joint Committee on Atomic Energy believed "that an applicant who was not financially qualified might take shortcuts in construction that could affect the facility's safety."[e]

The NRC is not the only federal agency concerned about the financial health and qualifications of the industry it regulates. The Federal Aviation Administration, for example, requires that air carriers seeking certificates of public convenience and necessity provide extensive financial information in

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(a) New England Coalition on Nuclear Pollution v. NRC, 795 F.2d 168 (D.C. Cir. 1984).
(b) 49 Federal Register 35747, September 12, 1984.
(c) A federal court of appeals has stated that the Atomic Energy Act "gives the NRC complete discretion to decide what financial qualifications are appropriate." New England Coalition on Nuclear Pollution v. NRC, 582 F.2d 87, 93 (1st Cir. 1978).
(d) M. W. Losee, compiler, Legislative History of the Atomic Energy Act of 1954, U.S. Government Printing Office, Washington, D.C., 1955.
(e) G. T. Mazuzan and J. S. Walker, Controlling the Atom: The Beginnings of Nuclear Regulation 1946-1962, University of California Press, p. 75, 1984.

their applications.[a] Several studies have examined whether an airline's financial health affects its safety record. Some studies have found a weak statistical correlation, but an equal number of studies have found no relationship between an airline's financial health and its safety performance.[b]

In most foreign countries, electric utilities are publicly owned. Financial qualification review of nuclear power plant owners is therefore uncommon, but at least one country - Japan - has a financial qualification review as part of its licensing process.[c]

The analysis in this report focuses on investor-owned electric utilities. Several measures of financial qualification and safety are used to test the existence of a relationship between financial qualification and safety performance. Financial measures used in the analysis are debt to equity ratio, the interest coverage ratio, debt to asset ratio, rate of return on equity, and ratings on long term bonds. A discussion of why these measures were used is in Section 4.1. Safety measures used are results from the NRC's Systematic Assessment of Licensee Performance (SALP) program, the number of safety violations found by NRC inspectors and recorded on Form 766, and reported licensee event reports (LERs). A discussion of these safety measures is in Section 4.2. The financial and safety measures could be used to further examine the possible relationship between financial health and safety performance such as an examination of whether operating nuclear power plants may require increased regulatory attention because of financial difficulties experienced by the plants' owners.

The remainder of this report includes four sections. Section 2 provides a historical review of financial qualification requirements and some of the important principles developed in NRC and AEC licensing decisions. Section 3 discusses the relative volatility of the financial health of investor-owned electric utilities. Section 4 discusses the measures of financial qualification and plant safety used in the analysis. Section 5 discusses the statistical techniques used in the empirical examination of the relationship between financial health at the CP stage and the subsequent safety performance of the operating plant and the results of the analysis.

(a) 14 CFR Part 204.

(b) U.S. General Accounting Office, Aviation Safety: Measuring How Safety Individual Airlines Operate, GAO/RCED-88-61, pp. 4, 28, March 18, 1988.

(c) Organization for Economic Cooperation and Development, Licensing Systems and Inspection of Nuclear Installations, Paris, France, 1986.

2.0 HISTORICAL REVIEW OF FINANCIAL QUALIFICATION REQUIREMENTS

This section reviews the development of financial qualification regulatory requirements and the interpretation of the requirements in the courts and administrative proceedings. Section 2.1 chronologically reviews the development of financial qualification regulations issued by the NRC and the AEC.[a] Section 2.2 briefly reviews the interpretation of the requirements in licensing proceedings that led to principles and decision criteria for financial qualification.

2.1 CHRONOLOGICAL DEVELOPMENT OF REGULATIONS

Table 2.1 contains a chronological list of significant events following passage of the Atomic Energy Act of 1954 related to development of financial qualification regulations. This section provides supporting detail on the events.

The first financial qualification regulations were adopted by the AEC in January 1956. Under the 1956 regulations, license applicants were to state in their application their financial qualifications to engage in the proposed activities [10 CFR 50.33(f)]. In determining whether a license would be issued, the AEC considered whether the applicant was financially qualified to engage in the proposed activities in accordance with AEC regulations [10 CFR 50.40(b)]. In reviewing and evaluating the financial qualifications of a CP applicant, the principal matters examined by the AEC included:[b]

1. A review to determine the reasonableness of the applicant's estimates of costs to construct the proposed facility.
2. Analysis of the applicant's plan for financing the cost of the facility; identification of the sources of funds relied upon, e.g., external sources such as borrowings and stock subscriptions, or internal sources such as earnings or depreciation reserves.
3. Analysis of the applicant's certified financial statements and supporting schedules to address his current financial condition in relation to his financing plan.

(a) The NRC was created by Section 201 of the Energy Reorganization Act of 1974 (42 USC 5841). The Act transferred to NRC the licensing and related regulatory functions of the AEC.

(b) Letter from Harold Price, AEC Director of Regulation, to John Conway, Executive Director of the Joint Committee on Atomic Energy, January 30, 1967. The letter is reprinted in Licensing and Regulation of Nuclear Reactors: Hearings Before the Joint Committee on Atomic Energy, 90th Congress, 1st Session, Appendix 12, (1967).

TABLE 2.1. Chronology of Events Related to Financial Qualifications

Date	Citation	Event
January 19, 1956	21 FR 355	AEC issues 10 CFR 50.33(f) and 50.40(b) requiring that license applicants state their financial qualifications and actually be financially qualified.
July 4, 1968	33 FR 9704	AEC adopts more detailed information requirements for CP and OL applicants in 10 CFR 50.33(f). Appendix C to 10 CFR 50 containing guidance for the information is adopted.
January 6, 1978	In the Matter of Public Service Co. of New Hampshire, 7 NRC 20.	NRC Commissioners direct staff to initiate a rulemaking proceeding to examine the factual, legal, and policy aspects of the financial qualifications issue.
May 25, 1978	43 FR 22373	NRC issues notice initiating financial qualifications rulemaking.
April 27, 1979	SECY 79-299	NRC staff memorandum to Commissioners recommending that financial qualification review be satisfied if a utility applicant determines its own rates or has them determined by a state or federal regulatory agency and if its long term debt is rated A or higher.
August 18, 1981	46 FR 41786	NRC issues notice proposing elimination of financial qualifications review for electric utility CP and OL applicants except for possible review at the OL stage of ability to meet decommissioning costs.
March 31, 1982	47 FR 13750	NRC issues final rule eliminating financial qualification review for electric utility CP and OL applicants.

TABLE 2.1 (contd)

Date	Citation	Event
February 7, 1984	New England Coalition on Nuclear Pollution v. NRC, 727 F.2d 1127 (D.C. Circuit).	The March 31, 1982 rule is found to be unsupported by the accompanying statement of basis and purpose and is remanded to NRC.
April 2, 1984	49 FR 13044	NRC proposes to eliminate financial qualification review for electric utilities seeking an OL and to reinstate such review for CP applicants.
June 12, 1984	49 FR 24111	NRC issues policy statement that the March 31, 1982 rule will continue in effect until action is completed on the April 2, 1984 proposed rule.
August 22, 1984	Memorandum from Samuel Chilk to Herzel Plaine and William Dircks. SECY-84-329.	Commissioners Bernthal and Zech request that NRC staff consider a rulemaking to eliminate financial qualification review of electric utilities at the CP stage.
September 12, 1984	49 FR 35747	NRC adopts April 2, 1984 proposed rule.
September 30, 1985	SECY-85-316	NRC staff recommend to the Commissioners that further rulemaking on financial qualification review of electric utilities at the CP stage be discontinued.
January 30, 1986	Memorandum to Victor Stello from Samuel Chilk.	NRC Commissioners approve the recommendation for discontinuance, but request a future recommendation on financial qualifications review following the completion of litigation on the September 12, 1984 rulemaking.
July 11, 1986	Coalition for the Environment, St. Louis Region v. NRC, 795 F.2d 168 (D.C. Circuit).	The September 12, 1984 rules on financial qualification are upheld by the U.S. Court Of Appeals.

4. In those cases in which external sources are relied upon for all or part of the required funds, documentary or other evidence relating to contractual arrangements or commitments for such financing, and sometimes the contracts themselves, are also reviewed.

5. Where the applicant is a newly formed entity, the review particularly covers the capitalization of the organization and the reliability of sources of capital funds needed to construct the facility.

No formal financial qualification review criteria were ever adopted by the AEC or NRC.

In July 1968 the AEC issued a revised and more detailed version of 10 CFR 50.33(f) and also a new Appendix C to 10 CFR 50 to provide guidance for required information to establish financial qualification. The Commission noted in its supplementary information accompanying the rules that a license applicant's financial qualifications can contribute to its ability to meet its responsibilities on safety matters.

The version of 10 CFR 50.33(f) adopted in July 1968 requires a CP applicant to provide information that shows that it possesses the funds necessary for estimated construction costs or has reasonable assurance of obtaining the necessary funds. This requirement remains in effect today at 10 CFR 50.33(f)(1). OL applicants were required to demonstrate that they either had the necessary funds to cover estimated operating costs or had reasonable assurance of obtaining the funds. This requirement has been eliminated for electric utilities.

Appendix C to 10 CFR 50 was adopted to apprise license applicants of the type of financial data needed to demonstrate financial qualification. Separate guidance was provided for existing and newly formed entities and for CP and OL applications. Appendix C continues in effect today with the exception of the guidance for OL applicants. For CP applications from established organizations, the data to be provided include construction costs broken down into nuclear production plant costs, transmission, distribution, and general plant costs and the nuclear fuel inventory for the first core; the source of construction funds; and the applicant's financial statement. The NRC reserves the right to request additional information.[a]

Following issuance of the July 1968 rules, financial qualification gradually became a contested issue at many hearings on applications for a CP. One of the most important cases involved Public Service Co. of New Hampshire's application to build the two unit Seabrook nuclear power station.[b] The full NRC Commission concluded that the company and its associated applicants did have reasonable assurance of obtaining the funds necessary to build the plants

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(a) 10 CFR 50, Appendix C (IV). NRC staff typically have requested CP applicants to provide more detailed financial information than set out in Appendix C to 10 CFR 50. The request for additional financial information from the Public Service Co. of New Hampshire for the Seabrook power stations is reproduced in D. W. Stever, Seabrook and the Nuclear Regulatory Commission, University Press of New England, Appendix VII, 1980. Additional information requested included: 1) a detailed breakdown of estimated capital costs, 2) a copy of the joint ownership agreement with a detailed explanation of provisions relating to progress payments, 3) a complete schedule of the source of funds for construction expenditures, 4) copies of the most recent officer's certificate or net earnings certificate prepared in conjunction with the issuance of mortgage bonds or debentures including interest coverage calculations, 5) a detailed explanation of restrictions on the issuance of new stock and debt, 6) a detailed statement of financial statistics for the two years prior to the application, and 7) a discussion of the company's economic regulatory environment including the outcome of its most recent rate relief application and the nature of any pending rate relief request.

(b) Public Service Co. of New Hampshire, as lead applicant for a consortium of New England utilities, originally applied for the CPs in March 1973. An Atomic Safety and Licensing Board granted the permits in June 1976, 3 NRC 857. An Atomic Safety and Licensing Appeal Board affirmed the issuance of the CPs in July 1977 on a 2-1 vote, 6 NRC 33. The dissenting Board member would have reversed the Licensing Board's decision to award the CPs on the basis that the applicants did not establish that they have the financial qualifications necessary to carry out construction safely. The full NRC Commission affirmed the Appeal Board in January 1978, 7 NRC 1. The U.S. Court of Appeals (First Circuit) affirmed the Commission's decision in August 1978. New England Coalition on Nuclear Pollution v. NRC, 582 F.2d 87.

within the meaning of the regulations.[a] In its decision, the Commissioners directed NRC staff "to initiate a rulemaking proceeding in which the factual, legal, and policy aspects of the financial qualifications issue may be reexamined" (7 NRC 20). A notice initiating the rulemaking was subsequently published in the Federal Register on May 25, 1978.

After reviewing the public comments in response to the May 1978 notice and conducting its own staff analyses, NRC issued a new proposed rule on financial qualification in August 1981. The proposed rule would have eliminated financial qualification review for electric utility CP and OL applicants with the possible exception of retaining financial qualification review at the OL stage for the cost of permanently shutting down a facility and maintaining it in a safe condition. After reviewing the public comments on the August 1981 proposal, NRC adopted a final rule on March 31, 1982 which eliminated entirely financial qualification review for electric utilities seeking a CP or OL. The supplementary information in the March 31, 1982 Federal Register notice states that the basis for the rule was a determination by NRC that elimination of financial qualification review would reduce the effort and resources devoted to this issue during licensing without reducing the protection of the public health and safety. Reasons for this determination cited in the August 1981 and March 1982 Federal Register notices included:

1. A finding that regulated electric utilities or publicly owned utilities able to set their own rates will be able to recover the costs needed for safe construction and operation of a nuclear power plant; and

2. A determination that the NRC's inspection and enforcement process will adequately protect public health and safety.

In February 1984, the March 31, 1982 rule issued by NRC was found to be invalid by the U.S. Court of Appeals (District of Columbia Circuit) because it was not supported by a statement of basis and purpose demonstrating a rational connection between the facts found and the choice made.[b] The NRC subsequently issued a policy statement in June 1984 concluding that the decision did not have the effect of restoring the financial qualification regulations in effect prior to March 31, 1982.

(a) For a variety of reasons, construction costs for the two Seabrook units escalated sharply. The units were originally estimated to cost less than $2 billion. Unit 2 was canceled in November 1986. Unit 1 was completed in July 1986, but has yet to receive an OL. Its final cost is expected to be on the order of $5 billion. The financial condition of the Public Service Co. of New Hampshire became sufficiently weak that it filed for protection from its creditors under Chapter 11 of the Federal Bankruptcy Code in January 1988.

(b) New England Coalition On Nuclear Pollution v. NRC, 727 F.2d 1127, 1131 (1984).

In response to the February 1984 decision by the court of appeals, NRC issued a new proposed rule on April 2, 1984 eliminating financial qualification review for electric utility OL applicants and reinstating such review for CP applicants pending further study. The proposed rule was made final on September 12, 1984. The basis for the rule was a finding by NRC that the rate-making process assures that funds needed for safe nuclear power plant operation will be made available to regulated electric utilities and electric utilities able to set their own rates. As an aside, NRC also noted that there is no proven link between financial qualification review and safe operation of nuclear power plants. The final rule published on September 12, 1984 was upheld by the U.S. Court of Appeals (District of Columbia Circuit) in July 1986.

The September 1984 rule added several provisions to 10 CFR 50.33(f). One provision requires CP applicants to submit estimates of the total construction cost and related fuel cycle costs and indicate the sources of funds to cover the costs.[a] Another provision provides that CP applications from newly formed entities are to include information on the legal and financial relationship the entity has with its owners and the financial ability of the owners to meet any contractual obligation to the newly formed entity.[b]

2.2 FINANCIAL QUALIFICATION PRINCIPLES AND DECISION CRITERIA DEVELOPED IN NRC/AEC ADMINISTRATIVE DECISIONS

The NRC and the AEC evaluated the financial qualifications of utility CP applicants from 1956 through 1978.[c] They evaluated the financial qualifications of utility OL applicants from 1958 through the March 31, 1982 rule eliminating financial qualification review for utility OL applicants.[d] Altogether more than 200 license applications from electric utilities have been reviewed by the NRC and AEC for financial qualification. The NRC has also acted on petitions under 10 CFR 2.206 to institute proceedings to modify,

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(a) 10 CFR 50.33(f)(1).
(b) 10 CFR 50.33(f)(3).
(c) The first CPs for commercial nuclear power plants were issued in May 1956 to Consolidated Edison Co. for the Indian Point Station Unit 1 and to Commonwealth Edison Co. for the Dresden Nuclear Power Station Unit 1. U.S. Department of Energy (DOE), U.S. Central Station Nuclear Electric Generation Units: Significant Milestones, DOE/NE--0030/12, May 1985. (Hereafter "DOE 85"). The most recent CP was issued to Long Island Lighting Co. and New York State Electric & Gas Corp. in January 1979 for the Jamesport Nuclear Power Station, Units 1 and 2. These units were subsequently canceled in January 1980. M. B. Spangler, Reactivation of Nuclear Power Plant Construction Projects, NUREG-1205, Table 1, July 1986. NRC Office of State Programs, Owners of Nuclear Power Plants, NUREG-0327 Rev. 3, pp. 5, 6, November 1982.
(d) The first OL application for a commercial nuclear power plant was received by the AEC in June 1958 from Commonwealth Edison Co. for its Dresden Nuclear Power Station, Unit 1. DOE 85.

suspend, or revoke existing CPs and OLs because of alleged lack of financial qualifications.[a] In all of these reviews, no electric utility has been found to be financially unqualified to receive or maintain a license.[b] Some of the important principles and criteria developed by the Commission and the licensing boards for reviewing financial qualifications are discussed in this section.

One of the early principles established was that financial qualification review is conducted to further the Commission's regulation of the radiological safety aspects of nuclear power plant construction and operation.[c] The Commission does not need to inquire into the economic soundness of a utility's investment in a nuclear power plant.[d] Such an economic inquiry can be conducted by states, however.[e] One corollary to this principle is that the holder of an OL that is undergoing financial difficulties is not subject to an enforcement action unless there is evidence of problems that could affect public health and safety.[f] A second corollary is that a decision by a CP holder to slow or halt construction because of financial constraints is not subject to an enforcement action unless there is evidence that the constraints have had an adverse impact on safety or are substantially likely to adversely affect public health and safety.[g]

The Commission interpreted the phrase "reasonable assurance" in 10 CFR 50.33(f)(1) in the Seabrook case. The Commission stated that the phrase:

> "does not mean a demonstration of near certainty that an applicant will never be pressed for funds in the course of construction. It does mean that the applicant must have a reasonable financing plan in the light of relevant circumstances."[h]

Finally, for a plant with multiple owners, a finding that a minor owner is only marginally qualified will not make the CP applicants as a group

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(a) See, for example, In the Matter of Public Service Co. of New Hampshire et al., 10 NRC 703 (1979); In the Matter of Petition Concerning Financial Qualifications of Nuclear Power Plant Licensees, 14 NRC 1807 (1981); and In the Matter of Maine Yankee Atomic Power Co., 18 NRC 157 (1983).
(b) Coalition for the Environment, St. Louis Region v. NRC, 795 F.2d 168, 171 (D.C. Cir. 1986).
(c) In the Matter of Public Service Co. of Colorado, (Fort St. Vrain Nuclear Generating Station), 4 AEC 154 (1968).
(d) Ibid. See also, Power Reactor Development Co. v. Electrical Workers, 367 U.S. 396, 413 (1961).
(e) Pacific Gas and Electric Co. v. State Energy Resources Conservation and Development Commission, 461 U.S. 190 (1983).
(f) In the Matter of Maine Yankee Atomic Power Co., (Maine Yankee Atomic Power Station), 18 NRC 157 (1983).
(g) In the Matter of Cleveland Electric Illuminating Co. et al., (Perry Nuclear Power Plant, Units 1 and 2), 22 NRC 635 (1985).
(h) In the Matter of Public Service Co. of New Hampshire et al., (Seabrook Station, Units 1 and 2), 7 NRC 1, 18 (1978).

financially unqualified. In the Millstone 3 case, one participant owning less than 4% of the plant was found to have only marginal financial qualifications. Nevertheless, the applicants as a whole were found to be financially qualified.[a]

(a) In the Matter of Northeast Nuclear Energy Co., (Millstone Nuclear Power Station, Unit No. 3), 8 AEC 187, 634 (1974).

3.0 VOLATILITY IN THE FINANCIAL HEALTH OF INVESTOR-OWNED ELECTRIC UTILITIES

The issue of the volatility in the financial health of electric utilities is related to the question of whether financial qualification review for CP applicants is worthwhile. If financial health is highly volatile, financial qualification review may have reduced value, especially considering that the elapsed time from CP issuance to plant retirement is likely to be on the order of 50 years.[a] If the financial health of electric utilities is relatively unvolatile, the potential value of financial qualification review is enhanced.

Selected financial statistics for the electric utility industry as a whole are shown in Table 3.1. The data show that the industry has generally been in declining financial health since about 1965. The amount of operating income available for debt repayment as measured by the interest coverage ratio has been declining. The market/book ratio has also been generally declining, although it has improved in recent years. The market/book ratio reflects investor expectations about the earning capability of the firm. It is closely related to a firm's return on equity.[b] If investors believe that future returns on equity will be comparable to returns available on alternative investments, the market/book ratio will be about one.[c] A market value/book value ratio less than one indicates that earnings per share of stock are likely to be reduced by issuance of new common stock, thus diluting the earning power of existing shareholders' stock. Finally, the quality ratings of long term debt peaked around 1965 and have been gradually declining since then, although there has been recent improvement.

Even though the financial health of electric utilities has generally declined over the last 20 years, utility bankruptcies have been rare since the depression years of the 1930s. Between 1929 and 1936 there were 53 utility bankruptcies involving $1.7 billion in outstanding securities.[d] Since that period the only investor-owned electric utility (IOU) that has filed for bankruptcy is the Public Service Co. of New Hampshire. Three publicly owned utilities (POUs), all involving rural electric cooperatives, have filed for reorganization under Chapter 11 of the Bankruptcy Code. The Orcas Power & Light Co. serving northwest Washington State filed in 1982 as a result of financial problems created by its involvement in the nuclear power plant construction

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(a) The time from CP issuance to plant fuel load averages about 8 years. M. A. Radlaver et al., "Nuclear Construction Lead Times: Analysis of Past Trends and Outlook for the Future," The Energy Journal, pp. 45, 61, January 1985. Operating licenses are issued for a term of 40 years. 10 CFR 50.51.

(b) L. S. Hyman, "Utility Stocks in 1967-72: A Tale of Woe," 93 Public Utilities Fortnightly 23, 27, February 28, 1974.

(c) U.S. General Accounting Office, Analysis of the Financial Health of the Electric Utility Industry, GAO/REED-84-22, p. 7, June 11, 1984.

(d) B. Robinson, "In Re Blackacre Power and Light: The Bankruptcy of a Public Utility," 50 Albany Law Review 641, Spring 1986.

TABLE 3.1. Selected Financial Statistics For Investor-Owned Electric Utilities

Year	Interest Coverage Ratio[a]	Market/Book Ratio[b]	Percentage of Long Term Debt Rated Aaa or Aa[c]
1945	4.2x	99%	
1946	4.6	125	52%
1947	4.6	107	
1948	4.2	97	
1949	4.2	100	
1950	4.2	107	52
1951	4.0	108	
1952	4.1	114	
1953	3.8	121	
1954	3.8	139	
1955	3.9	151	59
1956	3.9	146	
1957	3.7	139	
1958	3.4	158	
1959	3.4	175	
1960	3.4	177	74
1961	3.4	220	
1962	3.5	211	
1963	3.6	227	
1964	3.6	228	
1965	3.7	235	89
1966	3.6	200	
1967	3.4	190	
1968	3.1	174	
1969	3.0	160	
1970	2.7	127	78
1971	2.6	129	
1972	2.6	117	
1973	2.6	100	
1974	2.4	67	
1975	2.4	69	49
1976	2.4	79	
1977	2.4	87	
1978	2.4	80	
1979	2.4	75	

TABLE 3.1. (contd)

Year	Interest Coverage Ratio[a]	Market/Book Ratio[b]	Percentage of Long Term Debt Rated Aaa or Aa[c]
1980	2.3X	66%	37%
1981	2.3	67	
1982	2.4	77	
1983	2.5	89	
1984	2.5	85	
1985	2.3	101	41
1986	2.4	125	40

(a) $$\text{Interest Coverage Ratio} = \frac{\text{Pretax Operating Income}}{\text{Interest Expense on Long-Term Debt}}$$

(b) $$\text{Market/Book Ratio} = \frac{\text{Average Common Stock Price}}{\text{Book Value of Common Stock}}$$

where book value is the amount of money per share that common stockholders have invested plus retained earnings.

(c) Based on a sample of 73 utilities and bond ratings prepared by Moody's Investors Service Inc. Bonds rated Aaa are considered to be the best quality, carrying the smallest degree of investment risk. Bonds rated Aa are judged to be of high quality by all standards.

Sources: Columns 1 and 2

1. Leonard S. Hyman, America's Electric Utilities: Past, Present and Future, Public Utility Reports, Inc., Arlington, Virginia, Tables 13-7 and 14-5, 1988 (hereafter "Hyman").
2. Energy Information Administration, DOE, Financial Statistics of Selected Electric Utilities 1985, DOE/EIA-0437(85), Table 6, February 1937.

Column 3

1. Hyman, Table 28-3.

program of the Washington Public Power Supply System. The case was voluntarily dismissed a year after the filing.[a] In 1985 the Wabash Valley Power Association, Inc., a group of 24 electric cooperatives, filed for reorganization as a result of participation in the canceled Marble Hill nuclear power plant project in Indiana.[b] The case was still in bankruptcy court in September 1987.[c] Finally, the Eastern Maine Electric Cooperative filed under Chapter 11 in August 1987 as a result of its involvement in construction of the Seabrook nuclear power stations.[d]

A complicating factor in evaluating the volatility of financial health is that the future financial health of a utility can be significantly impacted by construction of a nuclear plant. The impact can be especially great for relatively small utilities where the investment in the nuclear power plant will represent a substantial portion of the utilities' assets. A noteworthy example is Public Service Co. of New Hampshire, whose pretax gross plant investment in the Seabrook nuclear power stations represent 70% of the company's assets.[e] Moreover, there is empirical evidence that utilities with nuclear power plants have overall lower bond ratings and have market to book value ratios less than nonnuclear utilities.[f]

It is difficult to draw firm conclusions about the impact of financial health volatility on the desirability of financial qualifications review. As an industry, the financial health of investor-owned electric utilities has generally been declining. Bankruptcies remain, however, a very rare event in the utility industry.

(a) E. D. Flashen and M. J. Reilly, "Bankruptcy Analysis of a Financially Troubled Electric Utility," 22 Houston Law Review 965, July 1985.
(b) Ibid.
(c) The Wall Street Journal, September 1, 1987, p. 8, col. 3.
(d) Ibid.
(e) Merrill Lynch Capital Markets, New York, N.Y., "Electric Utility Nuclear Construction," p. 9, May 1987. Other IOUs listed in the report with 50% or more of their assets invested (pretax) in nuclear power plants that have yet to receive an OL are Illinois Power (67%), Long Island Lighting (66%), El Paso Electric (62%), Toledo Edison (55%), Central Power & Light (54%) and Gulf States Utilities (50%).
(f) R. J. Nesse, The Effect of Nuclear Ownership on Utility Bond Ratings and Yields, PNL-4175, February 1982. Joseph P. Tomain, Nuclear Power Transformation, Indiana University Press, pp. 86, 87, 1987.

4.0 MEASURES OF FINANCIAL HEALTH AND SAFETY PERFORMANCE

This section discusses the measures of financial health and safety performance used for this study. Financial measures are discussed in Section 4.1. Safety measures are discussed in Section 4.2.

4.1 MEASURES OF FINANCIAL HEALTH

The measures of utility financial health of interest for this study are measures of long term solvency. As noted in Section 3, the period of time between NRC's decision on whether to issue a CP and final shutdown of a nuclear power plant can be on the order of fifty years. No measure of financial solvency is reliable for that lengthy period. Consequently, the best available measures that indicate long term solvency are needed. For this analysis five measures are utilized:

- rating on senior long term bonds
- interest coverage ratio
- debt/asset ratio
- debt/equity ratio
- rate of return on equity.

The U.S. General Accounting Office (GAO) examined potential measures to indicate the financial health of the electric utility industry in a 1984 study.[a] It found that although there is no universally accepted definition of financial health, to remain financially healthy a firm needs the ability to: 1) survive adversity, 2) attract capital, and 3) maintain solvency and profitability.

GAO identified and examined the following 17 financial measures that are used by the investment community and others to analyze the financial health of investor-owned electric utilities:

- rate of return on common equity
- market to book value ratio
- bond ratings
- interest coverage ratio

(a) U.S. General Accounting Office, Analysis of the Financial Health of the Electric Utility Industry, GAO/RCED-84-22, June 11, 1984.

- debt to equity ratio
- internal generation of funds
- load factor
- dividend as a percentage of book value
- rate of return on net plant investment
- allowance for funds used as a percentage of income
- effective tax rate
- price earnings ratio
- capital expenditures as a percentage of total capital
- construction work in progress as a percentage of net plant in service
- capital employed per kilowatt hour
- production cost per kilowatt hour
- dividend payout.

For its study GAO wanted financial measures that reflected both current and long term prospects for a utility and that were broad and comprehensive in nature. It selected the first three measures from the preceding list as best meeting these criteria.

Bernstein states that earnings and earning power are among the most important and reliable measures of long term financial strength.[a] He also notes that the higher the proportion of a firm's debt, the larger the fixed charges of interest and debt repayment, and consequently the greater the likelihood of insolvency during long periods of declining earnings or other adversities. Bernstein suggests the following financial measures for the analysis of a firm's long term solvency:

- ratios of short term, long term, and total debt to total equity capital
- ratio of earnings to fixed charges
- ratio of funds provided by operations plus fixed changes to fixed charges

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(a) L. A. Bernstein, Analysis of Financial Statements, Dow Jones-Irwin, Homewood, Illinois, Ch. 5, 1984 (hereafter "Bernstein").

• ratio of working capital provided by operations to total debt and preferred stock.

Clearly there are a variety of financial indicators that could be used as measures of long term financial health. The five measures noted at the beginning of Section 4 were selected because they appear to provide broad and comprehensive coverage, because data to compute the measures were available, and because they are supported by the financial literature. A brief description of each measure follows.

Bond Ratings

Bond ratings for the utilities used in the analysis were generated by Moody's Investors Service Inc. as reported in the Moody's Public Utility Manual. Ratings used are for the bonds with the most senior position (i.e., first priority on assets) in the debt hierarchy of the utility. Moody's rates bonds from C to Aaa where Aaa is the highest investment quality.

In preparing ratings, we converted these ratings to a numerical scale according to the following schedule:

Numerical Value	Moody's Rating
9	Aaa
8	Aa
7	A
6	Baa
5	Ba
4	B
3	Caa
2	Ca
1	C

Moody's uses both historical financial statistics and its own appraisal of the long-term risks facing a firm. Among the specific factors considered in setting a rating are the extent of the issuing firm's asset protection, the firm's financial resources, earning power, management, the nature of the industry, and specific provisions in the debt security.[a]

(a) Bernstein, p. 186.

Interest Coverage Ratio

The interest coverage ratio used in this report is defined as:

$$\frac{\text{total operating income before taxes}}{\text{total interest expenses}}$$

The source of the financial information to compute this ratio for each utility was a custom set of annual financial statement data prepared for PNL by Standard & Poor's Compustat Services, Inc. based in Englewood, Colorado. This data set was also used to compute the values for the remaining three financial measures listed below.

Debt/Asset Ratio

The debt/asset ratio was computed according to following formula:

$$\frac{\text{Total Long-Term Debt}}{\text{Total Net Utility Plant Assets}}$$

Net utility plant reflects historical cost less accumulated depreciation.

Debt/Equity Ratio

The debt/equity ratio was computed as:

$$\frac{\text{Total Long-Term Debt}}{\text{Total Common Equity}}$$

Rate of Return on Equity

This ratio was computed as:

$$\frac{\text{Total Operating Income}}{\text{Total Common Equity}}$$

4.2 MEASURES OF SAFETY PERFORMANCE

A fundamental objective of the NRC is to ensure that nuclear power plants are constructed and operated in a manner consistent with the public health and safety. The relative safety performance of particular power plants is difficult to capture, particularly in the absence of a significant safety related event. Nevertheless, there are a number of possible measures that can be used to capture safety performance. These measures include:

- results from the Systematic Assessment of Licensee Performance (SALP) program
- civil penalties assessed by NRC for safety violations
- licensee event reports (LERs)
- safety violations recorded in the 766 file
- results from the NRC performance indicator program
- construction deficiency reports.

A description of each of the preceding possible safety measures follows.

4.2.1 Systematic Assessment of Licensee Performance

NRC initiated the SALP program in 1979 following the accident at Three Mile Island Nuclear Station Unit No. 2 as a formal, in-depth evaluation of licensee performance. The program was developed to aid in the identification of those licensees that were more likely than others to have safety problems and to provide a rational basis for allocation of inspection resources. SALP reviews are performed by the NRC regional offices every 12 to 18 months on average and scores are assigned to individual plants in a number of areas. For operating plants, scores are assigned for plant operations, radiological controls, maintenance, surveillance, emergency preparedness, fire protection, security, outages, quality programs and administrative controls affecting quality, licensing activities, and training and qualification effectiveness. For plants under construction scores are assigned for soils and foundations; containment, safety-related structures, and major steel supports; piping systems and supports; safety-related components; auxiliary systems; electrical equipment and cables; instrumentation; design-engineering; quality assurance and administrative controls affecting quality; and licensing activities. For this report we have focused on SALP scores for operating plants.

The SALP scores are intended to represent the best assessment that the NRC staff can make of overall safety performance of each plant in each of the functional areas. Plants are either scored as 1 (high level of performance - can have reduced NRC oversight), 2 (satisfactory - normal oversight required), or 3) (minimally acceptable level - requires increased NRC attention). Most scores are 2, which signifies satisfactory performance. SALP scores are recorded in the NRC document Historical Data Summary of the Systematic Assessment of Licensee Performance, NUREG-1214, which is updated semiannually.

The SALP process involves a review of the previous year's LERs, inspection reports, enforcement history, and licensing issues. Also important are the evaluations by NRC's resident and region-based inspectors, licensing project managers, and senior regional managers, all of whom are to some degree familiar with the plant's performance.[a] The performance rating provides an integrated, comprehensive assessment as to how the licensee's management directs, guides, and provides resources for the assurance of safety. It is thus the most comprehensive of the measures of safety performance examined in this study.

For purposes of this study, the SALP evaluations have the limitation that there is no overall plant score. We consequently elected to use two summary measures: the average score for all 11 functional areas for operating plants, and the average score for four of the most important functional areas (plant operations, maintenance, surveillance, and quality programs and administrative controls affecting quality).

4.2.2 Civil Penalties Data Set

One of the enforcement actions sometimes taken by the NRC against utilities that violate regulatory requirements is to issue monetary penalties. These civil penalties may be imposed for violations of: 1) certain specific licensing provisions of the Atomic Energy Act or supplementary NRC rules or orders, 2) any requirement for which a license may be revoked, or 3) reporting requirements under section 206 of the Energy Reorganization Act. Civil penalties are closely related to the more severe violations in the 766 file (see Section 4.2.4). Violations of regulatory requirements are classified by NRC into five levels of severity with I being most severe and V least severe. Generally, civil penalties are imposed for Severity Level I violations and for Severity Level II violations if there are no mitigating circumstances. They are considered for severity Level III violations and may be imposed for Level IV violations that are similar to previous violations for which effective corrective action was not taken. The size of the civil penalty is also scaled to the gravity of the incident; thus, recommended fines data have an advantage over the 766 file in that the data emphasize violations that the NRC considers to be important. Finally, the general context of the incident is included in the fines data since the NRC has the option of increasing or decreasing the base amount of the civil penalty up to a maximum of $100,000 per day for prompt or lax reporting (plus or minus 50%), for prompt or minimally acceptable corrective action (plus or minus 50%), for prior performance in the area of concern (plus or minus 100%), or for multiple occurrences (up to plus 50%).

NRC's general statement of policy and procedure for enforcement actions appears in Appendix C to 10 CFR Part 2. The statement was approved by the Commission on September 4, 1980 at which time the Commission directed the staff to implement the policy as interim guidance. The policy was published in the Federal Register on March 9, 1982.[b] The policy has subsequently been amended several times. A summary of enforcement actions, including information on monetary penalties, is contained in the quarterly NRC publication Enforcement Actions: Significant Actions Resolved, NUREG-0940.

(a) NRC 1986, p. 115.
(b) 47 Federal Register 9987.

4.2.3 Licensee Event Reports

The licensee event report (LER) system is covered by regulations at 10 CFR 50.73. The system applies to holders of nuclear power plant operating licenses. Licensees are to submit an LER within 30 days for all reportable events listed at 10 CFR 50.73(a) In addition, the technical specifications for each nuclear plant include a section on reporting requirements detailing the types of operational and environmental events that must be reported by the licensee to the NRC. Reporting requirements therefore can vary significantly from plant to plant. For this reason, it is generally recommended by the NRC that the counts of LERs not be used in their raw form for comparisons of the operating records of individual plants and utilities. The situation has improved since 1984, when additional clarification of reporting rules was provided by NRC.[a]

The raw LER reports were summarized during the years 1973 through 1982, first by the AEC, and later by the NRC and the Oak Ridge National Laboratory in an annual report called Nuclear Power Plant Operating Experience. We also obtained counts of LERs for all operating plants for the period from 1980 to 1987 from the Sequence Coding and Search System (SCSS), a computerized storage and retrieval system for LER data maintained under contract to the NRC by the Nuclear Operations Analysis Center at Oak Ridge, Tennessee. The coverage of the LERs is quite comprehensive, including reports of incidents or events that involve system, component, or structural failure; malfunctions; personnel errors; design deficiencies; management deficiencies; and other matters related to plant operational safety. The information contained in the LERs conveys primarily negative aspects of plant operations, such as shutdowns required by the plant's technical specifications, actuations of safety features, and procedural errors and inadequacies. A large number of reported events of one type (indeed, most events reported) may not be significant in terms of safety, whereas a single event of another type may be much more important in its safety implications. In the absence of some kind of weighting or categorization according to safety significance, LER counts are at best a crude indicator of safety performance.

4.2.4 Office of Inspection and Enforcement Reports (766 FILE)

The NRC generates a file on every safety violation found by NRC safety inspectors. Violations are recorded on forms 766 and 766A. These forms are an internal NRC management tool designed to capture, maintain, and report statistical and planning data concerning each inspection, investigation, or inquiry at licensees' places of business. Among other data, each form has recorded on it the NRC docket number that uniquely identifies the facility of interest (in the current study, the individual reactor unit), the procedure being examined at the facility, the number of staff hours devoted to the investigation, inspection, or inquiry, and the severity of the fault found in the examined

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(a) NRC, Annual Report, NUREG-1145, Vol. 2, p. 61, June 1986.

procedure. Each deviation from correct procedures that has a severity level assigned to it is also assigned to an activity area such as reactor operations, facility construction, safeguard, etc.

There were significant limitations to using the 766 file data in the present study. The first and perhaps most important is that the severity level coding scheme has changed significantly over time, making comparability between codes assigned in early years difficult to compare with those assigned later. For example, in 1979 the previous system of assigning a severity of 1, 2, 3, or D (deviation) was changed to a system in which severity was rated 1, 2, 3, 4, 5, 6, or D. In addition the frequency of inspections increased. The system was changed again in 1984 to a 1, 2, 3, 4, 5, or D system.

The other major limitation of the 766 file data is that, although the system dates from the early 1970s, resident inspectors were assigned to nuclear power plants beginning in the 1977-1978 time period. This institutional change probably affected both the number of reports filed and the type of severity codes assigned.

Although data are theoretically available from the 766 file back to 1975, the data are sufficiently detailed and extensive that it would be very costly in terms of time and computer resources to sort these data so that they could be used in this study. We elected not to sort the 1975-1980 data, because the effort and cost did not appear commensurate with the value of data, given the availability of alternative safety measures.

4.2.5 Performance Indicator Program

The Performance Indicator Program emerged from a long-standing NRC effort to characterize trends in performance at nuclear power plants. The NRC Interoffice Task Group on Performance Indicators in a 1986 policy issue paper (SECY-86-144) identified a number of NRC staff groups that had been monitoring various performance indicators (PIs) for some time and to varying degrees. For example, some of the regional offices had used indicators such as reactor trips, engineered safety feature actuations, entry into limiting conditions for operations, and unplanned exposures and radioactive releases as support for arriving at SALP evaluation scores. From this review of PIs, a series of steps was identified in the paper for a systematic development process. The objective of the process was to develop a set of validated PIs that would correlate well with SALP evaluations and nuclear safety and regulatory performance and that would be available on a more frequent basis than SALP evaluations. To integrate the PIs into a system, the task group developed a logic model outlining the relationship of the PIs to safety. An initial set of 17 indicators was eventually pruned down to the current set of 7 indicators. This set includes automatic scrams while the plant is critical, safety system actuations, "significant events," safety system failures, forced outage rate, equipment forced outages per 1000 critical hours, and collective radiation exposures.[a] For this study, data were available on the 7 PIs from 1984 through the second quarter of 1987.

There are several features of the PIs that limit their usefulness for this study. For example, the indicators as a group provide an excellent appraisal of individual plant safety performance in several dimensions; however, there is no over-all safety performance score for the plant. This problem could be alleviated to some degree in the following ways: 1) relate each PI separately to the financial data; 2) relate an average score to the data on financial performance; and 3) relate the PI most closely associated with overall SALP score with the relevant financial data.

A second limitation of the PI data for this study is that the available time series extend back in time only to 1984. This means that there is no performance indicator history for either the construction period or early operating period for the majority of today's nuclear power plants.

4.2.6 Construction Deficiency Reports [50.55(e) Reports]

Reports on construction deficiencies found at nuclear power plants that are under construction are to be submitted to the NRC by CP holders within 30 days.[b] Potentially this is a very useful source of information on the safety-related performance of CP holders during nuclear power plant construction. The 50.55(e) reports are available in a computer data base beginning in April 1984.[c] Prior to that date, it is theoretically possible to retrieve a count of 50.55(e) reports filed for each reactor in each year, but it is quite difficult to do so since it is necessary for the NRC Document Control System contractor to query the document control system computer to check every record in the system and allocate it to the correct nuclear facility, then accumulate all the records allocated to each facility.[d] Because of the time and cost involved, and because only the most recently constructed plants are on the computer system, we chose not to obtain this data base.

(a) NRC 1986, pp. 140-141.
(b) 10 CFR 50.55(e).
(c) Personal communication with Ms. Susan Pagan, Techna Associates (NRC document control system contractor), September 29, 1987.
(d) See E. G. Silver, The Data Base User's Manual, NUREG/CR-4011, September 1984.

5.0 EMPIRICAL ANALYSIS

In this section, data on utility financial qualifications at the time of the CP and on subsequent plant safety performance are statistically examined to determine whether there is empirical evidence of a relationship between financial qualifications at the CP stage and safety. If a relationship is found, this will lend support to the argument that NRC should continue to review financial qualifications of CP applicants. If on the other hand there is no evidence of a relationship, the need for continued review of financial qualifications at the CP stage could be questioned. It should be stressed at the outset, however, that the empirical evidence is only one of a number of factors to be considered in assessing whether to continue financial qualifications reviews.

The analysis consists of three major steps:

1. Exploratory analysis of the financial qualifications data
2. Exploratory analysis of the safety performance data
3. Examination of the relationship between financial qualifications and safety.

To facilitate understanding of the empirical analysis and its implications, extensive use is made of graphical methods. The analysis was performed using the S language and system for interactive data analysis,[a] which has specialized graphical analysis capabilities suitable for this study, as well as a wide range of statistical capabilities, e.g., regression analysis, analysis of variance, clustering, and multivariate analysis.

Section 5.1 characterizes the population of utilities and plants that are included in the analysis. Section 5.2 presents the financial qualifications data and describes their behavior across time; the interrelationships among the various measures of financial qualifications are also discussed. Section 5.3 presents the safety performance data. Section 5.4 examines the relationships between financial qualifications and safety. Findings and conclusions from the empirical analysis are summarized in Section 5.5.

5.1 UTILITIES AND PLANTS USED FOR ANALYSIS

We elected to focus our analysis on IOU owners of nuclear power plants with an OL. The utilities, associated plants, and the date the CP was issued for each plant are shown in Table 5.1. For plants with multiple owners, the owner with the largest percentage interest in the plant at the time of CP application is assumed for this analysis to be the plant owner.

(a) R. A. Becker and J. M. Chambers, S: A Language and System for Data Analysis, Bell Laboratories, Murray Hill, New Jersey, 1981.

TABLE 5.1. Utilities and Plants Used in the Analysis

Lead Applicant	Plant	Date CP Issued
Alabama Power	Joseph M. Farley Nuclear Power Plant Unit 1	8/72
	Joseph M. Farley Nuclear Plant Unit 2	8/72
Arizona Public Service	Palo Verde Nuclear Generating Station Unit 1	5/76
	Palo Verde Nuclear Generating Station Unit 2	5/76
	Palo Verde Nuclear Generating Station Unit 3	5/76
Arkansas Power & Light	Arkansas Nuclear One Unit 1	12/68
	Arkansas Nuclear One Unit 2	12/72
Baltimore Gas & Electric	Calvert Cliffs Nuclear Power Plant Unit 1	7/69
	Calvert Cliffs Nuclear Power Plant Unit 2	7/69
Boston Edison	Pilgrim Station Unit 1	8/63
Carolina Power & Light	Brunswick Steam Electric Plant Unit 1	2/70
	Brunswick Steam Electric Plant Unit 2	2/70
	H. B. Robinson Steam Plant Unit 2	4/67
Cleveland Electric Illuminating	Davis Besse Nuclear Power Station Unit 1	3/71
	Perry Nuclear Power Plant Unit 1	9/74
Consumers Power	Big Rock Point Nuclear Plant	5/60
	Palisades	3/67
Commonwealth Edison	Byron Station Unit 1	12/75
	Dresden Nuclear Power Station Unit 2	1/66
	Dresden Nuclear Power Station Unit 3	10/66
	LaSalle County Nuclear Station Unit 1	9/73
	LaSalle County Nuclear Station Unit 2	9/73
	Quad-Cities Station Unit 1	2/67
	Quad-Cities Station Unit 2	2/67
	Zion Station Unit 1	12/68
	Zion Station Unit 2	12/68
Connecticut Light & Power	Millstone Nuclear Power Station Unit 1	5/66
	Millstone Nuclear Power Station Unit 2	12/70
	Millstone Nuclear Power Station Unit 3	8/74
Consolidated Edison	Indian Point Station Unit 2	10/66
Detroit Edison	Enrico Fermi Atomic Power Plant Unit 2	9/72
Virginia Electric & Power (Dominion Resources)	North Anna Power Station Unit 1	2/71
	North Anna Power Station Unit 2	2/71
	Surry Power Station Unit 1	6/68
	Surry Power Station Unit 2	6/68
Duke Power	Catawba Nuclear Station Unit 1	8/75
	Oconee Nuclear Station Unit 1	11/67
	Oconee Nuclear Station Unit 2	11/67
	Oconee Nuclear Station Unit 3	11/67
	William B. McGuire Nuclear Station Unit 1	2/73
	William B. McGuire Nuclear Station Unit 2	2/73
Duquesne Light	Beaver Valley Power Station Unit 1	6/70
Florida Power & Light	St. Lucie Unit 1	7/70
	St. Lucie Unit 2	5/77
	Turkey Point Station Unit 3	4/67
	Turkey Point Station Unit 4	4/67

TABLE 5.1. (contd)

Lead Applicant	Plant	Date CP Issued
Florida Power	Crystal River Plant Unit 3	9/68
Georgia Power	Edwin I. Hatch Nuclear Plant Unit 1	9/69
	Edwin I. Hatch Nuclear Plant Unit 2	12/72
Gulf States Utilities	River Bend Station Unit 1	3/77
Illinois Power	Clinton Nuclear Power Station Unit 1	2/76
Indiana & Michigan Power	Donald C. Cook Plant Unit 1	3/69
	Donald C. Cook Plant Unit 2	3/69
Iowa Electric Light & Power	Duane Arnold Energy Center Unit 1	6/70
Jersey Central Power & Light	Oyster Creek Nuclear Power Plant	12/64
Kansas Gas & Light	Wolf Creek	5/77
Long Island Lighting	Shoreham Nuclear Power Station	4/73
Louisiana Power & Light	Waterford Steam Electric Station Unit 3	11/74
Metropolitan Edison	Three Mile Island Nuclear Station Unit 1	5/68
Middle South Utilities	Grand Gulf Nuclear Station Unit 1	9/74
Niagara Mohawk Power	Nine Mile Point Nuclear Station Unit 1	4/65
Northern States Power	Monticello Nuclear Generating Plant	6/67
	Prairie Isl. Nuclear Generating Plant Unit 1	6/68
	Prairie Isl. Nuclear Generating Plant Unit 2	6/68
Ohio Edison	Beaver Valley Power Station Unit 2	5/74
Pacific Gas & Electric	Diablo Canyon Nuclear Power Plant Unit 1	4/68
	Diablo Canyon Nuclear Power Plant Unit 2	12/70
Pennsylvania Power & Light	Susquehanna Steam Electric Station Unit 1	11/73
	Susquehanna Steam Electric Station Unit 2	11/73
Philadelphia Electric	Limerick Generating Station Unit 1	6/74
	Peach Bottom Atomic Power Station Unit 2	1/68
	Peach Bottom Atomic Power Station Unit 3	1/68
Portland General Electric	Trojan Nuclear Plant	2/71
Public Service Co Of Colorado	Ft. St. Vrain Nuclear Generating Station	9/68
Public Service Electric & Gas	Hope Creek Generating Station Unit 1	11/74
	Salem Nuclear Generating Station Unit 1	9/68
	Salem Nuclear Generating Station Unit 2	9/68
Rochester Gas & Electric	R. E. Ginna Nuclear Power Plant Unit 1	4/66
South Carolina Electric & Gas	Virgil C. Summer Nuclear Station Unit 1	3/73
Southern California Edison	San Onofre Nuclear Generating Station Unit 1	3/64
	San Onofre Nuclear Generating Station Unit 2	10/73
	San Onofre Nuclear Generating Station Unit 3	10/73

TABLE 5.1. (contd)

Lead Applicant	Plant	Date CP Issued
Union Electric	Callaway Plant No. 1	4/76
Wisconsin Electric Power	Point Beach Nuclear Plant Unit 1	7/67
	Point Beach Nuclear Plant Unit 2	7/68
Wisconsin Public Service	Kewaunee Nuclear Power Plant Unit 1	8/68

Sources: 1. U.S. Department of Energy. U.S. Central Station Nuclear Electric Generating Units: Significant Milestones, DOE/NE-0030/12, May 1985.
2. R. S. Wood, Owners of Nuclear Power Plants, NUREG-0327 Rev. 4, August 1987.

Plants where the majority owner at the time of CP application was a publicly owned utility (POU) were not used for several reasons. First, our source for financial data, Standard & Poor's Compustat Services, Inc., had no information for POUs other than the Tennessee Valley Authority. Second, the financial measures are not identical for POUs. For example, POUs have no rate of return on equity. Finally, it was felt that a satisfactory indication of the possible relationship between financial qualification at the time of CP application and subsequent plant safety performance could be obtained from the IOU data set. IOU owned plants with a CP but without an OL were also excluded from the analysis.

5.2 FINANCIAL QUALIFICATIONS DATA

Five alternative measures of the financial health of utilities were introduced in Section 4.1. The five measures, which were selected from a larger set of candidate measures, were 1) bond ratings (i.e., the ratings on a utility's most senior long-term bonds); 2) interest coverage ratio, which is essentially the ratio of before-tax income to interest charges; 3) debt/asset ratio; 4) debt/equity ratio; and 5) rate of return on equity. The five measures reflect several diverse aspects of a utility's financial condition. Taken together, they represent a broad and comprehensive set of measures that are supported by the financial analysis literature and for which adequate data were available for this study. Many alternative measures of financial health could also be used; however, it is unlikely that the results of the study would be substantially different if other measures were used (see Section 5.2.6).

5.2.1 Bond Rating

For the utilities in this study, the bond ratings at the time of the CP ranged from Aaa to Ba, based on Moody's rating system. The great majority of ratings were A or better. The lowest bond ratings at the CP stage were for Palo Verde 1, 2, and 3 (Arizona Public Service had a bond rating of Baa in 1976, when the CP was issued) and Trojan (Portland General Electric had a bond rating of Baa in 1971 when the CP was issued). The highest bond ratings (Aaa) were for such utilities as Commonwealth Edison (multiple plants), Duke Power (at the time of the Oconee CPs), Baltimore Gas and Electric (Calvert Cliffs), Boston Edison (Pilgrim), and Connecticut Power and Light (Millstone 1). The Tennessee Valley Authority, a publicly owned utility, has maintained Aaa ratings consistently over many years. Bond ratings tend to change infrequently, but on average, utility bond ratings have been trending downward slightly over time. Commonwealth Edison's bond ratings, for example, were Aaa in 1975 when CPs were issued for Byron and Braidwood; by 1980, the ratings had declined to A. As a second example, Duke Power's bonds declined from Aaa in 1967, when the Oconee CPs were issued, to A in 1975, when the Catawba CPs were issued; Duke's ratings subsequently rose back to Aa in 1983. Many observers expect a gradual improvement in utility bond ratings in the years ahead.

5.2.2 Interest Coverage Ratio

Interest coverage ratio, defined as the ratio of pretax operating income to interest expense, is a measure of a utility's ability to pay the interest on its debt. Large values of the interest coverage ratio signify that interest charges are only a small fraction of income--a healthy sign. Small values signify that a large fraction of income is devoted to interest payments--a sign of financial strain. For the utilities in this study, the interest coverage ratio at the time of the CP ranged from a low of 1.21 (Georgia Power in 1974, when the CP was issued for Vogtle 1) to a high of 7.32 (Commonwealth Edison in 1966, Dresden 2 and 3).

Figure 5.1 shows the trend in interest coverage ratio from 1961 to the present for the utilities included in this study.[a] The data for each year are represented by a "box plot."[b] The chart shows that interest coverage ratios declined in the late sixties, remained relatively low through the seventies, and are beginning to recover in the eighties. Much of the decline in the late sixties and early seventies was occasioned by rising rates of inflation and increasing interest rates which drove utility interest charges up. There was also a large amount of borrowing by utilities over this time period to construct new generating capacity, and downward pressure on income due to increases in the cost of fuel.

(a) As noted in Section 4.1, the source of the financial data used in this study was Standard & Poor's Compustat Services Inc.

(b) The box plot is a graphical display technique introduced by J. W. Tukey, in his book Exploratory Data Analysis, Addison-Wesley, 1977. The upper and lower quartiles of the data are represented by the top and bottom of the rectangular box. The median is represented by a horizontal line somewhere in the middle of the rectangular box. The spread of the data is represented by the vertical dashed lines extending above and below the ends of the rectangular box. The length of the dashed lines is based on a robust estimator of spread (roughly 1.5 times the interquartile range, which is the difference between the upper and lower quartiles). Points beyond the end of the dashed lines are indicated by an asterisk, and they are called "outside values." Box plots provide an effective summary of the location and spread of the data as well as an indication of any extreme values.

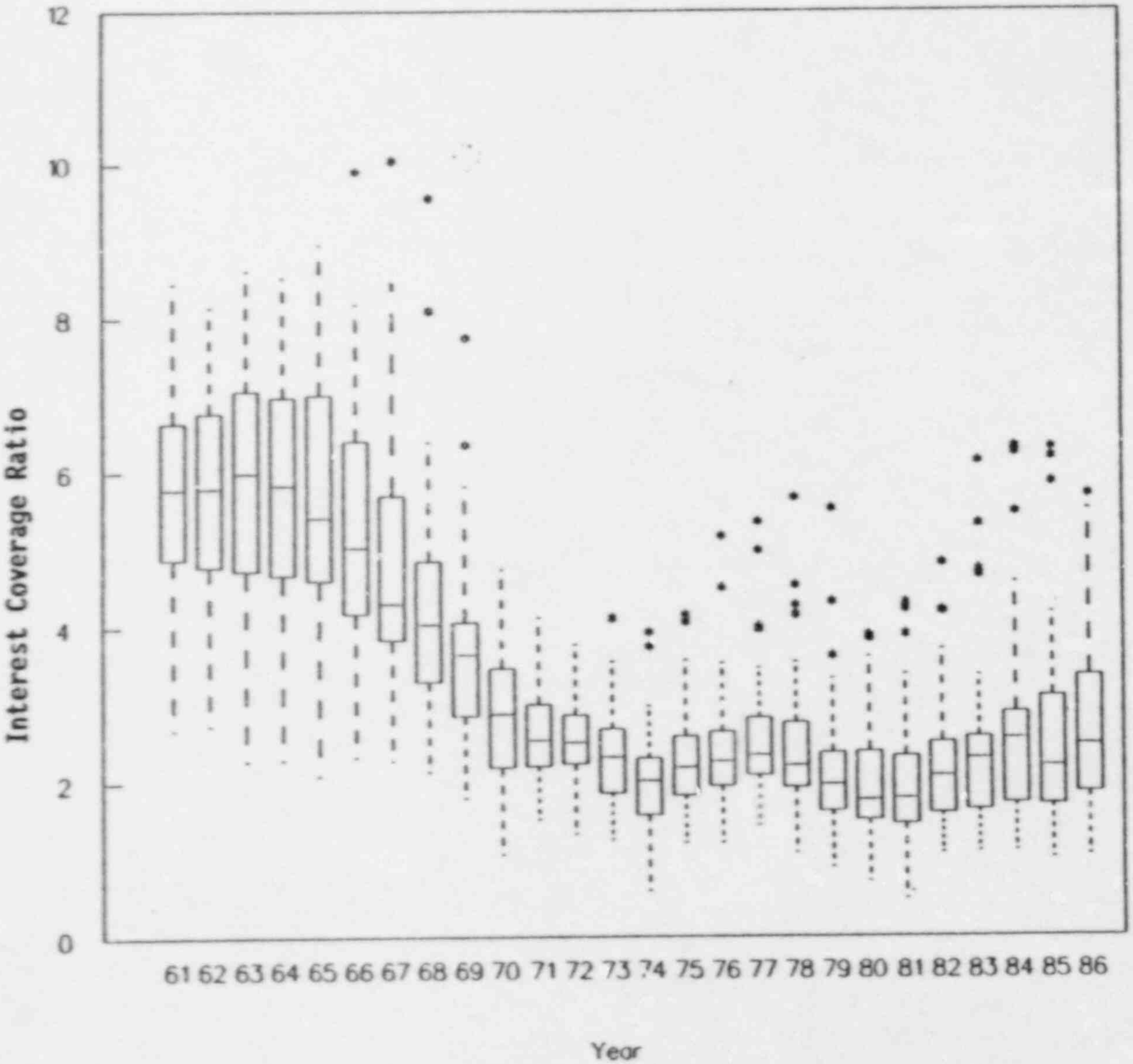

FIGURE 5.1. Interest Coverage Ratio Over Time for Utilities Included in the Study

Figure 5.2 shows how the interest coverage ratios of ten individual utilities have varied since the early sixties. The ten utilities were selected at random from the population of utilities included in this study. The same downward trend seen in Figure 5.1 is also visible here. However, considerable variation between utilities can also be seen. Some utilities experienced sharply rising interest coverage ratios at the same time the industry as a whole was experiencing falling ratios on average. Conversely, some utilities continued to experience declining ratios in the 1980s while the industry as a whole was stabilizing or improving. The relative rankings of the ten utilities also change significantly over time. The important point to draw from Figure 5.2 is that financial health, as measured by interest coverage ratio, is highly variable over time for any given utility. A strong ratio at the time of a construction permit will not necessarily remain strong throughout the construction period. In fact, the need to finance the construction will usually tend to depress the ratio.

5.2.3 Debt/Asset Ratio

Debt/asset ratio is the ratio of total long term debt to total net utility plant where net utility plant is the historical (i.e., original cost) value, adjusted for depreciation, of the utility's generating capacity. Other assets such as cash or investments in other businesses are not included in the denominator of this ratio.

Figure 5.3 shows the debt/asset ratio between 1961 and 1986 for the utilities included in this analysis. The values tend to be centered around 0.5, with most utilities falling between 0.4 and 0.6. A slight upward trend is apparent in the late sixties to early seventies, followed by a downward trend since then. Large amounts of debt were raised to build new plant in the late sixties and seventies, which increased the numerator of the ratio. The construction of new plants in the seventies led to increases in the denominator of the ratio, which tended to drive it back downward. On balance, the ratio has remained fairly stable; increases in debt tend to be matched roughly by increases in net utility plant.

Several of the extreme values are worth noting. In 1984-86, one utility had a debt-asset ratio around 0.9, a sign of severe financial strain. The utility in question is CMS Energy Corp., a holding company whose principal subsidiary is Consumers Power. The Midland plant, which was canceled in 1984, is largely responsible for CMS Energy's high debt/asset ratio. More than $2 billion in assets became unusable when the plant was canceled. The remainder of the plant is being converted to a natural gas cogeneration plant, in a partnership with Dow Chemical Co. CMS Energy is gradually recovering its financial health, as can be seen from the downward trend in its debt/asset ratio.

At the other extreme, Wisconsin Public Service and Wisconsin Power and Light, which jointly own the Kewaunee plant, have had among the lowest debt/asset ratios in recent years, around 0.3 to 0.4. It is interesting to note that Kewaunee is consistently ranked as one of the best plants in the U.S. in terms of safety performance. One might conjecture that there could be a

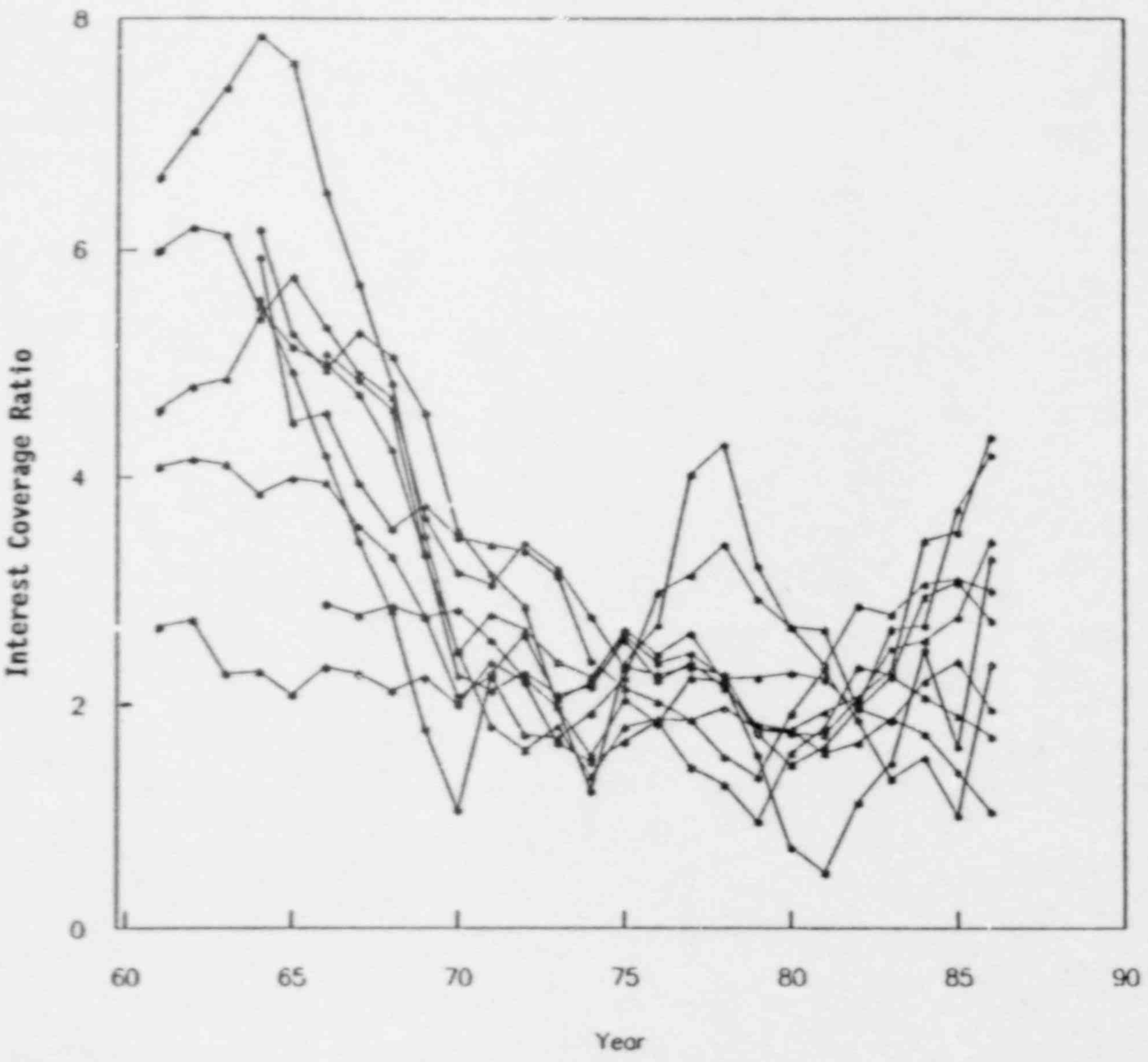

FIGURE 5.2. Time Trends in Interest Coverage Ratios for Ten Selected Utilities

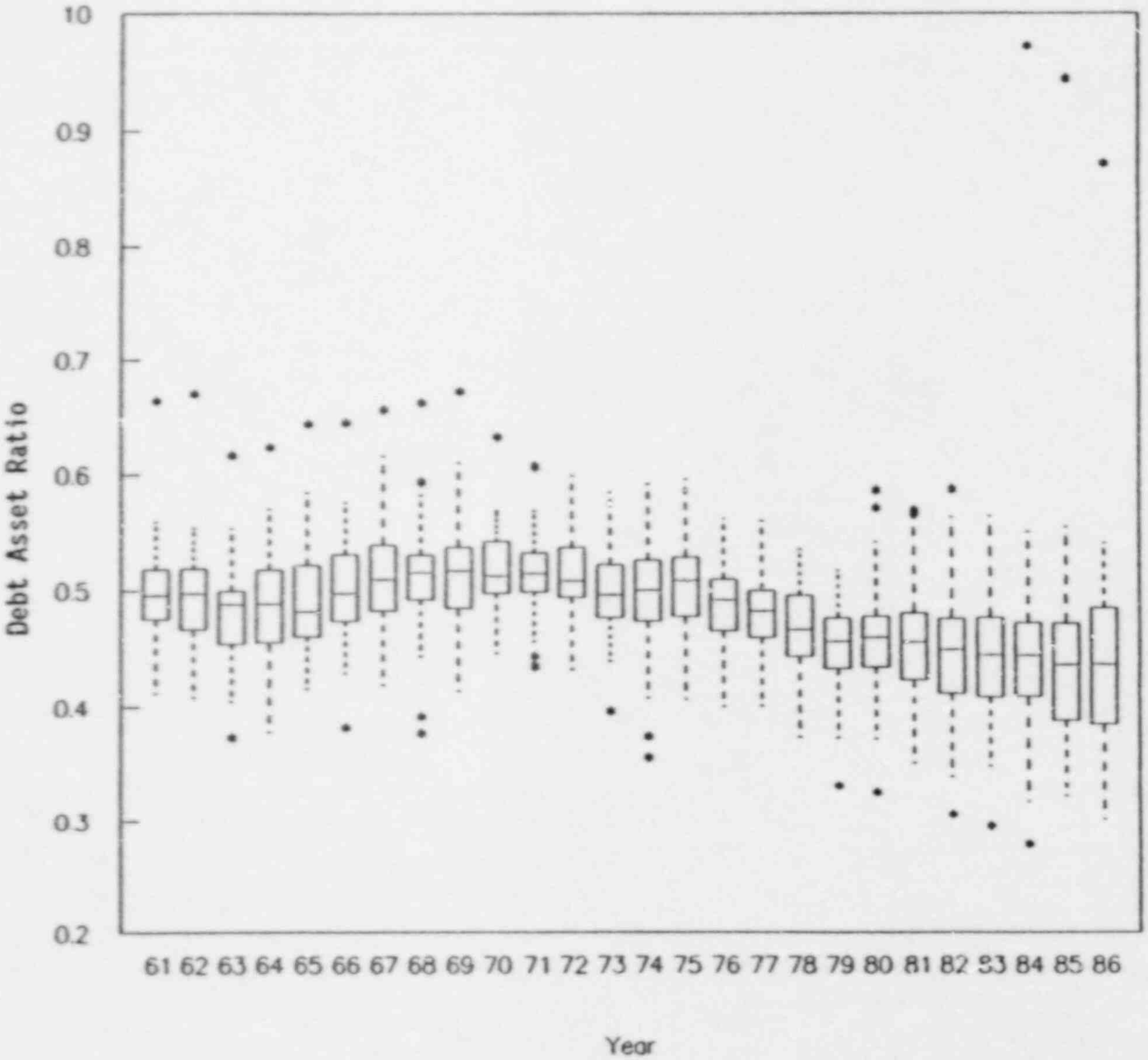

FIGURE 5.3. Debt/Asset Ratio Over Time for Utilities Included in the Study

relationship between low debt/asset ratio and strong safety performance. However, upon further examination, this conjecture does not hold up. Other utilities with strong debt/asset ratios have plants with widely varying safety records. Moreover, at the time of the CP in 1968, Wisconsin Public Service had a debt/asset ratio of 0.49, which was about average at the time; Wisconsin Power and Light's ratio in 1968 was 0.46.

Figure 5.4 shows time trends in the debt/asset ratio for ten randomly selected utilities. Wide fluctuations over time in the ratios for individual utilities are evident. Clearly, a utility's debt/asset ratio at the time of a CP is not a very reliable predictor, in general, of its debt/asset ratio several years later.

5.2.4 Debt/Equity Ratio

Debt/equity ratio is defined as the ratio of total long-term debt to total common equity. Common equity is essentially the net worth of common stockholders' investment in the utility. It is composed of the par or stated value of common shares issued, any premium on common stock, other paid in capital, and retained earnings. Figure 5.5 shows the debt/equity ratios for the utilities in this study from 1961 to 1986. Most of the values range from 1 to 2, with the center of the distribution varying around 1.5. On average, debt/equity ratios drifted upward in the late sixties and early seventies, as utilities borrowed money for construction. Debt/equity ratios have been moving down gradually since the mid-seventies.

Figure 5.6 shows trends in the debt/equity ratios of ten utilities selected at random from the population of utilities included in this study. Again, the most striking aspect of the graph is the wide fluctuations of the ratios over time. Both the amount of debt and the value of shareholders' equity can change significantly from year to year as new debt is issued, old debt is retired, and retained earnings are added to common equity. For most utilities, common equity tends to increase over time, i.e., the value of shareholders' investment is appreciating. Long-term debt is more variable. Utilities may switch between short-term and long-term debt depending on relative interest rates, causing fluctuations in the numerator of the debt/equity ratio. In any case, the debt/equity ratio at the time of the CP is not a very reliable predictor of debt/equity ratio later.

5.2.5 Rate of Return on Equity

Rate of return on equity is a measure of the return on common stockholders' investment in the utility. It is defined as the ratio of total pretax operating income to total common equity. The rates of return of IOUs are typically regulated by state public utility commissions, although a utility's actual rate of return is influenced by other factors as well, such as general economic conditions, weather, fuel costs, and management efficiency.

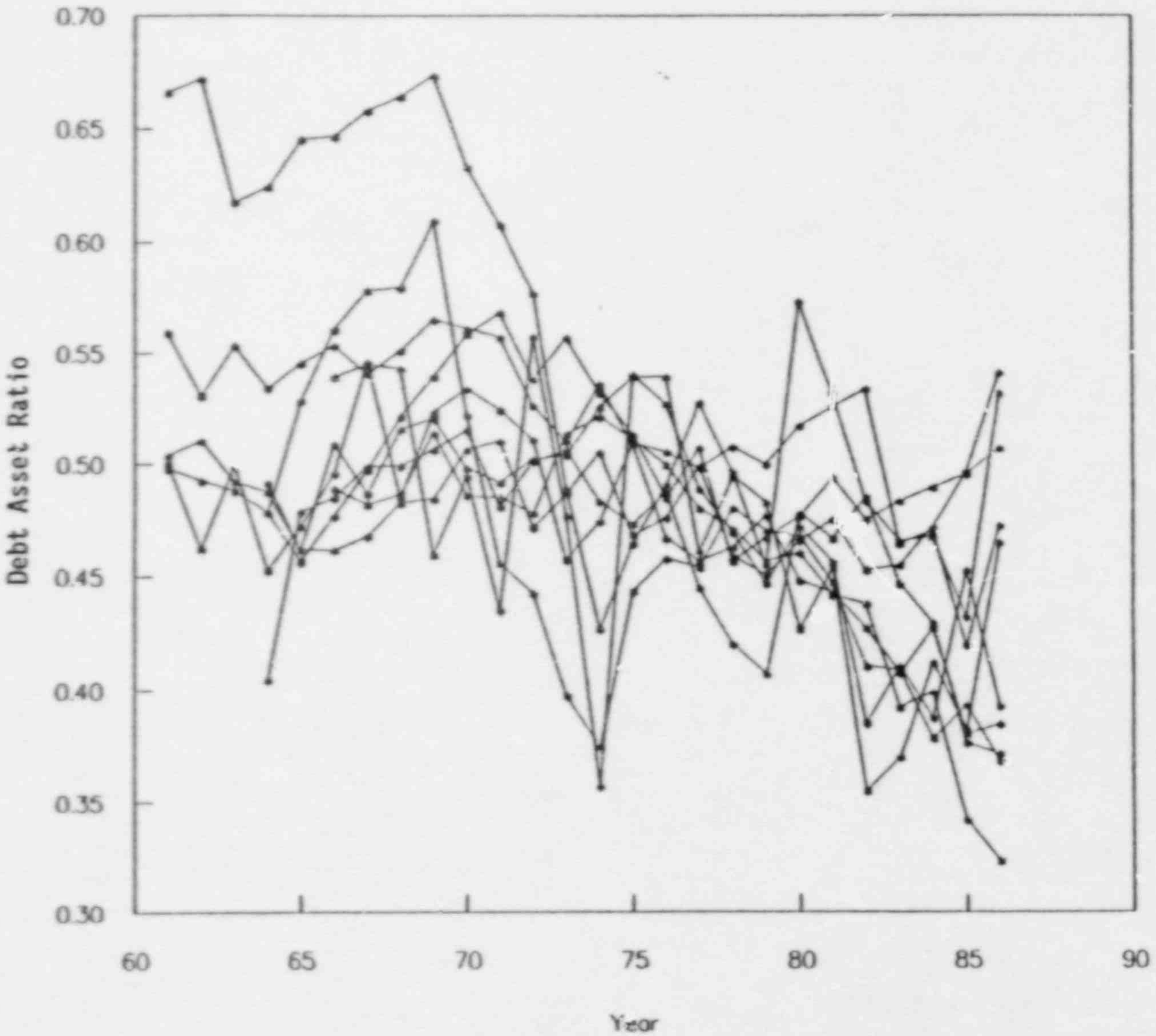

FIGURE 5.4. Time Trends in Debt/Asset Ratios for Ten Selected Utilities

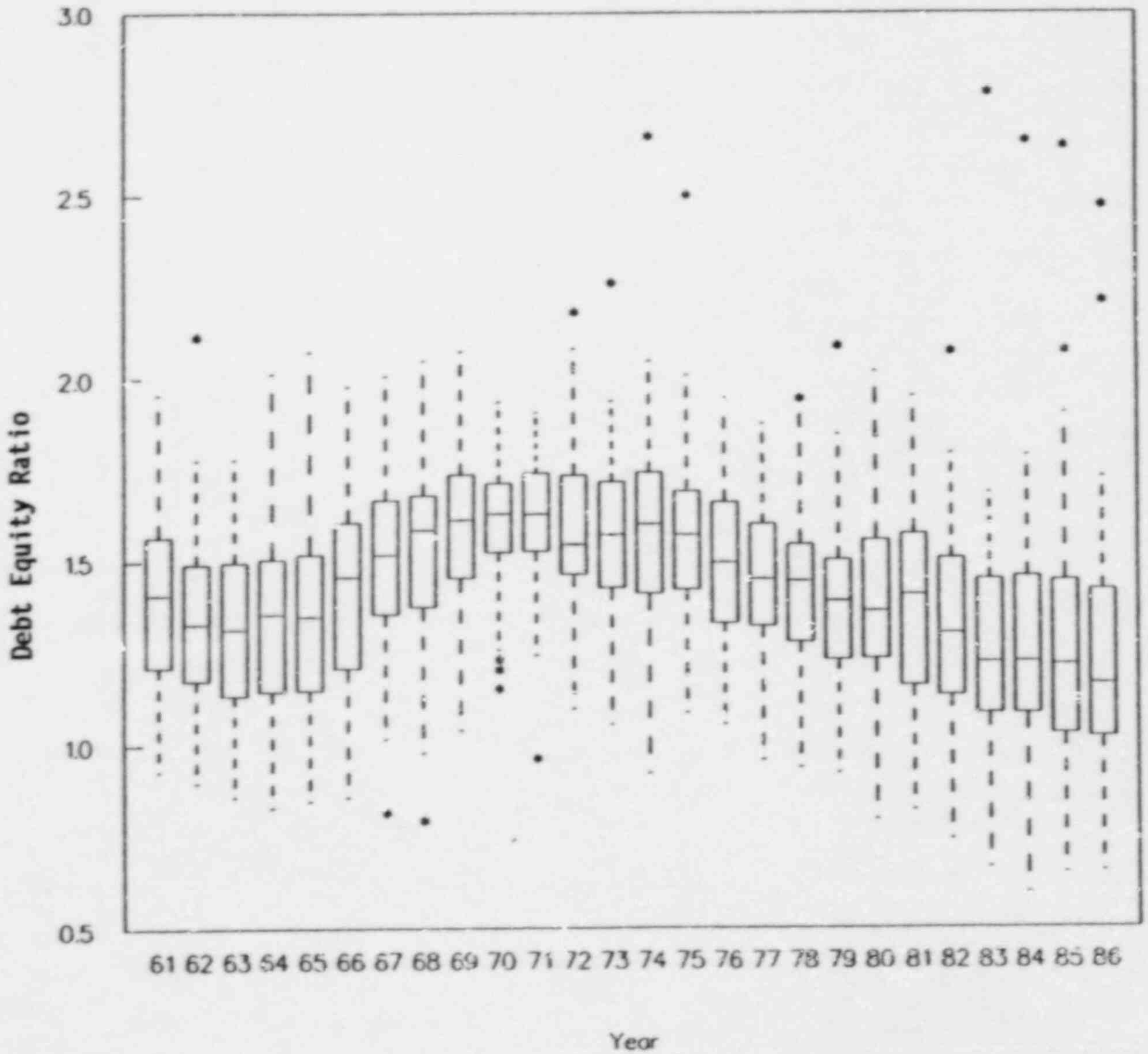

FIGURE 5.5. Debt/Equity Ratio Over Time for Utilities Included in the Study

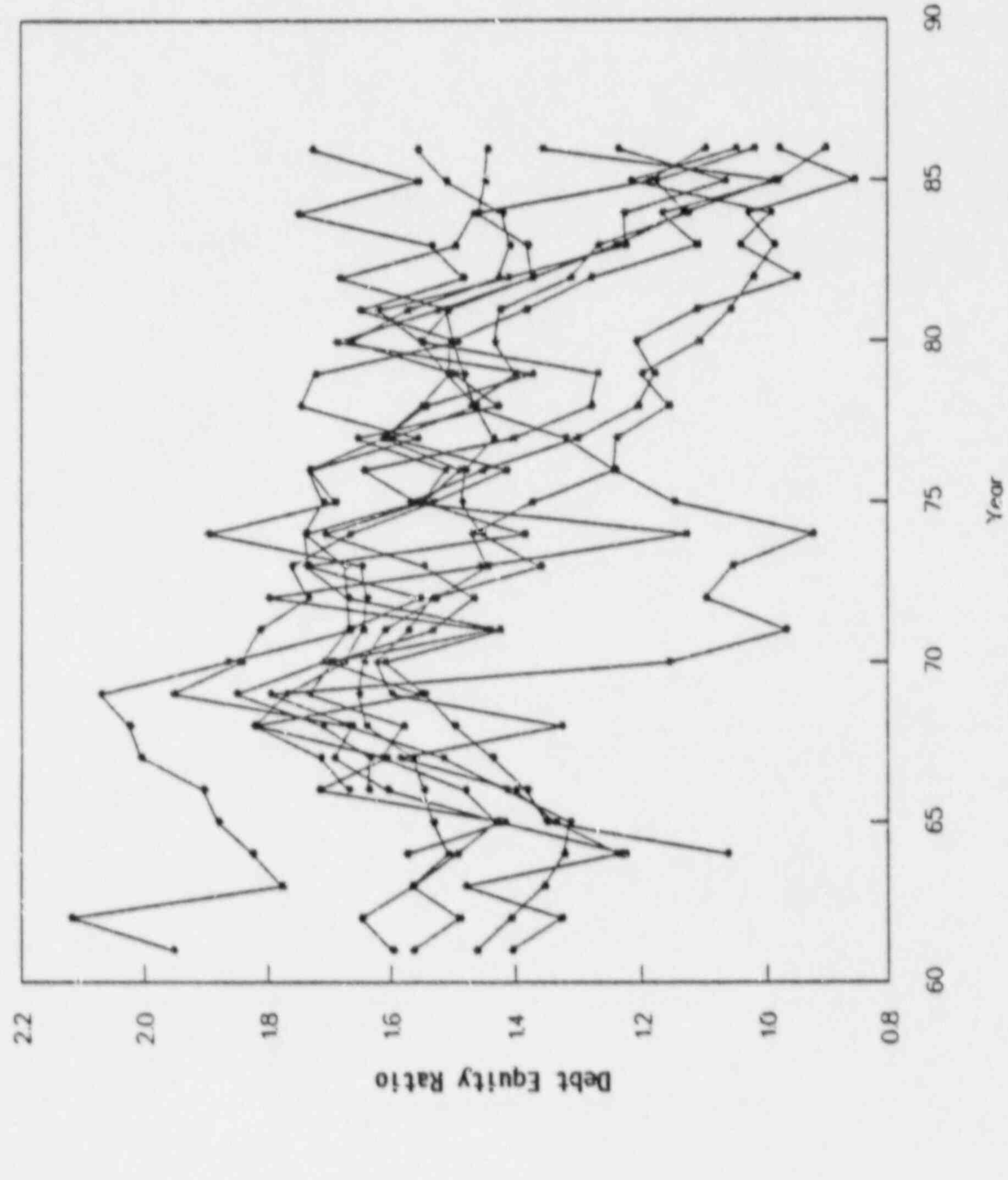

FIGURE 5.6. Time Trends in Debt/Equity Ratios for Ten Selected Utilities

Figure 5.7 shows the rates of return on equity for the utilities in this study from 1961 to 1986. Most of the values are in the range of 15% to 25%. During the sixties, a slight upward trend is apparent, followed by slumps in the early and late seventies. The trend in the eighties has been upward, indicating improving financial performance on the average.

One striking feature in Figure 5.7 is the increasing spread in the distribution of rates of return. The spread in the mid-eighties is much larger than in the sixties and seventies. This means that investments in utilities have become increasingly risky in recent years. This is attributable in part to changes in regulation of utilities. The entire utility industry and its regulatory framework are in a period of significant change. Increasing financial risk is one aspect of this change.

Figure 5.8 shows trends in rate of return on equity for ten utilities chosen at random. Again, considerable fluctuation from year to year is evident. The increased risk in the eighties is also apparent. Rate of return at the CP stage is not a very reliable predictor of rates of return in subsequent years.

5.2.6 Relationships Between the Financial Measures

Since all of the financial measures are designed to capture some aspect of a utility's financial health, it is reasonable to expect some degree of agreement among them. Utilities that are financially healthy by one measure should also tend to be healthy according to the other measures. To test this hypothesis, the relationships among the various measures are examined in this section.

Figure 5.9 displays the relationships between each pair of financial measures in 1985. The graphical display in Figure 5.9 is called a "scatterplot matrix." Each element in the matrix is a scatterplot of one variable against another. The labels on the axes are abbreviations of the financial measures. For example, in the lower left corner of the matrix, rate of return on equity (RRE) is plotted against bond rating (BOND) for each of the utilities in the study in 1985. Each data point in the scatterplot represents one utility's rate of return on equity and its bond rating. The bond ratings have been converted to the numerical scale described in Section 4.1 (Aaa = 9, Aa = 8, A = 7, Baa = 6, Ba = 5, etc.).

If the financial measures are consistent, one would expect to see some indication of a relationship in the individual scatterplots. As an example, consider the plot of interest coverage ratio (ICR) versus bond ratings using 1985 financial data (second row, first column in Figure 5.9). It can be seen that utilities with low interest coverage ratios tend have low bond ratings, while utilities with high interest coverage ratios tend to have high bond ratings. This is what one would expect since both measures are proxys for financial health, albeit in different ways.

As a second example, consider the plot of debt/asset ratio (DAR) versus debt/equity ratio (DER) (third row, fourth column of the matrix). The first

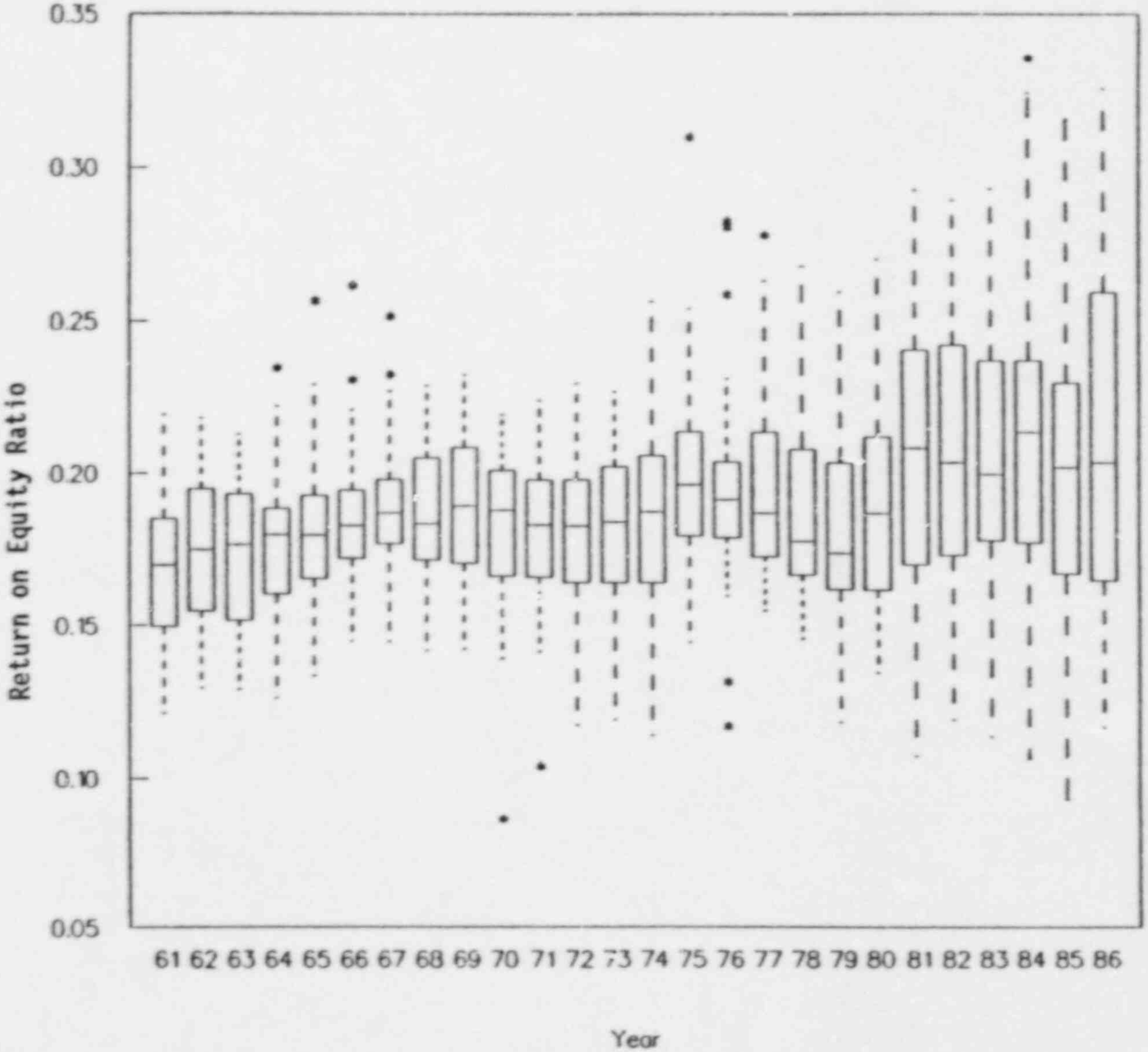

FIGURE 5.7. Rate of Return on Equity Over Time for Utilities Included in this Study

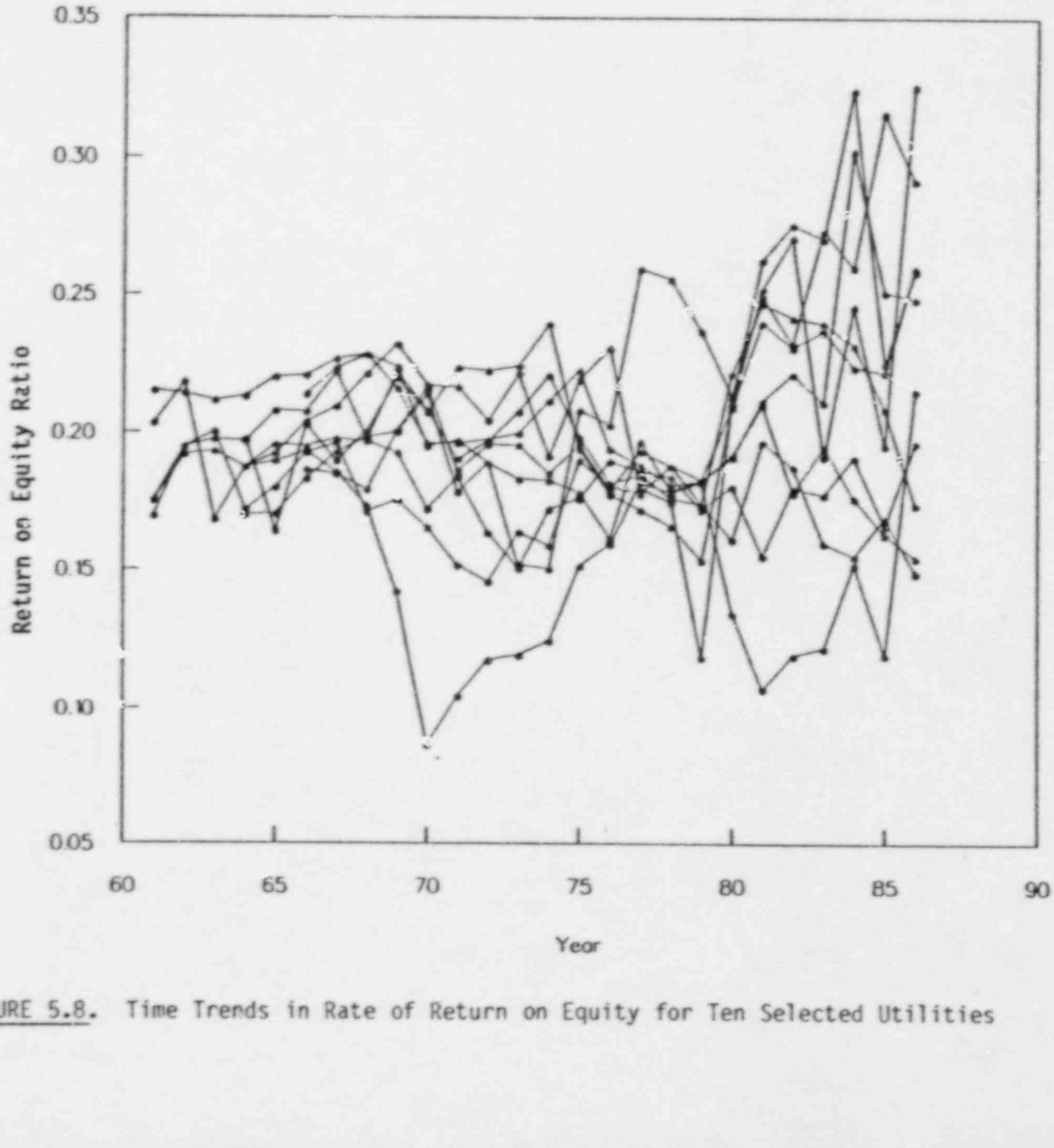

FIGURE 5.8. Time Trends in Rate of Return on Equity for Ten Selected Utilities

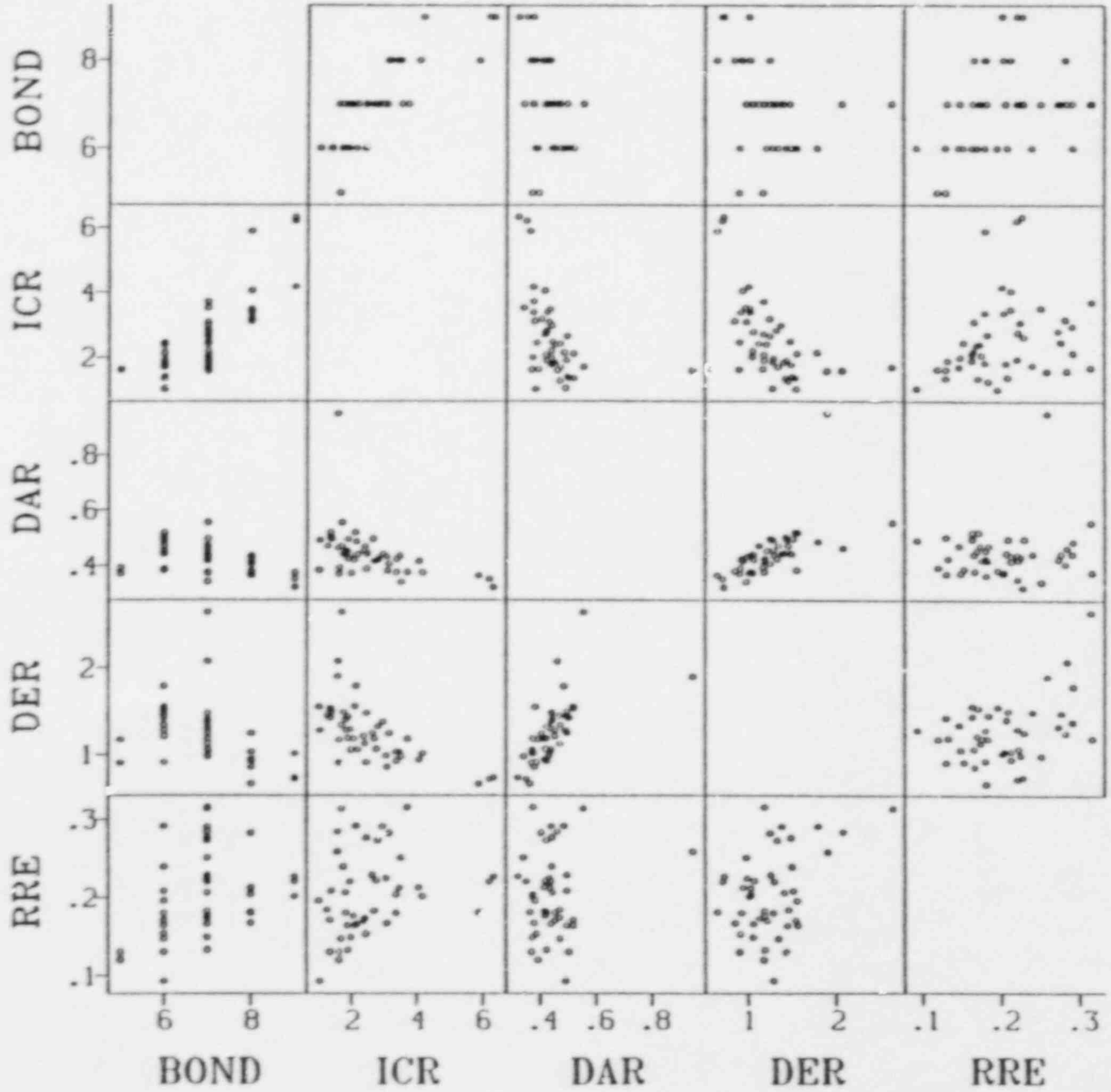

FIGURE 5.9. Relationships Between the Financial Measures (1985 data)

thing to notice is an outlying point with a very large debt/asset ratio. This utility stands apart from the others. As noted in Section 5.2.3, this large debt/asset ratio is due to the cancellation of the Midland plant in 1984; the plant was being built by Consumers Power Company of Michigan. If one ignores this outlier and concentrates on the remainder of the data, one can observe a fairly close relationship between debt/asset ratio and debt/equity ratio. Utilities with large debt/asset ratios tend to have large debt/equity ratios, while utilities with small debt/asset ratios tend also to have small debt/equity ratios. Again, this is to be expected, since the ratios are conceptually related.

As a third example, consider the plot of debt/equity ratio versus interest coverage ratio (fourth row, second column of the matrix). There are three utilities with very large interest coverage ratios and low debt/equity ratios; the three points are in the lower right corner of the plot. These utilities are Wisconsin Electric Power, which owns Point Beach 1 and 2, Wisconsin Public Service, which is joint owner of Kewaunee, and Consolidated Edison of New York, which owns Indian Point 2. (Note that these same three outliers can be seen clearly in each of the plots in the second column of the matrix. At the top of the column, for example, it can be seen that each of these utilities also has very high bond ratings.) Considering the entire plot, the data generally indicate an inverse relationship between interest coverage ratio and debt/equity ratio: the higher the interest coverage ratio, the lower the debt/asset ratio. Again, such a relationship is to be expected if the financial measures are valid indicators of financial health.

Taken as a whole, the relationships that are apparent in the scatterplot matrix displayed in Figure 5.9 tend to lend support to the validity of the financial measures. The measures seem to be in approximate agreement. Each measure is capturing some common aspect of financial health. Each is also capturing some unique aspects of each utility's condition, as indicated by the lack of perfect agreement among them; if they were all measuring exactly the same thing, they would agree perfectly, and a single measure would be sufficient.

5.3 SAFETY PERFORMANCE DATA

In Section 4.2, a number of alternative measures of plant safety were described and their strengths and limitations were summarized. In this section, data on four of the measures are presented.

5.3.1 Systematic Assessment Of Licensee Performance

The SALP process provides an in-depth, comprehensive evaluation of licensee performance in eleven key functional areas including plant operations, radiological controls, maintenance, surveillance, emergency preparedness, fire protection, security, outages, quality programs and associated administrative controls, licensing activities, and training/qualifications. A score of 1, 2, or 3 is assigned for each functional area. A score of 1 designates a high level of performance. A score of 2 is satisfactory. A score of 3 designates minimally acceptable performance.

The SALP program does not provide an overall assessment that integrates performance across all the functional areas. In the Performance Indicator Program (SECY 86-317), NRC used an overall summary measure for purposes of analysis and validation of the performance indicators. It consisted of the average score across four of the functional areas: operations, maintenance, surveillance, and quality programs. This summary measure has been used in this study as one of the safety measures. Some analyses have also considered the average across all eleven functional areas as a summary SALP score.[a] Therefore, this option has also been explored in this study as one of the safety measures.

Figure 5.10 shows SALP scores for plants with OLs averaged over all eleven functional areas for the years 1979-1986. Figure 5.11 is the corresponding plot using the average over the four key functional areas of operations, maintenance, surveillance, and quality programs. The overall impressions conveyed by the two figures are similar, indicating slight improvement in the average scores since 1979. However, the data in Figure 5.11 are more variable and the box plots show a wider spread. This result is to be expected. An average of four numbers will usually be more variable (less stable) than an average of eleven numbers.

Figure 5.12 shows the time trends in average SALP scores for the four key functional areas for a randomly chosen subset of the data. Again, only plants with OLs are included. The variation in scores from year to year is apparent.

Since financial health at the CP stage is a single fixed value, it cannot possibly account for the variations in safety performance from year to year. At most, financial health at the time of the CP application could affect long-term average safety. Therefore relationships between financial health and SALP scores averaged over the entire period for which data are available (1979-1986) are examined in Section 5.4.

5.3.2 Licensee Event Reports (LERs)

The number of LERs submitted is a possible measure of safety performance. Hypothetically, it could be argued plants experiencing a large number of reportable events may be less safe than those with relatively few such events. A significant disadvantage of this measure, however, is that not all reportable events are equally important. Simply counting the number of LERs overlooks this fact. For the sake of simplicity, we limit the presentation here to the raw LER counts. As will be seen later, the raw number of LERs is in fact related to SALP and to other measures of safety.

(a) See, for example, Nucleonics Week, Vol. 28, No. 33, August 13, 1987, p. 10.

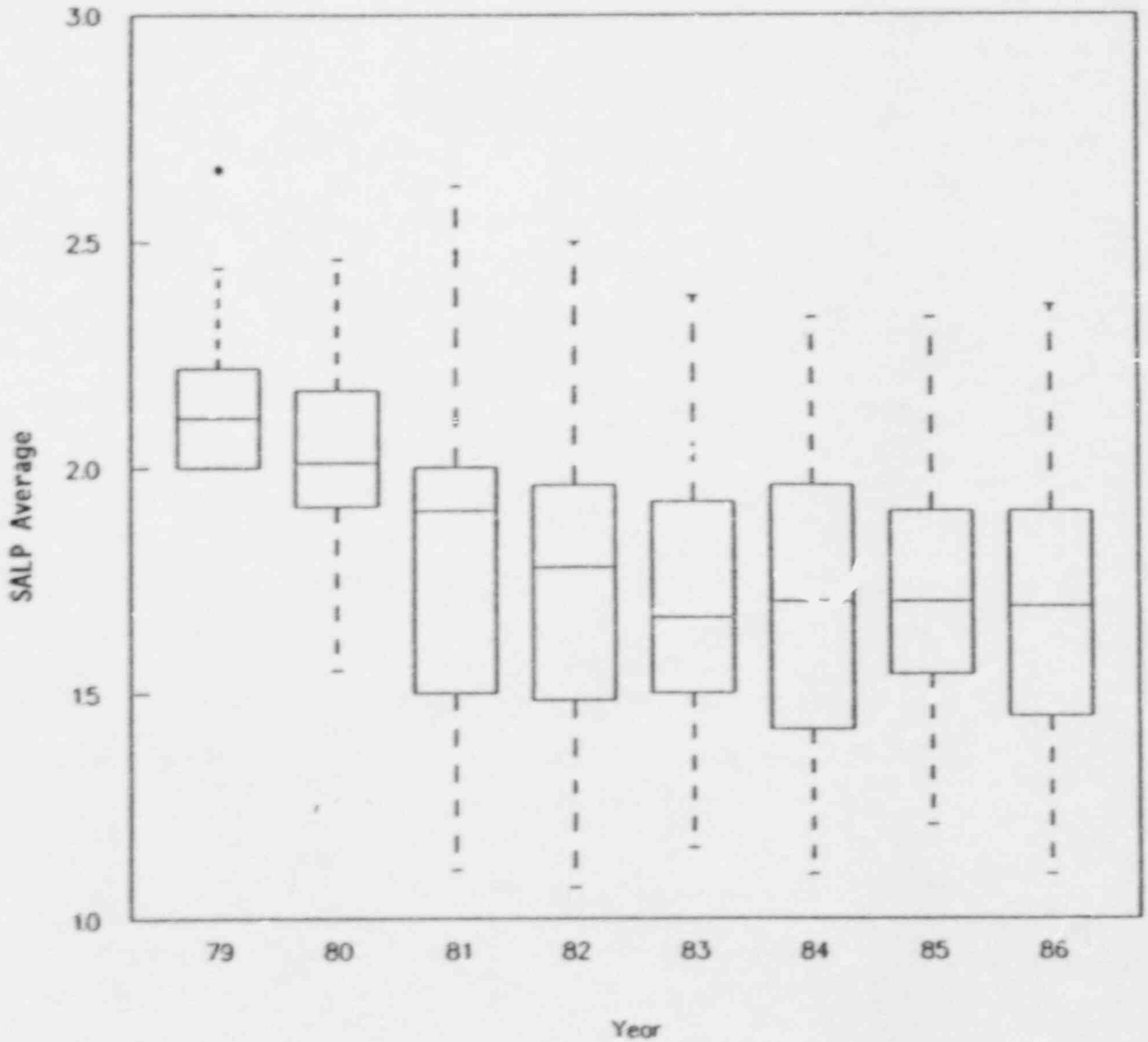

FIGURE 5.10. SALP Scores Averaged Over All Functional Areas, 1979-1986

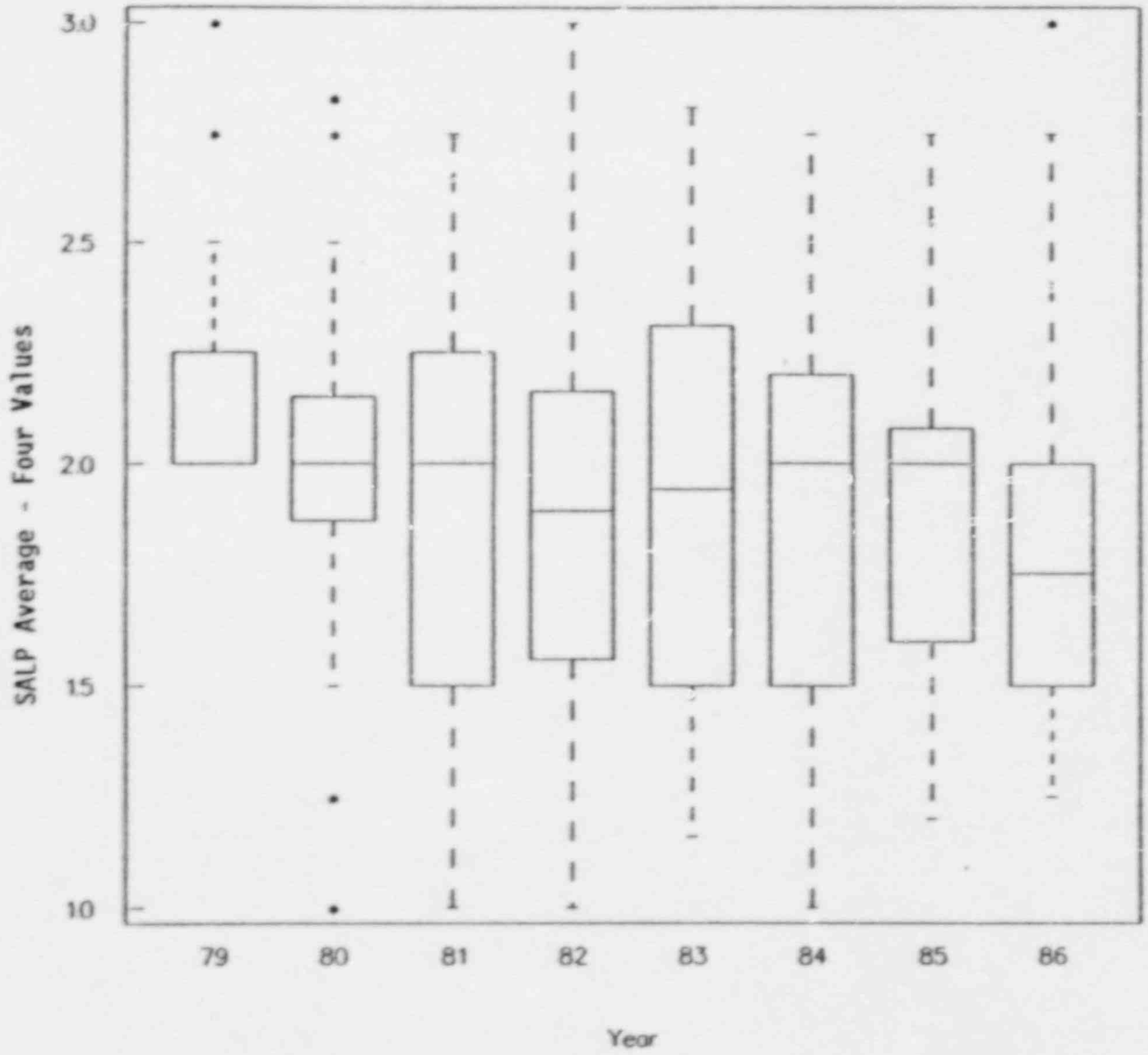

FIGURE 5.11. SALP Scores Averaged Over Four Functional Areas: Operations, Maintenance, Surveillance, and Quality Programs

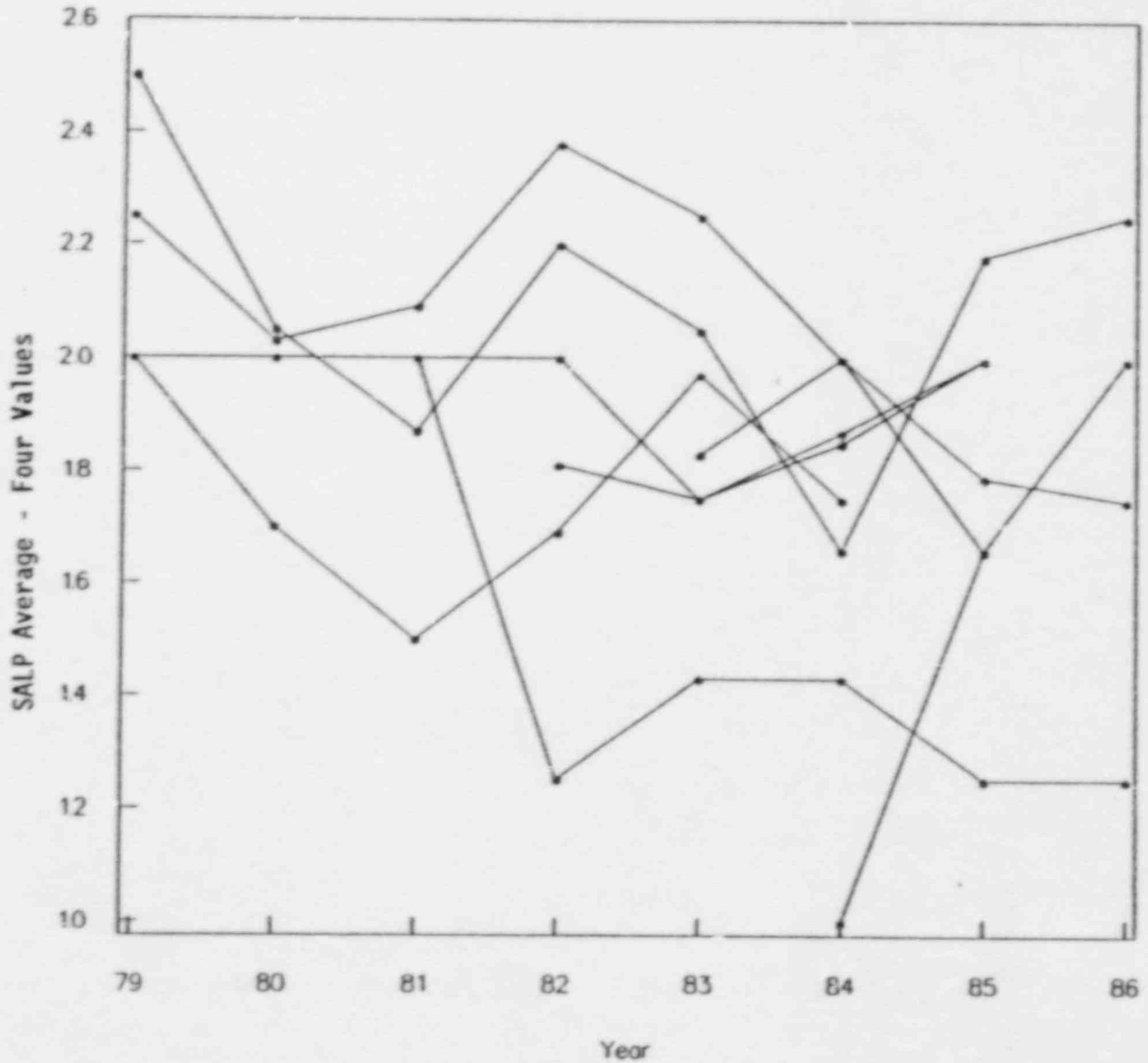

FIGURE 5.12. Time Trends in Average SALP Scores for Selected Plants

Figure 5.13 is a plot of the number of LERs per year for each plant in Table 5.1 from 1974 to 1986. Several features of the plot should be noted. First, there is a marked drop in the distribution of LERs in 1984 compared to prior years. This result is due to a major change in LER reporting requirements (10 CFR 50.73) in 1984. This change further limits the usefulness of the LER data for this study. A second feature to note is the wide spread in the data and the fact that the distributions are skewed. In 1985, for example, some plants have 3 to 4 times as many LERs as the average (median) plant. The extreme values of 94 and 102 LERs are for new plants (Palo Verde and Byron). This result is not particularly unusual. New plants often have a relatively large number of reportable events in their first years of operation.

5.3.3 Number of Violations

NRC's 766 file contains information on safety violations found during NRC inspections. A variety of safety measures can be constructed from these data. In this section, the total number of violations is considered as a potential safety performance measure. Again, not all violations are equally significant, and prior work has considered various weighting schemes to take the importance of the violations into account. The database used for this study contains data for several of these alternatives. For simplicity, however, only the unweighted total number of violations is presented here. It will be seen below that even this crude measure is clearly related to other safety measures such as SALP.

Figure 5.14 shows the number of safety violations found at each plant in Table 5.1 for the years 1977 to 1985. The data prior to 1980 are not as reliable as the data for 1981-1985. In the latter period, the plot shows a gradual decline in the average number of violations. Not all plants improved, however. The distributions are also quite skewed, with some plants having 3 to 4 times as many violations as the average.

5.3.4 Relationships Among the Safety Measures

Since all of the safety measures are intended to measure some aspect of plant safety performance, it is reasonable to expect that the measures are related. Plants that score well on one measure should tend to score well on the others also. In this section, the relationships between the safety measures are examined.

Figure 5.15 is a scatterplot matrix of the four safety measures discussed in Sections 5.3.1 through 5.3.3. The data are for calendar year 1985. "SALP4" denotes the average SALP score across the four key functional areas: operations, maintenance, surveillance, and quality programs. "SALP" denotes the average SALP score across all eleven functional areas. "LER" denotes the number of LERs. "766" denotes the total number of safety violations, as determined from the 766 File.

First, consider the scatterplot of SALP versus SALP4. As one would expect, the two measures are closely related, falling very nearly along a straight line with a slope of 1. Of the two measures, SALP4 is preferred for

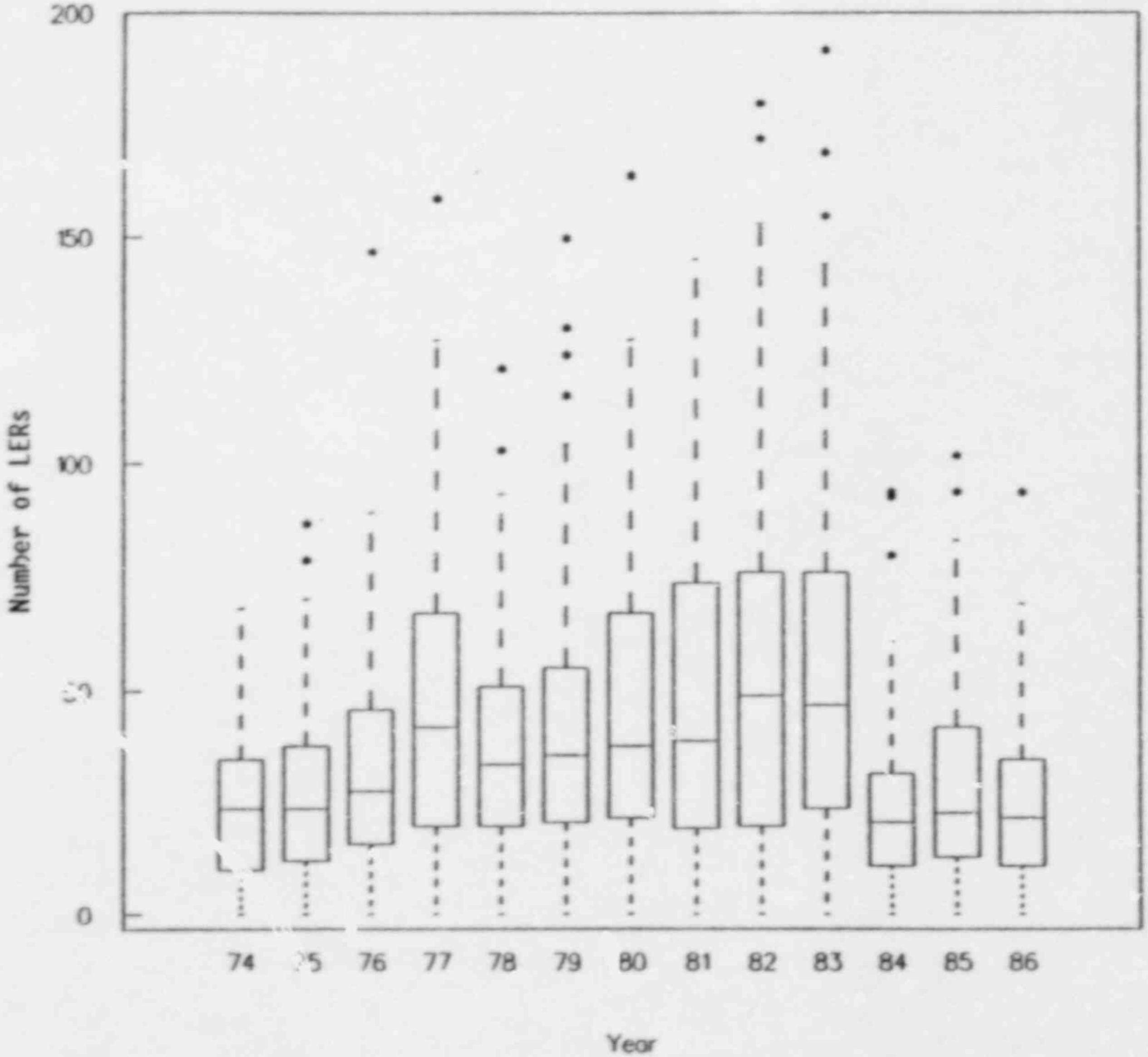

FIGURE 5.13. Number of LERs Per Plant Year, 1974-1986

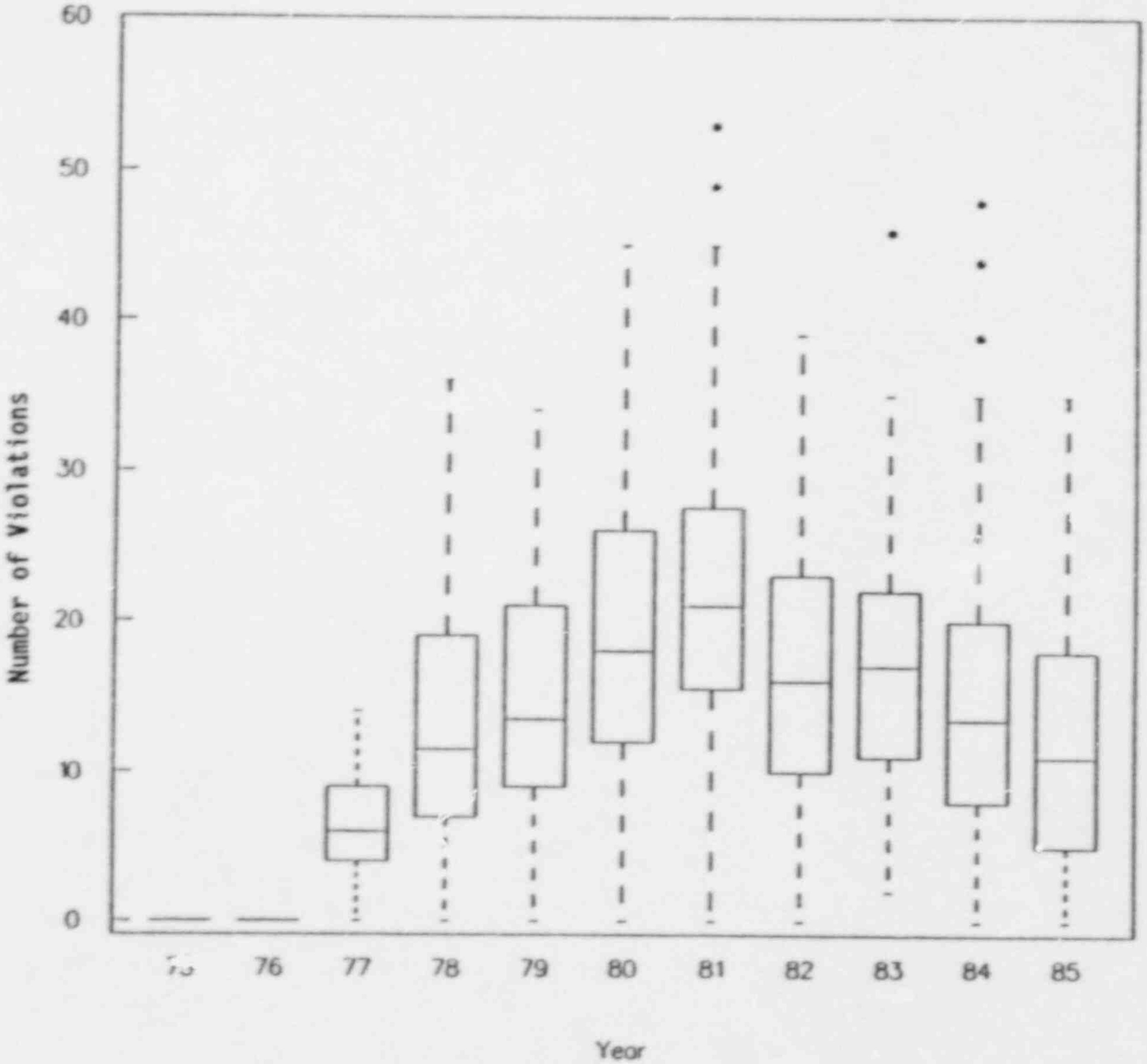

FIGURE 5.14. Number of Safety Violations Per Reactor Year, 1977-1985

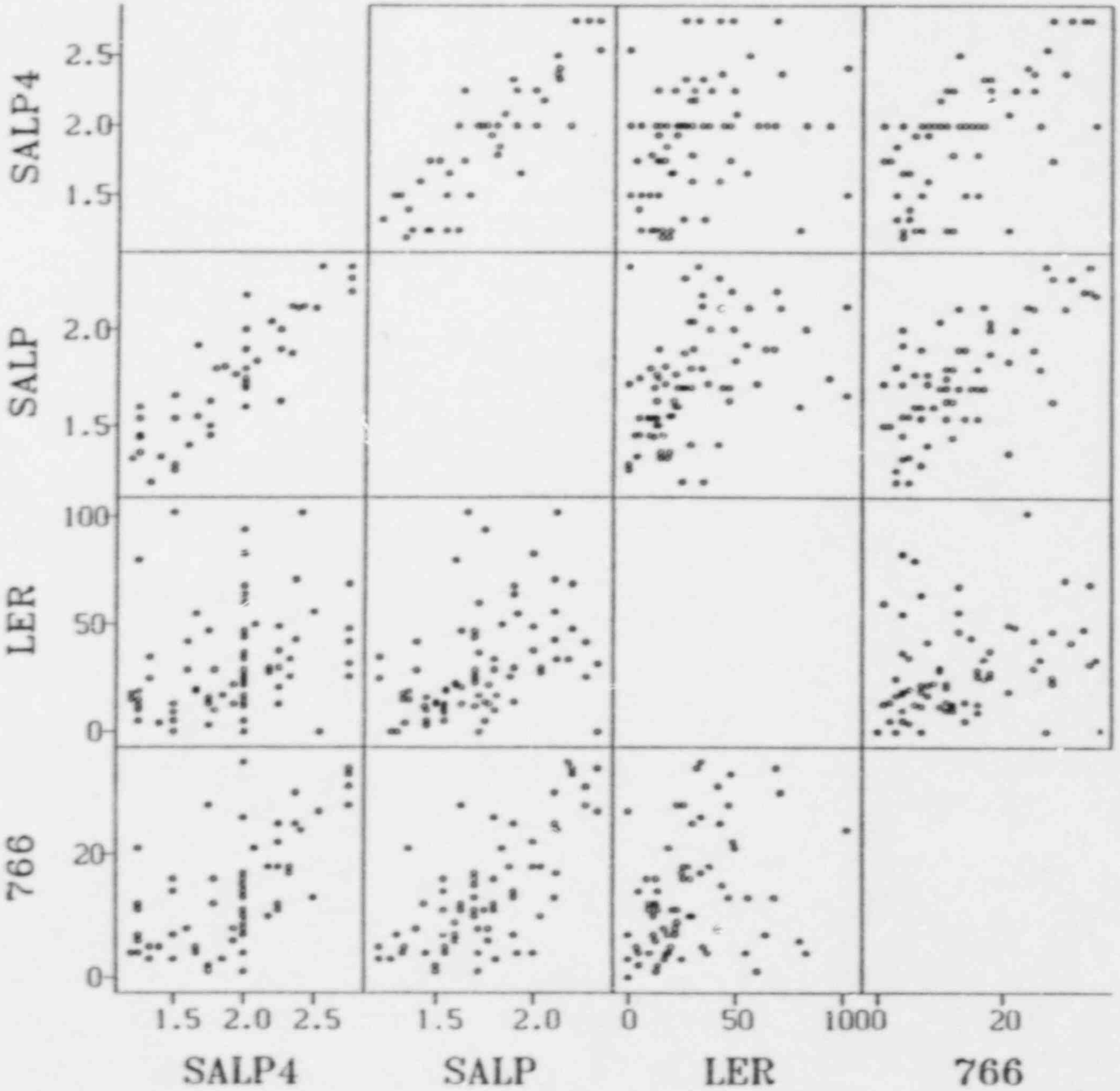

FIGURE 5.15. Relationships Between Four Safety Measures (1985 performance data)

this study because it is formed from four functional areas that are thought to be most directly related to plant safety. However, because SALP and SALP4 are so closely related, either measure should give approximately the same results as the other in any analysis.

SALP4 is also clearly correlated with the number of LERs and the number of safety violations as recorded in the 766 file, although the relationships exhibit considerable scatter. The number of violations appears to be somewhat more closely related to SALP4 than the number of LERs. The scatter in both relationships reflects the wide variability and the skewness of both the LER measure, as shown in Figure 5.13, and the safety violations measure, as shown in Figure 5.14. There also appears to be a relationship between number of LERs and number of safety violations, although again there is a lot of scatter.

SALP4 is considered to be the best of the measures for purposes of this analysis. The SALP evaluations are based on an in-depth, comprehensive assessment of plant performance by NRC personnel and they integrate all of the information available to the NRC, including quantitative data as well as technical and management judgments by NRC staff with direct knowledge of the plant. For this reason, the SALP4 measure is used as the primary safety measure in this report. This choice is consistent with the choices made in prior studies such as the NRC Performance Indicator Program.

5.4 RELATIONSHIP BETWEEN FINANCIAL QUALIFICATIONS AND SAFETY

The relationships between financial qualifications and safety are compactly summarized in Figure 5.16. Five financial measures and one safety measure are plotted. The financial measures are: bond ratings (BOND) converted to the numerical scale defined in Section 4.1; interest coverage ratio (ICR); debt/asset ratio (DAR); debt/equity ratio (DER); and rate of return on equity (RRE). All of the financial data are for the year in which the construction permit was issued. The safety measure (SALP4) is the long-term average of the SALP scores in the four key functional areas: operations, maintenance, surveillance, and quality programs. Each data point represents one reactor, or, in the case of multi-unit sites, one site.[a]

The bottom row of the scatterplot matrix contains the basic results of the analysis. The first plot shows the SALP4 score versus the scaled bond

(a) SALP evaluations are generally conducted for each site rather than separately for each reactor. Thus, Surry 1 and 2, for example, receive a single SALP appraisal. When two reactors at the same site have different owners, however, such as Indian Point 2 and 3, they receive separate SALP appraisals.

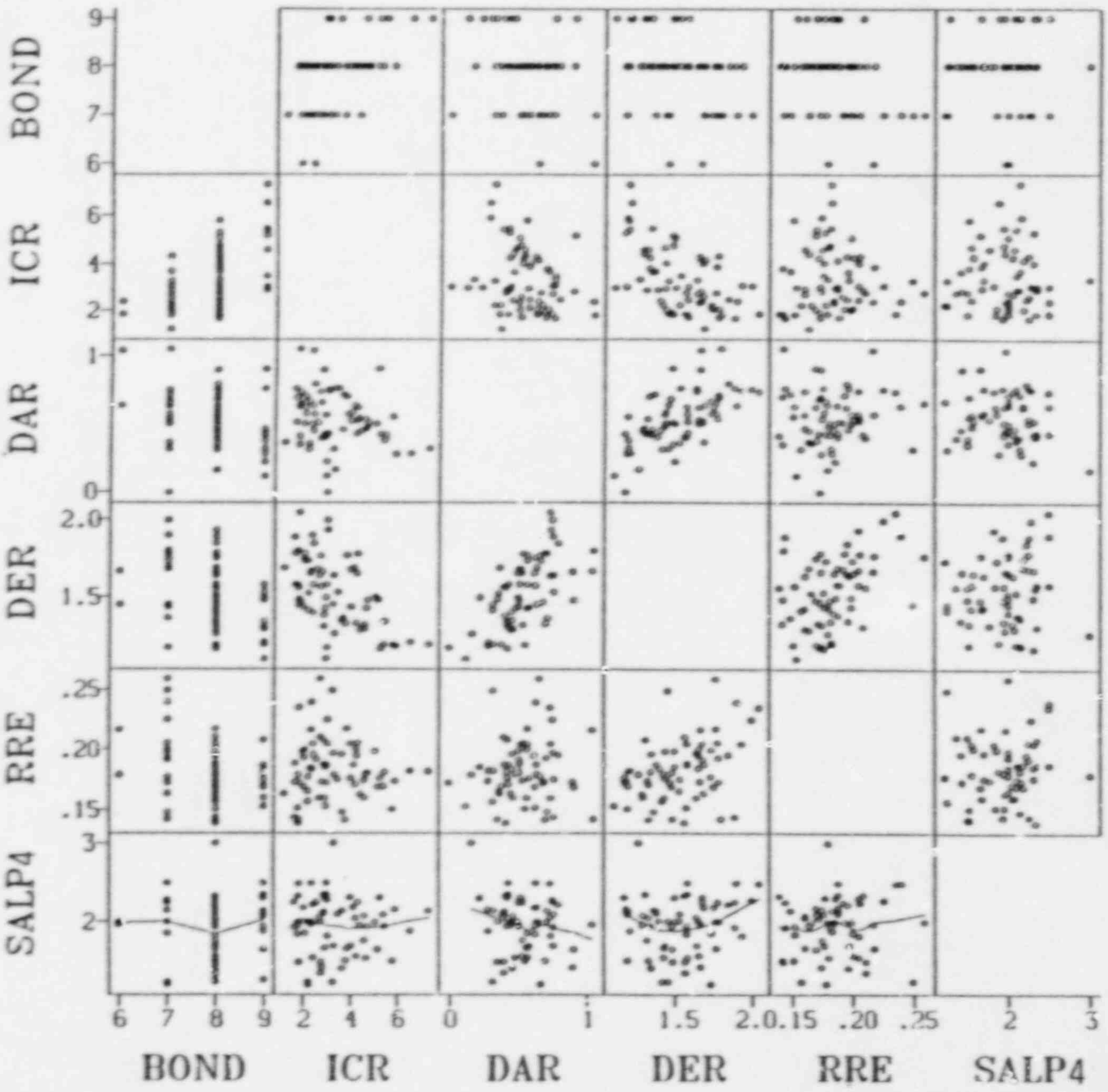

FIGURE 5.16. Relationships Between Financial Qualifications at the CP Stage and Subsequent Safety Performance

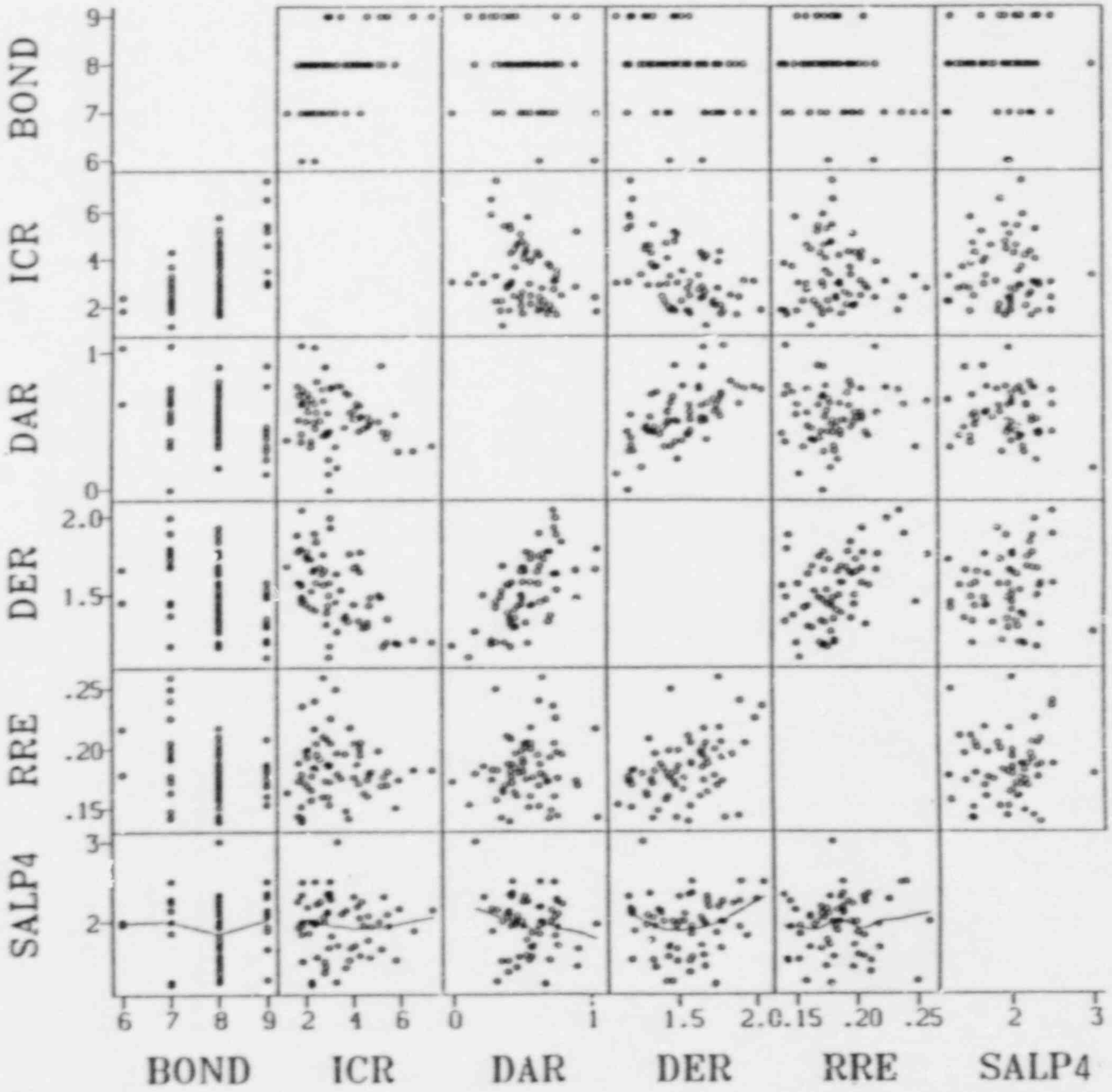

FIGURE 5.16. Relationships Between Financial Qualifications at the CP Stage and Subsequent Safety Performance

rating. Superimposed on the plot is a smoothed curve fit to the data.[a] This line is essentially the estimated average value of SALP as a function of bond rating. If SALP4 were related to bond rating, one would expect the line to slant downward from the upper left (poor SALP4, weak bond rating) to the lower right (good SALP4, strong bond rating). In Figure 5.16, the line is nearly horizontal, indicating the lack of any such relationship. Bond ratings at the time of the CP do not appear to be associated with subsequent safety performance as measured by SALP4.

The bottom row, second column gives the results for interest coverage ratio. If the ratio were related to plant safety, one would again expect to see a line slanting from the upper left (poor SALP4, low interest coverage) to the lower right (good SALP4, high interest coverage). Once again, the line is nearly horizontal and there is no indication of a relationship.

In the bottom row, third column is the scatterplot for debt/asset ratio. Here, the expected line should slant from the lower left to the upper right, because a high debt/asset ratio is bad, as is a high SALP4 score. The actual line is nearly horizontal; there is some indication of a nonzero slope, but if anything the line slants in the wrong direction. Thus, debt/asset ratio does not appear to be reasonably related to subsequent safety performance as measured by SALP4.

The next plot in the bottom row shows SALP4 versus debt/equity ratio. Since a low debt/equity ratio is an indicator of financial wealth, one would expect to see a trend from the lower left to the upper right. Despite some of the expected curvature toward the right of the plot, the overall impression is flat. Again, no relationship is readily apparent.

The plot of SALP4 versus rate of return on equity is in the fifth column of the bottom row. Since a high rate of return is good for a utility's financial health, the expected trend is from the the upper left to the lower right. The smoothed curve does not show the expected trend. Again, the data do not support the hypothesis that financial qualifications at the CP stage are related to safety.

To provide a more formal test of the possible relationships between the variables, correlation coefficients were calculated. They are shown in Table 5.2. None of the correlations of the financial measures with the safety

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(a) The smooth curve was obtained by a technique known as "lowess," which is an abbreviation for "locally weighted scatterplot smoothing." Lowess is a robust, highly flexible, generalized technique for fitting a curve to a scatterplot. Unlike conventional methods that fit straight lines, quadratics, exponentials, etc., to the data, lowess allows for curves of arbitrary shape. A detailed explanation of the method can be found in J. M. Chambers et al., Graphical Methods for Data Analysis, Duxbury Press, 1983. The lowess calculations in this report were performed in S, a specialized language and system for data analysis.

TABLE 5.2. Correlation Coefficients for the Scatterplots in Figure 5.16

	BOND	ICR	DAR	DER	RRE	SALP4
BOND		0.54	-0.31	-0.41	-0.25	0.05
ICR			-0.24	-0.58	0.01	0.0
DAR				0.60	0.05	-0.17
DER					0.38	0.04
RRE						0.05
SALP4						

measure are statistically significant. Thus, the statistical tests reinforce the conclusions obtained through the graphical analysis in Figure 5.16.

In addition to the analyses described above, other analyses were also performed using additional variables and measures and alternative statistical approaches. For example, the analyses described above focused on absolute measures of financial health and plant safety. In a separate series of analyses, relative measures were examined to determine whether measures of a utility's health relative to other utilities might be better predictors than the absolute measures. In other analyses, consideration was given to possible effects due to plant age/vintage, plant size, type, and different time windows for the financial and safety measures. In none of these analyses was a statistically significant relationship found between financial qualifications at the CP stage and subsequent safety performance.

5.5 CONCLUSIONS

The potential link between the financial qualifications of the lead utility license applicant at the CP stage and the subsequent safety performance of the operating plant was analyzed empirically in Sections 5.2-5.5. No evidence of a relationship was found. Several qualifications apply to this conclusion, however.

First, the safety measures considered in this study are only approximate measures of plant safety performance following the granting of a CP. The measures used in this study are the best available within the scope of the work. However, it is conceivable that some other safety measure could be developed in the future that might give a different result. This is considered unlikely, for reasons discussed below, but the possibility cannot be ruled out.

Second, the financial measures considered in this study are also approximate. They were selected based on the available data and are supported by the financial analysis literature. Nevertheless it is conceivable, although unlikely, that some other financial measure not considered here might show a positive relationship between financial qualifications at the CP stage and safety.

Third, the population of utilities considered in this study was limited to those which successfully obtained CPs and OLs for their plants. All of the utilities that have built nuclear plants to date have had relatively strong financial qualifications at the time of the CP application. There were, for example, no CP applicants with a bond rating lower than Ba (according to Moody's rating system). The fact that no relationship was found for the utilities in this limited population does not imply that no relationship would exist if utilities with much weaker financial qualifications had received CPs and OLs and were included in the analysis. In other words, if financial qualifications reviews were eliminated, it is possible that financially weak utilities that would not qualify under current regulations would begin to construct nuclear plants, and these utilities might subsequently demonstrate poor safety performance during operation. Although this scenario is conceptually possible, it is not considered likely. A utility with very low bond ratings, for example, would probably have great difficulty raising the funds to build a $5 billion nuclear power plant.

Fourth, the failure to detect a relationship between financial qualifications and safety does not prove conclusively that no relationship exists. It may simply be that the relationship is obscured by other factors. As the data demonstrated, both safety performance and financial qualifications are highly variable. The variation is due to many factors such as management, training, maintenance, aging effects, human performance, etc. The effect of financial qualifications may be real, but so small compared to other sources of variation that it could not be detected by the statistical approach. Intuitively, this seems plausible. With all the factors that can influence plant safety performance either directly (e.g., maintenance) or indirectly (e.g., management), the effect of financial qualifications at one point in time, long before the plant even begins to operate, is likely to be relatively minor.

REFERENCE ABBREVIATIONS

Bernstein	Leopold A. Bernstein, Analysis of Financial Statements, Dow Jones-Irwin, Homewood, Illinois, 1984.
Cygna	Cygna Energy Services, Boston, Massachusetts, Statistical Analysis of Financial Qualifications and Operational Safety for Electric Utilities Operating Nuclear Power Reactors, August 9, 1984.
DOE 85	U.S. Department of Energy, U.S. Central Station Nuclear Electric Generating Units: Significant Milestones, DOE/NE--0030/12, May 1985.
Hyman	Leonard S. Hyman, America's Electric Utilities: Past, Present and Future, Public Utilities Reports, Inc., Arlington, Virginia, 1988.
NERA	A. Gerber, H. G Rosen, National Economic Research Associates, Inc., Palm Beach, Florida, An Analysis of the NRC Proposal to Eliminate the Review and Findings of Financial Qualifications of Utility Applicants for Licenses to Operate Nuclear Facilities, May 31, 1984.
NRC 1986	U.S. Nuclear Regulatory Commission, 1986 Annual Report, NUREG-1145, Vol. 3, June 1987.

APPENDIX A

PREVIOUS ANALYSES OF THE RELATIONSHIP BETWEEN FINANCIAL QUALIFICATIONS AND NUCLEAR POWER PLANT SAFETY PERFORMANCE

APPENDIX A

PREVIOUS ANALYSES OF THE RELATIONSHIP BETWEEN FINANCIAL QUALIFICATIONS AND NUCLEAR POWER PLANT SAFETY PERFORMANCE

Two previous empirical analyses examined the relationship between financial health of investor-owned nuclear utilities and the safety performance of their nuclear power plants. Both studies were performed in 1984 in response to NRC's rulemaking that eliminated financial qualification review for electric utilities seeking OLs and reinstating such review for CP applicants.[a] The first study was prepared by National Economic Research Associates, Inc. (hereafter cited as the "NERA" report).[b] The second study was prepared by Cygna Energy Services (hereafter cited as the "Cygna" report).[c] Both studies examined the financial health-operational safety relationship using contemporaneous financial and operations data--that is, they attempted to correlate financial health of a utility in a given year with safety performance in that same year. Thus, both analyses have limited applicability in the current case, since neither focused on whether safety performance was correlated with financial health at the CP stage.

The NERA study discussed the question of financial incentives and counter-incentives involved in operating nuclear power plants. The authors analyzed the ratemaking context for electric utilities and concluded that the financial incentives do not favor reducing the operating and maintenance expenditures associated with nuclear power plants, which might in turn reduce safety performance. Specifically, they concluded that the financial risks of an extended shutdown caused by cutting corners on operations and maintenance far outweigh any potential short-term financial gain that might be achieved and that there are far more attractive cost-saving opportunities for utilities that do not involve comparable regulatory and financial risks.

(a) 49 Federal Register 13044, April 2, 1984. See also Table 2.1.
(b) A. Gerber and H. G. Rosen, National Economic Research Associates Palm Beach, Florida, An Analysis of the NRC Proposal to Eliminate the Review and Findings of Financial Qualifications of Utility Applicants for Licenses to Operate Nuclear Facilities, May 31, 1984. The report was submitted as an attachment to a June 1, 1984 letter comment by the Washington, D.C. law firm of Shaw, Pittman, Potts, and Trowbridge on the NRC's April 2, 1984 proposed rule. The letter and the report are available through the NRC Public Document Room.
(c) Cygna Energy Services, Boston, Massachusetts, Statistical Analysis of Financial Qualifications and Operational Safety for Electric Utilities Operating Nuclear Power Reactors, August 9, 1984. The report was submitted as an attachment to an August 10, 1984 letter comment by Shaw, Pittman, Potts, and Trowbridge on the April 2, 1984 proposed rule. The letter and the report are available through the NRC Public Document Room.

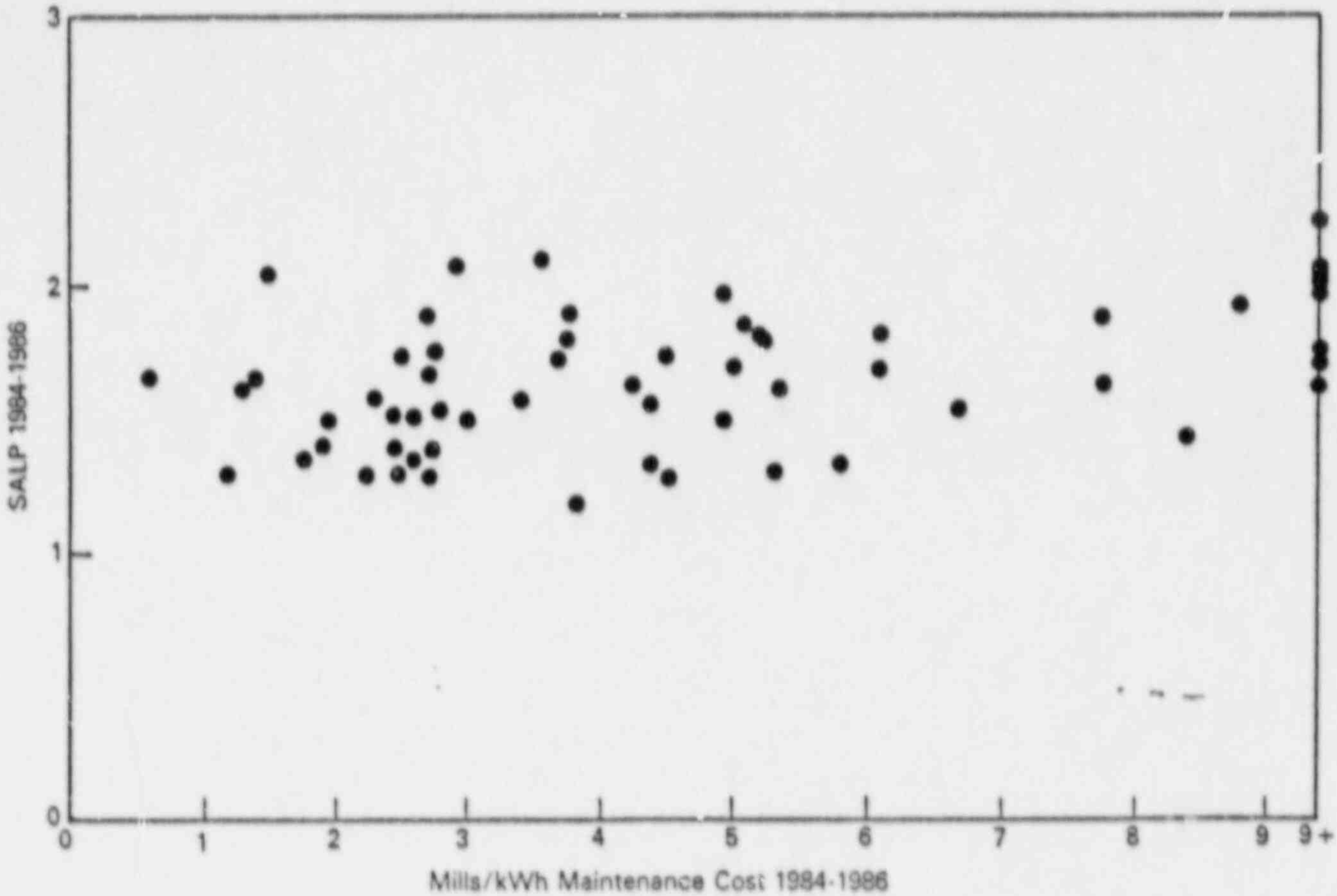
NERA also performed a series of regression analyses to examine the relationship between utility financial health and safety performance. Two financial measures were used to quantify financial strength: the ratio of cash flow to construction expenditures, and the interest coverage ratio (the ratio of pretax earnings before interest payments to total annual interest payments).[a] The higher the cash-flow ratio, the smaller the proportion of its construction funds the utility must raise from capital markets. The higher the interest coverage ratio, the more credit-worthy the utility is considered to be because it can more easily meet its fixed interest obligations. NERA elected to use two measures of maintenance expense--nuclear operations and maintenance expense as a percent of total cost and the growth rate in nuclear operation and maintenance expense. Low values for either measure could be construed as evidence of "corner cutting" on maintenance.[b] The authors did not find a statistically significant correlation between financial health (measured either way) and operations and maintenance expenditures (measured either way).

The NERA report addressed only contemporaneous financial condition as an explanation of safety performance and therefore did not discuss whether prior financial condition at the OL or CP stage is relevant to subsequent safety performance. This limitation diminishes the report's usefulness for the present study. However, an additional limitation of the NERA report is that the authors measured safety performance by looking only at current operation and maintenance expenditures rather than actual safety performance. A plot of maintenance cost and average SALP score shown in Figure A.1[c] suggests that higher maintenance expenditures are relatively uncorrelated with safety performance.

The Cygna analysis also examined the relationship between the contemporary financial condition of utilities and their safety performance. Cygna utilized different variables than the NERA study to measure financial health and safety performance. The two measures of financial performance used were the utilities' adjusted earnings per share of common stock and bond ratings. Earnings per share is a measure of profitability of the utility and therefore in one sense a measure of its financial health. The authors of the Cygna report adjusted the earnings per share figure by subtracting allowance for funds used during construction, an artificial bookkeeping addition to income that does not reflect actual cash flow to the utility and does not contribute to financial health. The bond ratings were assigned a numerical scale by the authors corresponding to ratings assigned in Moody's Public Utilities Manual.

To measure safety performance, the Cygna study authors considered using both SALP scores and enforcement statistics from the NRC's Inspection and Enforcement Program. At the time the Cygna study was performed there was not enough data yet available from the SALP program to permit an evaluation to be made. Consequently, the authors utilized data on the number of noncompliances

(a) The interest coverage ratio definition discussed in Section 4 is different from the definition used by the NERA report authors.
(b) The relationship of these two measures to plant safety is conjectural.
(c) Nucleonics Week, August 13, 1987, pp. 10-12.



Source: Plotted from data in Nucleonics Week, pp. 10-12, August 13, 1987.

FIGURE A.1. SALP Score vs. Maintenance Cost for Nuclear Power Plants

per number of inspection man-days spent at a nuclear power plant by NRC inspectors to measure safety performance. The data source used by Cygna contained annual data on noncompliances between 1977 and 1982. The number of noncompliances per man-day was designated as the safety "performance factor."

Cygna then performed three analyses. The first was to plot and visually inspect the data to see if there was any apparent correlation between the two financial variables and the performance factor. None was found. Second, they performed a Kendall rank correlation test to see if utilities having lower rated bonds had poorer performance factors. Rank correlation was used because the Moody's bond ratings only reflect ordinal ranking (e.g., one cannot say whether a Moody's rating of Aaa is 10% better than a rating of Aa, only that it is better.) No correlation was found. Third, the authors tested whether adjusted earnings per share correlated with their chosen performance factor after first checking to see whether it was statistically legitimate to pool the data for individual utilities. No statistically significant differences were found among the utilities; nor were any of the correlation coefficients statistically different from zero. Based on these results the authors concluded that there was no correlation between utility financial health and safety performance.

Over the six year period covered in the Cygna study, most utilities did not experience a change in their bond ratings. The vast majority of the bonds carried a rating of Aa, A, or Baa for the whole period studied. Cygna's safety performance measure, the number of noncompliances found per inspection man-day, varied continuously over the period. The fact that there were a large number of tie scores for bond ratings is important, since the Kendall rank correlation statistic reported by Cygna was apparently not adjusted for tie scores. When we corrected the rank correlation statistic in the Cygna report for the year 1977, the rank correlation that year increased from 0.01 to 0.19. This is still not statistically significant; however, any rank correlation of utility performance using bond ratings should adjust for tie scores.

In summary, neither the NERA or Cygna studies lead to the expectation that the financial health of utilities at the CP stage is correlated with the safety performance of operating nuclear power plants. However, because these studies focused on financial health and safety performance during the operating period alone, neither answers the specific question of whether financial health at the CP stage has any correlation with subsequent safety performance.

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The NRC and its predecessor the AEC have had a regulatory requirement since 1956 that utilities seeking a construction permit for a nuclear power plant be financially qualified to construct and operate the plant. Several amendments to the requirements were made over the years including an attempt in 1982 to drop financial qualification review for electric utilities. This attempt was subsequently found invalid by a federal court. Nevertheless, financial qualification reviews consume significant amounts of NRC staff time and time at Atomic Safety and Licensing Board hearings. The analysis reported in this study was conducted to determine whether there is any empirical evidence of a relationship between a utility's financial health at the time of its construction permit application and the subsequent safety performance of the operating plant. The principal financial measures used to test for this relationship were bond rating, interest coverage ratio, debt/asset ratio, debt/equity ratio, and rate of return on equity. The principal safety measure was the long-term average of the scores assigned the utility in four key areas by the NRC under the Systematic Assessment of Licensee Performance program. The results of the analysis showed no evidence of a relationship between financial health at the time of the construction permit and subsequent safety performance.

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