RESOURCE CONSERVATION AND RECOVERY ACT
SUBTITLE C - HAZARDOUS WASTE MANAGEMENT

Section 3004 - Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR Parts 264 and 265, Subpart H
Financial Requirements

BACKGROUND DOCUMENT FOR THE FINANCIAL TEST & MUNICIPAL REVENUE TEST FINANCIAL ASSURANCE FOR CLOSURE AND POST-CLOSURE CARE

APPENDIX A

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OFFICE OF SOLID WASTE

November 30, 1981

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I. GENERAL ANALYTIC APPROACH

A. Introduction

The financial responsibility regulations under RCRA reproposed on May 19, 1980 included a financial test as an option for demonstrating a firm's capability to meet the costs of its facility closure and post-closure obligations. The proposed financial test for closure and post-closure care included elements designed to verify the current ability of a firm to pay such costs (net working capital equal to or greater than twice the estimated closure and/or post-closure costs: a minimum of $10 million in net worth), and a financial ratio designed to indicate the overall viability of a firm (a total liabilities to net worth ratio of less than 3 to 1). The financial test provision prompted many public comments. Several commenters expressed general reservations about the validity of the financial ratio used as an indicator of viability, or questioned the net working capital or net worth requirements, and suggested that an evaluation of financial test performance should be carried out to determine the effectiveness of financial tests. The Agency agreed with this proposal, and conducted a rigorous and comprehensive evaluation of over 300 alternative financial tests.

This Appendix describes the methodology employed in performing this evaluation and summarizes the results of the analysis which provide a set of "best" candidate tests. The results of special analyses, performed to determine the comparative effectiveness of one-year versus three-year eligibility requirements, and the need for specialized, industry-specific ratio tests, are also summarized in this Appendix. The "best" candidate tests were further evaluated against a set of algorithms designed to estimate the total direct public and private costs that would result from their implementation. The results of the cost calculations performed, and their implications for the final selection of a financial test, are discussed in Appendix B of this Background Document.

B. Possible Elements of Financial Tests

The ideal financial test would pass all firms capable of meeting their closure and post-closure obligations while failing all firms that would enter bankruptcy and not be able to meet those obligations. Unfortunately, no method of financial forecasting is capable of achieving this ideal. It is therefore useful to examine a range of possible financial tests. Some of these tests have the advantage of eliminating almost all firms that would be unable to meet their closure and post-closure obligations, but at the same time they also eliminate a large number of firms that could meet those obligations; other tests have the advantage of passing a much higher percentage of the firms that could meet those obligations but they eliminate fewer firms that could not meet their obligations.

A firm may be unable to meet its closure and post-closure obligations for a variety of reasons. In addition to the ordinary business misfortunes which may lead a firm into bankruptcy, a firm owning a hazardous waste treatment, storage or disposal facility (TSDF) might fail to meet those specific obligations as a result of unique events. For example, a firm that might otherwise not have entered bankruptcy may be forced into bankruptcy if its permit is suddenly withdrawn and it suddenly has to put up the necessary funds for closure and post-closure. A firm also might enter bankruptcy unexpectedly as a result of large cleanup or repair expenditures unique to a hazardous waste TSDF or of a large liability judgment.

This Appendix analyzes the performance of different possible financial tests, with respect to the percentage of firms which pass the tests and could meet their financial obligations, and the percentage of firms that could not meet their obligations but still pass a given test. The question of what test is to be preferred must then be determined by the relative costs associated with the different tests.

Three types of elements which might be used as criteria in financial tests are considered in this Appendix:

(1) Financial ratios: These are ratios of the financial variables found in the income statements or balance sheets of firms.

(2) Multiples: In this text, these are measures of unencumbered assets and/or liquidity as multiples of the specific financial obligation considered (closure and post-closure).

(3) Net worth: This is a requirement, independent of the multiple requirement described above, that a firm must have net worth above a specified level.

Each of these possible elements of financial tests has a potential role in limiting the number of firms that will fail to meet their financial obligations. By requiring firms to meet specific requirements with respect to their financial ratios in order to pass a financial test, it is possible to limit the percentage of firms which pass the financial test but which ultimately enter bankruptcy. Multiples serve to ensure that the financial obligation itself does not have so great an effect on the firm that it is a cause for bankruptcy. Without multiples as a part of the test, a small firm with excellent financial ratios might still be unable to meet its closure and post-closure obligations because of the large size of their obligations relative to the size of the firm itself. A minimum net worth requirement serves two purposes: (1) it has been found that the larger the firm the less likely it is to fail, and (2) significant size enables the firm to withstand unusual contingencies associated with the ownership of hazardous waste TSDFs. Financial ratios and minimum net worth requirements both can help to ensure that the failure rate of the firms which will pass the financial test is lower than the average failure rate for all firms. The multiple element of the test and the minimum net worth requirement help to ensure that the failure rate of the firms considered is not higher than that for firms in all industries, due to the unusual size of these special financial obligations relative to the size of the firm or due to contingencies associated with the ownership of hazardous waste TSDFs.

C. Overview of the Methodology

This Section, and Figure I-1, provide an overview of this Appendix by outlining the major steps of the methodology employed. Detailed discussions of the topics outlined in this section are then presented in the following sections of this Appendix. Figure I-1 illustrates in

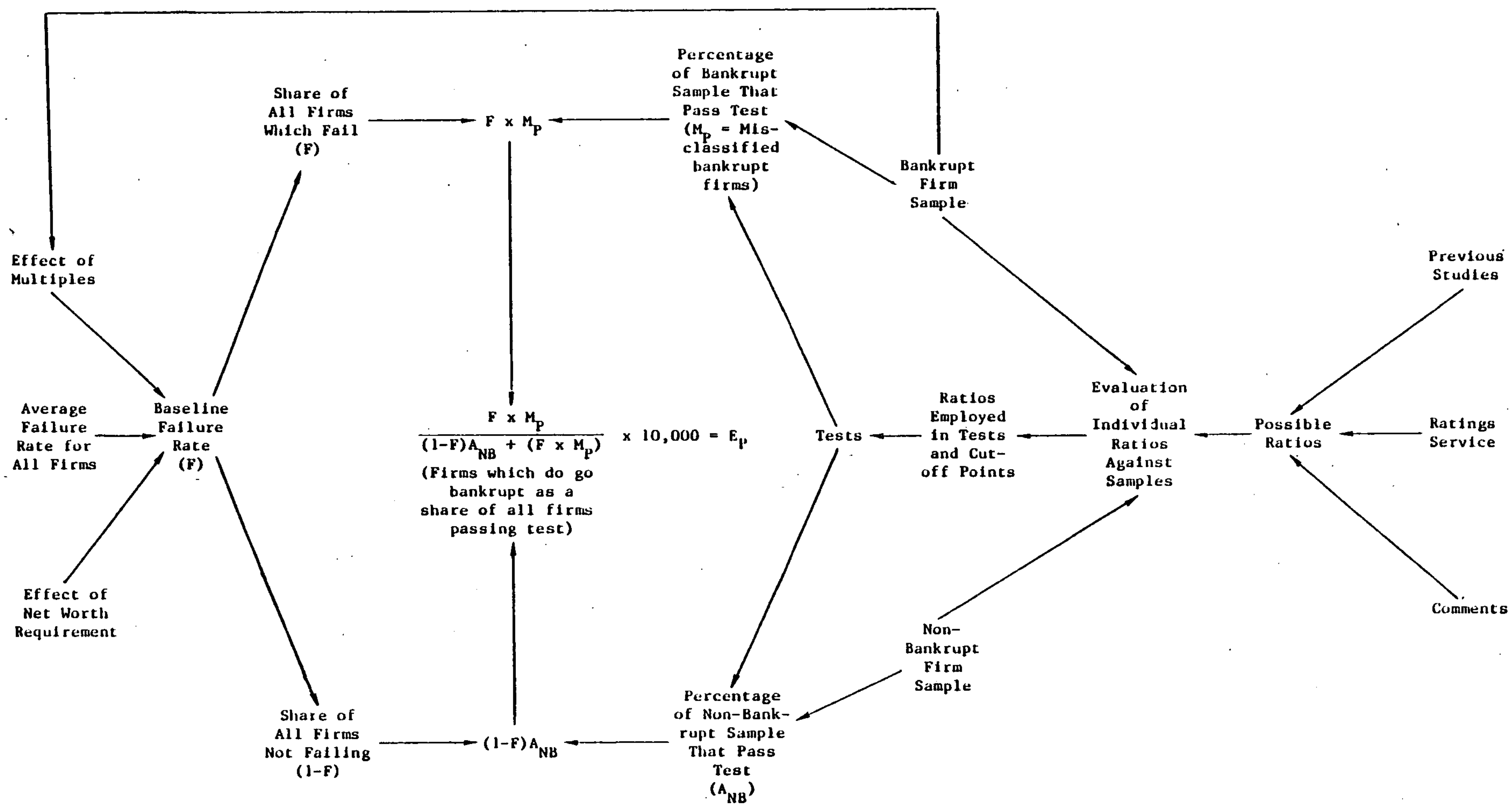

FIGURE I-1

APPENDIX A METHODOLOGY

particular the steps which were used to derive the effectiveness measure (E_p) of any given test, that is, the most probable estimate of the number of firms per 10,000 which pass a given financial test but later fail without providing alternative financial assurance.

1. Determination of Baseline Failure Rate

In order to compare the effectiveness of various tests, with respect to the relative costs associated with these tests, it is necessary to determine the failure rates of the set of firms which may use a financial test as evidence of financial responsibility. The baseline failure rate (F) is derived by first determining the average failure rate for all firms based on the historical data, and then by adjusting this rate to account for the effect of a net worth requirement on the average failure rate for firms which may be eligible for a financial test. In addition to determining the failure rate of firms, a financial test includes a multiple requirement to provide assurance that at the time a firm ceases to pass the test it will continue to possess assets sufficient so that it is able to pay for closure and post-closure costs. Otherwise, it is possible that the attempt to pay these costs will be sufficient to force the firm into bankruptcy before these closure and post-closure costs have been fully paid. In the nomenclature adopted in this Appendix, the fraction of all firms considered which will go bankrupt is designated as F; the fraction of all firms considered which will not go bankrupt is equal to 1-F.

2. Selection of Financial Ratios

The financial ratios to be evaluated as candidate ratios for the financial test were selected from three sources: (1) comments received on the May 19, 1980 regulation; (2) surveys of opinions of bond rating services and credit analysts; and (3) existing literature on bankruptcy forecasting. The list of ratios assembled was extensive and varied widely in content and estimated effectiveness.

An initial set of financial ratios was chosen for further evaluation because they satisfied three basic conditions: (1) they produced significant predictive results in the prior literature; (2) they were frequently identified by bond rating services and credit analysts as key parameters; and (3) their values were readily available from corporate balance sheet data.

3. Sample Selection

In order to determine the effect of financial ratio tests, the Agency gathered samples of non-bankrupt and bankrupt firms. Non-bankrupt firms, also referred to as viable firms, are firms that did not enter bankruptcy within three years of the time period for which data were gathered. For bankrupt firms, financial data were gathered for three years prior to the time the firm entered bankruptcy. The sample of bankrupt firms was gathered from a variety of sources. The sample of non-bankrupt firms was gathered using the Industry Index of Moody's Industrial Manual to determine members of industrial categories that generate, treat, store, or dispose of hazardous waste on-site.

4. Evaluation of Financial Ratios

These ratios were first tested individually against the primary bankrupt and non-bankrupt firm samples, using a variety of pass-fail cutoff points for each ratio derived from the bankruptcy forecasting literature. A second set of financial ratios was then selected and tested against a sample of bankrupt and non-bankrupt firms which were consistently misclassified by the original ratios, to determine if there were additional financial ratios which would improve the predictive ability of a test.

5. Design of Financial Tests

The most promising ratios were combined to form 151 alternate multi-ratio tests. The ratios were combined in three ways: (1) two-ratio tests (firms must pass both elements of the test to pass); (2) three-ratio tests (firms must pass all three elements of the test to pass); and (3) three-ratio contingent tests (firms must pass two of three conditions to pass). The tests were then retested against the primary sample to derive for each test the percentage of bankrupt firms of the sample that pass the test and are therefore misclassified by the test (M_P) and the percentage of the non-bankrupt firms sampled which pass the test (A_{NB}).

6. Determining the Effectiveness Measure (E_P) for a Given Test

The effectiveness measure for any given test is calculated according to a two-step process (see Figure I-1 above.) First, the fraction of all firms which will go bankrupt (F) is multiplied by the percentage of the bankrupt firm sample that is misclassified by a given test (M_P), that is, pass the test but later enter bankruptcy. This provides the fraction of all firms considered that pass a particular test and later go bankrupt (F x M_P). Similarly, the share of all firms that will not fail (1-F) is multiplied by the percentage of the non-bankrupt firm sample which pass the test (A_{NB}). This provides the fraction of firms that pass a given test and do not go bankrupt (1-F)A_{NB}.

Finally, the Agency uses F x M_P and (1-F)A_{NB} to calculate what fraction of all firms that pass a given test are firms which will go bankrupt (in Figure I-1 this operation is represented by F x M_P divided by the total of all firms which pass the test ((1-F)A_{NB} + (F x M_P)). This fraction is then multiplied by 10,000 to yield the number of firms per 10,000 that pass a given financial test that will go bankrupt. This number (E_P) is the measure of effectiveness of a given test.

7. Use of Performance Curves to Select the Best Financial Test

As discussed above, a financial test has two basic performance measures: (1) the percentage of non-bankrupt firms that can pass the test (A_{NB}): and (2) the number of firms per 10,000 that pass the test that will later enter bankruptcy without providing alternative financial assurance (E_P). The Agency developed performance curves consisting of those tests which pass the maximum percentage of non-bankrupt firms for any given percentage of firms that pass the test and later enter bankruptcy. The Agency used these curves in the analysis described in Appendix B to evaluate the relative costs of alternative tests and to determine a best single financial test.

8. Comparison to Other Tests

The resulting performance curves for the tests developed in this study were then compared to the May 19, 1980 proposed financial tests and the results of other bankruptcy forecasting studies.

9. Industry-Specific Problems

Although a given financial test may serve quite well for most industries, it is possible that unique characteristics of a specific industry may cause a high percentage of the viable firms in that industry to fail a given test. In order to determine the importance of such problems, the Agency examined the financial characteristics of firms in various manufacturing industries likely to dispose of hazardous waste, electric utilities, and hazardous waste management firms.

10. The Role of Bond Ratings in a Financial Test

Section VII of this Appendix discusses the use of bond ratings as either a substitute for or a supplement to other elements of the financial tests considered elsewhere in this Appendix.

D. Comparison to Alternative Methodological Approaches

The methodology adopted by the Agency and outlined in Section I.C. is not the only methodology that might be employed to derive a set of financial tests. This Section considers three alternative approaches: (1) the use of functions of financial ratios rather than cutoff points for financial ratios; (2) the development of industry-specific financial tests rather than single tests for all industries; and (3) the use of population sampling instead of the sampling procedure employed in this analysis.

1. The Use of Functions of Financial Ratios

The approach used by the Agency was to examine a series of financial tests consisting of requirements that specific financial ratios be at certain levels. An alternative approach would be to design financial tests that consisted of linear or nonlinear functions of a set of financial ratios (for example, a linear function of financial ratios would be a test that required that $(a \times R_1) + (b \times R_2) + (c \times R_3) > d$, where a, b, c, and d are constants and R_1, R_2, and R_3 are ratios). Three methods have been proposed in the literature for developing financial tests that consist of functions of financial ratios.

One approach is to rely on expert judgment to decide which ratios should be included and what values should be associated with them (see Tamari, 1966). This approach has the disadvantage that there is no statistical method of determining whether the ratings or the financial ratios chosen have been appropriately determined.

A second approach that has been proposed is to develop a functional model of the factors that lead to business failure and to use this model to estimate the probabilities of business failure for any specific firm. Though theoretically elegant, this approach has only been attempted once in the literature reviewed for this study, and that attempt did not include any statistical validation of the model (Wilcox, 1971, as discussed in McWilliams, 1977).

The Agency decided not to develop a functional model for two reasons. First, the time available in which to carry out the study of a financial test option was relatively short and might not have allowed sufficient research and refinement of the model to produce useful results. Second, because the technique was untested in this application, the Agency was concerned that it might prove unsatisfactory, and that, if it were not effective, insufficient time would be available to carry out an alternative analysis.

The third approach, and that most commonly used in the bankruptcy forecasting literature, is that of multi-discriminant analysis. This is a statistical search technique for arriving at the best linear or non-linear function for a set of chosen financial ratios for discriminating between bankrupt and non-bankrupt firms. This is the most statistically sophisticated approach to the problem. The use of this approach was rejected in this study for two reasons: (1) a function of financial ratios would be more difficult to compute, more difficult to administer, and more difficult to check quickly than a simple set of ratio requirements; and (2) it has been pointed out several times in the literature on bankruptcy forecasting that multi-discriminant analysis has not yielded more accurate forecasts of bankruptcy than the simpler approach adopted here (Deakin, 1972 and McWilliams, 1977). A comparison of the results of the financial tests developed in this Appendix to financial tests developed in bankruptcy forecasting studies that employed multi-discriminant analysis is included in Section V.

2. <u>Use of Industry-Specific Tests</u>

A number of commenters suggested that the Agency adopt specific tests for different industries. The problem with this approach is the extreme difficulty of gathering sizable samples of bankrupt firms. An extensive search (described in Section III) for firms which had gone bankrupt and which had publicly available financial statements yielded a total of only 95 firms, of which many were retail firms and none were electric utilities. To further subdivide this sample into, for example, two-digit SIC codes would result in samples of bankrupt firms too small to be significant. Thus, while industry-specific tests might be theoretically desirable, they cannot be developed from the data currently available. A review of the bankruptcy forecasting literature found only one study which had developed industry-specific tests (Altman, 1973). This study was of the extremely bankruptcy-prone railroad industry, and still had to use bankruptcies over a period of 50 years in order to develop an adequate sample size.

3. Use of Population Sampling

As outlined in Section I.C., the performance of a financial test was developed in two steps: first, the development of a baseline failure rate, and second, the determination of how this baseline failure rate was reduced by the performance of a specific test. The performance of each test was measured against the samples of bankrupt and non-bankrupt firms. An alternative procedure would be to gather relevent data for a large population of firms, determine which ones later entered bankruptcy and which ones did not, and then examine each test against this entire sample for its ability to forecast bankruptcy. The problem with this approach is that bankruptcy is a relatively rare event. The average business failure rate in the post-war period has been approximately 44 per 10,000 firms per year. This implies that in order to obtain a sample of bankrupt firms as large as that used in this study, it would have been necessary to obtain data on a total of 15,000 firms. Such an effort would have been beyond the scope of this study, and has not been attempted in any previous study of bankruptcy forecasting. The structured sample employed in the study should provide, however, approximately equivalent results.

II. BASELINE FAILURE RATES AND DETERMINATION OF MULTIPLES

A. Baseline Failure Rates

This Section explains how the Agency determined a baseline failure rate applicable to large firms from the existing data on failure rates by size of firm. For the purposes of this study, "large firms" were considered to be firms with over $10 million in net worth.

Table II-1 is a compilation by Dun & Bradstreet of historical failure rates per 10,000 firms, incorporating all sizes of firms. As shown in the Table, the arithmetic mean for the period 1950-1978 is 44 business failures per year per 10,000 firms. This is probably too high a baseline failure rate for the kinds of large firms considered in this study. Greater assets and net worth reduce the probability of corporate failure. The failure rates shown in the Table for all firms thus may overstate the rate of failure for large firms. Altman suggests a reason for this phenomenon:

> [M]any of these companies are not permitted to fail. Except in the event of fraud, or where the failing company is simply too large, we rarely observe in the decades before 1970 firms of over $25 million in assets actually going bankrupt. In many cases, the financially troubled firms can expect to be wooed by a highly liquid or managerially rich firm, usually resulting in a merger absorption before insolvency in a bankruptcy sense occurs. (Altman, 1971)

During the period from 1969 to 1974, for example, Douglas Aircraft, Ling-Temco-Vought, Lockheed Aircraft, and Mohawk Data Sciences came very close to failing, but failure was prevented by government intervention or private sector efforts (Altman et al., 1977).

Precise quantitative data on failure rates by size of firm are not available. Dun & Bradstreet, which maintains the only extensive failure

TABLE II-1

ANNUAL BUSINESS FAILURE PER 10,000 FIRMS

Years	Arithmetic Mean	Maximum Year	Number of Years Over 60
1970-78	36	44	0
1960-69	52	64	2
1950-59	42	56	0
1940-49	26	63	1
1930-39	86	154	8
1950-1978	44	64	2
1930-1978	49	154	11

SOURCE: Derivation from Dun & Bradstreet (1979).

rate data now published, does not regularly provide data on failure rates by size of assets, sales, or net worth. Although a good deal of indirect evidence suggests that larger firms have substantially lower failure rates, a combination or comparison of the different data bases is difficult. The estimate in this study of the baseline failure rate for large firms was derived from the following sources:

(1) Dun & Bradstreet publications on the relationship between credit ratings and failure rates;

(2) Quantitative data from Altman (1971) combined with IRS statistics on the number of corporations above a given size; and

(3) A study by Richard C. Edwards on long-term failure rates for very large firms.

1. Failure Rates by Credit Ratings and Firm Size

Dun & Bradstreet credit ratings are composed of two elements -- size and creditworthiness. Size is defined as the companies' tangible net worth. Creditworthiness is rated from 1 (high) to 4 (limited). Table II-2 provides the key to the ratings classifications.

A study of the relationship between business failures and these Dun & Bradstreet credit ratings has been published. The results of the study are presented in Table II-3. Because the size categories are approximately equal to the tangible net worth of the firm, two conclusions can be drawn from the results in this Table. First, firms in the top two categories for financial strength (representing firms of above $50 million in tangible net worth and firms of between $10 and $50

TABLE II-2

KEY TO RATINGS

Estimated Financial Strength				Composite Credit Appraisal			
				High	Good	Fair	Limited
5A	Over		$50,000,000	1	2	3	4
4A	$10,000,000	to	50,000,000	1	2	3	4
3A	1,000,000	to	10,000,000	1	2	3	4
2A	750,000	to	1,000,000	1	2	3	4
1A	500,000	to	750,000	1	2	3	4
BA	300,000	to	500,000	1	2	3	4
BB	200,000	to	300,000	1	2	3	4
CB	125,000	to	200,000	1	2	3	4
CC	75,000	to	125,000	1	2	3	4
DC	50,000	to	75,000	1	2	3	4
DD	35,000	to	50,000	1	2	3	4
EE	20,000	to	35,000	1	2	3	4
FF	10,000	to	20,000	1	2	3	4
GG	5,000	to	10,000	1	2	3	4
HH	Up	to	5,000	1	2	3	4

SOURCE: Dun & Bradstreet.

TABLE II-3

RELATIONSHIP OF D&B CREDIT RATINGS WITH BUSINESS FAILURES

Rating Category	Percent of Failures Rated High		Percent of Failures Rated Good		Percent of Failures Rated Fair		Percent of Failures Rated Limited	
	1971	1972	1971	1972	1971	1972	1971	1972
5A[1]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4A[2]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3A[3]	0.00	0.01	0.00	0.02	0.33	0.50	0.00	0.00
2A	0.00	0.00	0.09	0.04	0.37	0.23	0.00	0.00
1A	0.00	0.00	0.00	0.00	0.36	0.25	4.00	0.00
BA	0.00	0.00	0.05	0.03	0.30	0.15	0.31	0.00
BB	0.00	0.00	0.02	0.02	0.35	0.18	1.50	0.00
CB	0.00	0.01	0.04	0.05	0.31	0.28	1.17	1.02
CC	0.00	0.01	0.05	0.04	0.39	0.36	1.65	1.48
DC	0.01	0.00	0.05	0.05	0.37	0.43	1.46	2.46
DD	0.01	0.02	0.06	0.06	0.41	0.52	2.05	2.04
EE	0.01	0.00	0.08	0.08	0.46	0.52	1.89	0.00
FF	0.00	0.02	0.08	0.09	0.46	0.49	1.70	1.70
GG	0.05	0.06	0.08	0.08	0.43	3.63	1.33	1.40
HH	0.00	0.00	0.07	0.06	0.21	3.50	0.50	3.49

SUMMARY

Percent Failures to Listings Rated

	1971	1972
High	0.004%	0.007%
Good	0.07	0.06
Fair	0.40	0.40
Limited	1.42	1.51
Numeral	0.06	0.07
Blank	0.75	0.64
Total Failures per 10,000 listings	42	38

[1] Category represents firms with over $50 million in tangible net worth.

[2] Represents firms with between $10 and $50 million in tangible net worth.

[3] Represents firms with between $1 and $10 million in tangible net worth.

SOURCE: Sanzo (1974).

million in net worth) have substantially fewer failures for every credit appraisal rating than do firms in lower categories, including firms with from $1 to $10 million in net worth. The Table shows that the percent of failures is .00 percent for the top two credit ratings. However, the failure rate for firms in the financial strength category of 3A or lower, i.e., firms with less than $10 million in tangible net worth, increases, especially for those firms with a "fair" credit rating. The "limited" rating is given to firms for which insufficient data are available to provide a more specific rating. As the Table shows, the majority of firms with a "limited" rating are smaller firms in the lower financial strength categories.

One problem in using these data is that when very large firms, such as W. T. Grant, are believed to be approaching failure, they are not given a "limited" rating but rather are given a special rating indicated by a double hyphen. This means that if Dun & Bradstreet thinks that failure is a possibility for a very large firm, it is not rated at all. Nevertheless, this tends to be a relatively small category (Backer and Gosman, 1978).

Table II-3 also shows that Dun & Bradstreet has greater difficulty accurately rating small firms than large firms. For every credit rating, there are significantly more failures in the small-firm categories than in the respective large-firm categories.

2. Quantitative Data from Altman Analysis and IRS Statistics

In 1970, 12 firms of over $10 million in assets filed for bankruptcy (Altman 1971). At that time, there were 23,300 corporations of over $10 million in assets (U.S. Internal Revenue Service, Statistics of Income, Corporate Income Tax Returns). Thus, the implied bankruptcy rate in 1970 for firms of over $10 million in assets is approximately 5 per 10,000. Given that the failure rate for all firms is over 44 per 10,000, this implies that the failure rate for firms of over $10 million in assets is only about 11 percent of that reported for all firms.

3. Long-Term Failure Rates for Very Large Firms: Data from Edwards Analysis

In a study conducted in 1975, Richard C. Edwards traced the corporate development of 225 very large firms from the years 1919 to 1969. Very large firms in the Edwards study were defined as firms with over $50 million (in 1967 dollars) in assets in the year 1919. This is approximately equivalent to $100 million in assets in 1980 dollars. The purpose of Edwards' study was to determine the extent to which large size alone might effectively prevent the possibility of business failure. Table II-4 shows the results of this study. For comparison, the average failure rate for all firms for this period, as derived from Dun & Bradstreet data, is 61 firms per 10,000. As is shown in the Table, the failure rate for large firms as a percentage of the failure rate for all firms varies from 18 to 32 percent, depending on which class of firms is examined. This wide variance is largely due to the inclusion in the sample of 15 urban transit firms, virtually all of which failed during the 1920's and 1930's.

4. Summary of Failure Rate Data Bases and Conclusions

Table II-5 summarizes the results discussed above. These results strongly suggest significantly lower failure rates for larger firms, but

TABLE II-4

FAILURE RATES OF VERY LARGE FIRMS

Class of Firm	Number of Firms 1/	Number of Failures 1/	Implied Annual Rate Per 10,000 Firms 2/	Implied Failure Rate as a Percentage of Dun & Bradstreet Failure Rate For all Firms (61/10,000) 3/
Manufacturing	110	8	15	24
All Firms Except Urban Transit	210	11	11	18
All Large Firms	225	22	19.5	32

1/ Number of firms and failures are from Edwards (1975).

2/ Implied failure rate calculated as:

$$\left(1 - \frac{\text{number of failures}}{\text{number of firms}}\right)^{1/50}$$

3/ Derivation from Dun & Bradstreet data.

SOURCE: Derivation from Edwards, 1975.

TABLE II-5

SUMMARY OF EVIDENCE ON FIRM FAILURE RATES
BY SIZE OF NET WORTH

Size Category	Failure Rate as a Percentage of Failure Rate for All Firms
+$10 Million in Net Worth with a D&B Fair Credit Rating (1971-1972)	1
+$25 Million in Net Worth (1970)	11
+$100 Million in Assets (1919-1969)	18-32

a precise estimate is impossible to determine given the quality of the data bases. For example, the estimate of a 1 percent failure rate for firms with over $10 million in net worth as a percentage of the failure rate for all firms based on firms with a Dun & Bradstreet "fair" credit rating is probably an underestimate. Since Dun & Bradstreet provides no data on the distribution of firms by size, it is impossible to determine from Table II-3 if the entries of .00 percent, which Dun and Bradstreet states may be any percentage less than or equal to .004, represent a significant number of firms. Further uncertainty arises from the fact that large firms that are expected to fail are not rated at all.

Although it is impossible to derive a precise failure rate for large firms from the data available, all of the data suggest that the failure rate is at least 50 percent lower than the failure rate for all firms. The Agency concluded that an estimated baseline failure rate of 22 per 10,000 for firms with over $10 million in net worth was reasonable, assuming that the failure rate for large firms would be at least 50 percent lower than the estimated failure rate of 44 per 10,000 for all firms. Considering the quality of the data, however, even smaller failure rates than 22 per 10,000 are possible.

B. Ability to Pay

The fact that a firm has not actually entered bankruptcy does not ensure that it has adequate funds available to meet financial responsibility obligations. This Section therefore describes how the Agency determined if adequate funds would be available to those financially weakest firms which pass a financial test to meet their financial responsibility obligations. If a non-bankrupt firm does not have adequate funds, then such obligations may themselves be a cause of bankruptcy. This Section also describes how the Agency determined what additional requirements are necessary to ensure that such obligations can be met without increasing the failure rate. These determinations were made primarily through the examination of the characteristics of several firms that would pass many possible financial tests and enter bankruptcy within three years of passing the test. Such firms were the financially weakest of all firms that could pass financial tests.

1. Availability of Funds

To analyze the adequacy of the funds available to financially weak firms immediately prior to bankruptcy, the Agency examined a sample of 12 bankrupt firms. These firms passed many ratio tests (see Sections III and IV) three years prior to bankruptcy, and tests which were stringent enough to eliminate them also eliminated a large percentage of viable firms. The fact that several of the 12 firms also passed a number of tests two years prior to bankruptcy indicates that their financial status deteriorated very rapidly. They therefore represent the type of firms most likely to fail a financial test only at the point where they lack sufficient funds to establish an alternate form of financial assurance. The Agency examined financial data for these firms to determine whether they would have been able to meet financial responsibility obligations at the time they were eliminated by a financial test.

Table II-6 shows, for the 12 firms, the changes in net working capital, net worth and quick assets occurring over the three years preceding bankruptcy. As can be seen from this Table, even if these firms did not fail a financial test until two years prior to bankruptcy, all of the firms still would have had positive net worth and some quick assets. In fact, the quick assets of most of these firms increased between the third and second year prior to bankruptcy. Therefore, if these firms had failed a financial test two years prior to bankruptcy, they would have had significant amounts of cash and other liquid assets. Current assets would have exceeded current liabilities for two-thirds of the firms, and total assets would have exceeded total liabilities for 11 of the 12 firms.

If the establishment of an alternative means of financial assurance for these firms were delayed by, for example, legal proceedings, Table II-6 shows that 66 percent of the firms (8 out of 12) still would have had positive net working capital one year prior to bankruptcy. All except one firm would have had positive net worth, and all would have had significant quick assets. Therefore, with a delay up to one year prior to bankruptcy, 66 percent of the firms would have maintained adequate cash and net working capital to pay at least some of their obligations. Furthermore, negative net working capital alone does not necessarily imply that a firm cannot pay any of its debts. A conservative conclusion would be that if legal proceedings normally took one year or less, at least 50 percent of the firms that pass the test up to two years prior to bankruptcy would still have sufficient funds to establish an alternative form of financial assurance.

TABLE II-6

CHANGES IN KEY FINANCIAL PARAMETERS FOR 12 BANKRUPT FIRMS LIKELY TO BE MISCLASSIFIED BY A FINANCIAL TEST

Company Name	Percent of Decline From 3 Yrs To 2 Yrs Prior to Bankruptcy			Percent of Decline From 2 Yrs to 1 Yr Prior to Bankruptcy			Percent of Decline From 3 Yrs to 1 Yr Prior to Bankruptcy		
	NWK	NW	QA	NWK	NW	QA	NWK	NW	QA
Waltham	+ 1/	+	+	- 2/	92.8	35.5	-	90.2	7.3
Bowmar	+	+	+	+	76.4	12.9	+	50.7	+
Polarad	60.9	41.9	+	+	16.7	26.1	34.8	51.6	15.0
Beck	+	+	+	+	+	+	+	+	+
Unishops	+	11.5	+	-	-	+	-	-	-
Uniservices	+	+	+	66.7	48.5	27.3	40.0	32.0	20.0
Remco	39.7	9.0	+	75.6	84.0	12.3	85.3	85.4	6.5
Maule Industries	-	+	+	-	11.6	50.5	-	+	38.1
M.H. Fishman	4.9	5.7	13.6	2.6	4.6	+	7.4	10.0	+
National Video	NA	+	51.6	21.1	21.2	26.9	21.1	18.9	64.6
Dolly Madison	+	+	+	83.8	5.8	+	75.7	+	+
King Resources	89.5	+	NA	-	65.7	NA	-	38.6	NA

1/ A plus sign indicates that there was an increase in value rather than a decline.

2/ A negative sign indicates that there was a negative value so calculating the percentage decline is meaningless.

NA: Not available

To test this hypothesis, the Agency examined the net working capital and net worth of the entire sample of 66 bankrupt firms. Table II-7 shows that over 88 percent of all of these bankrupt firms had positive net working capital and positive net worth three years prior to bankruptcy. In fact, even one year prior to bankruptcy, 89 percent still had positive net worth and 72 percent still had positive net working capital.

2. Multiple Requirements

Adequate funds will only be available if the net working capital, net worth and quick assets of a firm are large enough to cover its required financial responsibility obligation, without the expenditures themselves causing bankruptcy. Financial test criteria which require net working capital and net worth to be equal to some multiple of the costs of closure and post-closure would help ensure the availability of adequate funds. Table II-6, which gives the rates of deterioration of net working capital, net worth and quick assets for the 12 bankrupt firms discussed above, shows that the quick assets for most of these firms deteriorated relatively slowly. This suggests that a financial test requiring minimum levels of quick assets will not necessarily ensure that adequate funds are available when needed. The percentage declines in net working capital and net worth are significant, and suggest that a test should require that net working capital and net worth be multiples of closure and post-closure costs.

Under normal circumstances, a firm with net working capital equal to twice the estimated closure and post-closure costs would be able to

TABLE II-7

GENERAL ABILITY TO PAY CHARACTERISTICS OF FIRMS APPROACHING BANKRUPTCY

	Years Prior to Bankruptcy		
	x-3	x-2	x-1
Percentage of All Bankrupt Firms with Positive Net Working Capital	88	79	72
Percentage of All Bankrupt Firms With Positive Net Worth	97	97	89

pay these costs without threatening its continued viability. Inspection of the financial data of bankrupt firms, however, indicates that net working capital may often decline precipitously as bankruptcy nears. Furthermore, firms approaching bankruptcy may frequently experience negative cash flow, which will place additional burdens on available net working capital. Nine of the 12 firms sampled, for example, had negative cash flows in the year prior to bankruptcy. Therefore, a financial test should require that net working capital be a multiple of closure and post-closure costs, in order to provide the Agency with a reasonable probability that a firm will have resources available for the establishment of an alternative form of financial assurance.

The Agency determined the appropriate multiple by assuming that if a firm met this multiple requirement three years prior to bankruptcy, then it would still have sufficient funds for its financial responsibility obligations one year prior to bankruptcy. This requirement can be derived in the following way:

(1) $V_3 \geq M \times FR$

(2) $V_1 \geq FR$,

where V_3 is the value of net worth or net working capital three years prior to bankruptcy, V_1 is the value of net worth or net working capital one year prior to bankruptcy, M is the value of the multiple, and FR is the value of the financial responsibility obligation (closure costs, post-closure costs, and/or liability requirements). Solving for M yields:

(3) $\frac{V_3}{V_1} \geq M$

This multiple has been calculated for each of the 12 firms in the sample discussed above, with the results shown in Table II-8. The average value of the multiple for the firms that experienced a decline in net working capital but still had positive net working capital is 2.8. That is, if net working capital had been equal to 2.8 times the cost of financial responsibility obligations three years prior to bankruptcy, then adequate funds would still have been available one year prior to bankruptcy (i.e., after the firm's net working capital had deteriorated). The average multiple for net worth for firms which had positive net worth remaining one year prior to bankruptcy was 3.3.

These multiples only ensure that these firms would have had net working capital and net worth exactly equal to their financial responsibility obligations. As noted above, this provides no margin of safety after the financial responsibility obligations have been met. If both of the above multiples are rounded to 3, and then multiplied by 2 to provide a reasonable margin of safety and to ensure that the firm has some funds remaining to cover other liabilities which may not be recorded on the balance sheet, then multiples of 6 result. These multiples provide a margin of safety to ensure that the failure rates are not greater than those estimated in the previous Section (22 per 10,000), and to ensure that adequate funds are available even in the event of lengthy legal proceedings to obtain the funds.

TABLE II-8

MULTIPLES OF FINANCIAL PARAMETERS NECESSARY TO INSURE AGAINST FIRM DETERIORATION

Company Name	Net Working Capital	Net Worth	Quick Assets
Waltham	-[1/]	10.2	1.1
Bowmar	+[2/]	2.0	+
Polarad	1.5	2.1	1.2
Beck	+	+	+
Unishops	-	-	+
Uniservices	1.7	1.5	1.3
Remco	6.8	6.8	1.1
Maule Industries	-	+	1.6
M. H. Fishman	1.1	1.1	+
National Video	1.3	1.2	2.8
Dolly Madison	4.1	+	+
King Resources	-	1.6	NA
Average Multiple	2.8	3.3	1.5
No. of firms that decline in value	10/12	9/12	6/12
% of firms that decline in value	83%	75%	50%

[1/] Negative sign indicates negative value

[2/] A plus sign indicates an increase in value from three years to one year prior to bankruptcy

NA: Not available

III. PROCEDURES USED IN SELECTING FIRM SAMPLES AND CANDIDATE FINANCIAL RATIOS

A. Sample Selection

The Agency assembled an initial sample of 95 firms that filed under either Chapter 10 or Chapter 11 of the Federal Bankruptcy Act between 1966 and 1979. These firms were identified in two ways. Previous articles on bankruptcy forecasting by Altman, Haldeman and Narayanan (1977) and Elam (1975) listed the bankrupt entities investigated in each study. The Agency included these firms in its sample if financial data for the three-year period preceding bankruptcy could be located. Additional bankrupt firms were identified through a two-step process. The Agency compiled a list of all companies that had ceased to be listed in Moody's Industrial Manual between 1968 and 1978 (excluding all firms specifically identified as having undergone name changes, mergers, etc.). The fate of these firms was then determined by consulting the company section of Funk and Scott's Annual Periodical Index. Actual bankruptcy filing dates for firms in this sample were identified either from Funk and Scott or the Bankruptcy heading of the annual Wall Street Journal Index.

The Agency then compiled financial data for each sampled firm for the three years immediately prior to bankruptcy. These data were collected primarily from Moody's Industrial Manual and supplemented when necessary by the company Form 10-K reports submitted annually to the Securities and Exchange Commission. As a result of serious data gaps, three firms were dropped from the original list of 95. Still later, the Agency decided to exclude all firms primarily engaged in wholesale, retail and/or transportation service activities from the sample, since these are not likely to be TSDFs, further reducing the final sample size to 66 firms.

The average net worth of the 66 bankrupt firms sampled (in the third year prior to bankruptcy) was $14.5 million; only one non-retail firm had a net worth greater than $100 million. The average asset size of the bankrupt firm sample was $46.5 million. Thus, as shown in Table III-1, the Agency obtained a sample with a higher average asset size than the samples in almost all previous studies (Beaver, 1968; Altman, 1968; Altman, et al. 1977; Deakin, 1972).

The Agency then assembled a sample of 190 non-bankrupt firms identified by the industry index of Moody's Industrial Manual as members of industrial categories that generate and dispose of large quantities of hazardous waste on-site (e.g., primary metals, petroleum refining, chemical and plastics manufacturing, textiles). Data were collected from Moody's, for these firms for the three-year period 1973-1975. The recession year of 1975 was deliberately chosen to evaluate the effects of business cycle fluctuations on financial ratio performance. Twelve of these firms were later eliminated because they were primarily engaged in wholesale, retail, or transportation service activities.

Of the 178 firms in the final non-bankrupt sample, slightly more than half had net worth (in 1973) of less than $100 million. For the smaller firms, the averages for net worth and asset size were $33.6 million and $69.8 million, respectively; for the larger firms, $519.5 and $985.7 million, respectively.

TABLE III-1

AVERAGE ASSET SIZE OF BANKRUPT FIRM SAMPLES

(In Millions of Dollars)

Sample	Number of Firms	Average Asset Size
EPA	66	46.5
Altman, et al. 1977	53	96.0[1/]
Deakin, 1972	79	20.0
Altman, 1968	31	6.4
Beaver, 1966	79	6.3

[1/] Five non-bankrupt firms (Douglas Aircraft, Ling-Tempco-Vought, Lockheed Aircraft, Memorex Corp., and Mohawk Data Sciences) with very large assets were included in the bankrupt firm sample because the firms remained non-bankrupt only due to extraordinary external support.

Several bankruptcy forecasting studies have utilized matched bankrupt and non-bankrupt firm samples. Each firm in the bankrupt sample had a counterpart in the non-bankrupt sample that had a relatively equal asset size and belonged to the same industry category. After careful deliberation, the Agency decided that use of such a matched sample would not satisfy the needs of this evaluation. Although the sample of bankrupt firms assembled for this study is one of the most comprehensive ever developed, it contains very few firms with greater than $50 million in net worth, because very few firms of this size fail. Several of the most highly publicized business failures of the last decade (W.T. Grant, Penn Central, United Merchants & Manufacturers) were excluded from the sample because those firms were primarily involved in activities other than manufacturing, and this reduced still further the number of large firms. As a consequence, matched sample techniques would not have provided information about the effectiveness of the various ratio tests in accurately classifying the large, viable firms most likely to make use of a financial test provision. The Agency did add a representative sample of large firms to the non-bankrupt group, in order to verify whether test options were effective over all size ranges.

The Agency also chose not to undertake a one-for-one matching of sampled firms by industrial category. In order to assemble a sample of bankrupt firms of sufficient size to provide statistically significant results, it was necessary to include a substantial number of firms involved in manufacturing activities not commonly associated with hazardous waste generation (such as bakeries). The Agency determined that the improvements in classification accuracy that would result from evaluating test alternatives against a set of firms likely to seek to use a financial test greatly outweighed any potential inaccuracies engendered by the use of an unmatched sample. To verify this conclusion, the Agency performed a supplementary comparison of industry financial ratio averages, as described in Section VI of this Appendix.

Many commenters on the May 19, 1980 regulation suggested that electric utilities and hazardous waste management firms possessed unique financial characteristics and should be provided with a separate financial test. To test these premises, special samples of 26 utilities and two representative large hazardous waste management firms were examined. These results are described in Section VI.

The fundamental limitation of this analysis with respect to the samples of firms, particularly the non-bankrupt firm sample, is uncertainty with respect to how well they match the financial characteristics of firms that own or operate TSDFs. In the absence of information about the population which the samples are to represent, there is no real way to check for biases created by the methods used to assemble the samples.

The firms in the non-bankrupt sample were not randomly selected from firms listed in Moody's. Judgment was applied to ensure that firms were chosen from the specific industries considered most likely to own or operate TSDFs and to ensure a greater representation of smaller firms than a random sample from Moody's would have produced. Because the sample was not randomly drawn, the possibility exists that the judgment employed may have inadvertently resulted in the selection of firms exhibiting unusually strong or weak financial characteristics. To check this possibility, the Agency compared the mean values of the non-bankrupt firm sample to those of other samples used in past studies of this kind. (This full comparison is given in Section V.D.2.) Where data on comparable ratios were available, the average values of ratios for the non-bankrupt sample in this study was either very similar to that for other studies (within 10 to 20 percent), or fell between the values given by other studies (average values for cash flow to total liabilities vary widely among samples in other studies). As a further check for possible bias, the distribution of specific ratios for the non-bankrupt firm sample was compared to the population of all firms in specific industries reportd in the Expanded Coverage section of the 1980 Moody's Industrial Manual (Volume I) (see Section VI.A of this Appendix). This comparison showed that most industries had from 5 to 10 percent more firms meeting a given ratio cutoff point than are found in the non-bankrupt firm sample for 1975. This would indicate that either due to changes in industry financial performance between 1975 and 1980, or due to differences between the two samples, the percentage of viable firms passing a test could be higher than that reported in this study.

B. Holdout Procedures

In an analysis in which numerous combinations of financial ratios are tested on a randomly drawn set of firms, it is important to avoid the possibility of search bias. If many combinations of financial data are tested, the test which is evaluated as the most effective may attain this result because it is peculiarly sensitive to the precise characteristics of the sample being analyzed. To ensure that such search biases did not influence the final conclusions of this analysis, the Agency created a "holdout" sample comprised of firms randomly selected by a computer from the original bankrupt and non-bankrupt samples (Frank, Massy, and Morrison, 1965). The testing procedure was then conducted in two phases. All tests were evaluated initially against the 136 non-bankrupt and 42 bankrupt firms which remained in the "primary" sample. Those tests which provided the best results were then validated against the 42 non-bankrupt and 24 bankrupt firms in the holdout sample.

C. Selection of Financial Variables to be Tested

In selecting the financial ratios to be tested in this analysis, the Agency consulted a broad spectrum of opinion, placing particular weight on available empirical results. Candidate financial ratios were drawn from three principal sources: the comments received on the May 19, 1980 proposed regulation, the surveyed opinions of bond rating service personnel and credit analysts, and the existing literature on bankruptcy forecasting. The recommendations from each of these sources are summarized below.

1. Recommendations of Commenters

Several commenters proposed other financial ratios as better indicators of firm viability than the total liabilities/net worth ratio. Alternative ratios most frequently mentioned involved cash flow, net income, net worth, total liabilities, debt and equity. Other measures identified were the quick ratio, estimates of return on investment, total fixed assets, retained earnings, and net sales. In addition, a number of commenters proposed that qualitative measures of a firm's financial position, such as corporate bond ratings or an affirmative auditor's statement in the company's annual Form 10-K report, be used to supplement or to substitute for a ratio test. None of these commenters provided quantitative data on the expected classification accuracy of their preferred alternatives, and only a few suggested what an appropriate pass-fail cutoff point would be for the ratios proposed. Consequently, these comments were used to identify candidate ratios, but did not play a significant role in the critical assessment process.

2. Bond Rating and Credit Analysts

Detailed interviews with senior financial analysts from the bond rating agencies, leading investment banking firms, and a number of major urban banks conducted for a study (Backer and Gosman, 1978) for the National Association of Accountants identified the financial ratios those analysts considered most important to their credit decisions. Those ratios are listed in Table III-2. The same authors also conducted an empirical study of the rate of deterioration in financial variables for 57 firms whose bond, trade credit, or bank loan ratings had been downgraded. This analysis indicated that the ratios of cash flow[1]/total debt, total debt/total net worth, and return on sales showed the most significant deterioration in the two years prior to downgrading, and hence had the highest correlation with actual credit actions. The

[1]Cash flow in this Appendix refers to the sum of net income, depreciation, depletion, and amortization.

TABLE III-2

FINANCIAL RATIOS CONSIDERED MOST SIGNIFICANT BY CREDIT ANALYSTS
(based on interview results)

Financial Ratios	Short-Term: Bank Loans Seasonal	Short-Term: Trade Credit	Intermediate Term: Bank Loans Term	Long-Term: Bonds
Accounts Receivable Turnover	X			
Cash Flow to Total Debt*			X	X
Current Liabilities to Tangible Net Worth		X		
Current Ratio	X	X		
Fixed-Charge Coverage				X
Inventory to Working Capital		X		
Inventory Turnover	X			
Long-Term Debt to Working Capital		X		
Quick Ratio	X	X		
Return on Sales			X	
Total Debt to Tangible Net Worth*	X	X	X	X
Working Capital to Sales			X	

Source: Backer & Gosman (1978).

*We have substituted the word "debt" for "liabilities" because the great majority of interviewees indicated that they exclude Deferred Taxes and Minority Interest from liabilities, thereby approximating debt.

analysis also revealed that many other ratios not identified in the interview process showed much greater deterioration for the sampled firms than the ratios listed in Table III-2.

3. Results of Prior Bankruptcy Forecasting Studies

The Agency carefully reviewed the existing literature on bankruptcy forecasting and identified a large array of financial ratios that have previously been analyzed for their predictive abilities. These ratios can generally be organized into four basic categories of financial information, as described below.

a. Profitability (Income or Cash Flow Based) Ratios

Profitability measures reflect the current response of market forces to the products manufactured and/or sold by the firm, and may indicate the ongoing profit-making potential of an operation. Since a firm's ultimate existence relies on the earning power of its assets, measures of this type should reflect the future stability of a firm. The most straightforward measure of profitability is net after-tax income (NI). Beaver (1968) tested the predictive power of these ratios of net income to sales, total assets, net worth, and total debt, and found the net income/total asset (NI/TA) ratio to have the most discriminating power. NI/TA has also been employed in a number of other studies (Deakin 1972, 1977; McWilliams, 1977). Beaver identified cutoff points for this ratio ranging from 0 to .04, depending on the number of years prior to bankruptcy the test was applied. McWilliams, in deriving qualitative descriptors for financial ratio data, assigned a plus to a firm with NI/TA greater than .04, and a minus to those with NI/TA below 0.

Altman (1968, 1977) proposed the use of earnings before interest and taxes (EBIT) as a substitute for net income. Theoretically, EBIT has the advantage of excluding discontinuities in income trends resulting from one-time extraordinary charges. However, EBIT fails to take into account the penalties to profitability suffered by a highly leveraged firm, as the result of interest payments. More importantly, Altman has never published results which compare the actual predictive abilities of EBIT versus NI. Since EBIT values are not always clearly identified in income account statements (particularly in the case of smaller firms), EBIT was not included in the list of variables tested.

Measures of cash flow (CF) have been observed in past studies to provide forecasting ability superior to net income ratios. The two most popular formulations of cash flow ratios are cash flow/total liabilities (in which CF = NI + depreciation), and cash flow/total debt (in which CF = NI + depreciation - dividends, and total debt = long-term debt + the current portion of long-term debt). Preliminary analysis indicated that certain key industries (most significantly, electric utilities) performed much worse on the latter of these two ratios. Consequently, the CF/TL ratio was used in the preliminary evaluation of tests. Beaver used cutoff points for cash flow/total debt of .03 to .11; McWilliams considered the cutoff points to be .15 to .35.

b. Liquidity Ratios

Liquidity ratios define the capability of a firm to respond to short-term or emergency expenditure needs without borrowing. Since the Agency may call on firms to close their facilities immediately, the availability of liquid assets to cover these costs is particularly relevant. Four measures of liquid assets are commonly employed: current assets (CA); quick assets (QA), defined as current assets minus inventories; net working capital (NWK), defined as current assets minus current liabilities (CL); and cash (including marketable securities). These measures are commonly contrasted to either current liabilities or total assets (TA).

Altman et al. in 1977 found the current ratio (CA/CL, or CURRAT) to be the most accurate predictive measure of firm stability, while in 1968 Altman used the ratio NWK/TA as his liquidity measure. Beaver (1968) obtained equivalent predictive results using both measures, as well as the quick ratio (QA/CL, or QRAT). Deakin (1972) used all seven variables (CURRAT, QRAT, Cash/CL, CA/TA, NWK/TA, Cash/TA) in his 14-variable multi-discriminant equation. In his refined five-variable model (1977), only CURRAT, CA/TA, and Cash/TA are used.

c. Leverage Ratios

Leverage ratios illustrate the percentage of a firm's total assets that are tied to short-term or long-term liabilities. A highly leveraged company may have substantial liquid or long-term assets on hand, but they may be secured by other creditors if the firm's financial condition begins to deteriorate. There are several alternate measures of leverage. Beaver (1968) looked at a number of ratios that contrasted current and other liabilities to total assets, and found total debt/total assets to be the most effective. Altman (1968) found that the ratio of the market value of common and preferred stock to equity provided better predictive results than other debt/equity measures, although the relative performance of the tested ratios was not documented. Long-term bond analysts cited the total liability (TL)/net worth (NW) ratio as the most important variable influencing their judgment (Backer and Gosman, 1978). The Agency used a TL/NW ratio as a measure of a firm's leverage in its preliminary evaluations. The common application in the business community and ease of calculation of this ratio make it an appealing candidate for these analytical purposes.

d. Turnover Ratios

Both Beaver (1968) and Altman (1968) tested a number of ratios relating various asset categories to net sales figures. Such turnover ratios are commonly used by analysts to measure the sales-generating capability of assets, or to indicate management's effectiveness in the competitive marketplace. Although these ratios have traditionally shown very poor predictive power when used independently, Altman, in his 1968 Z-score model, included a net sales (NS)/TA ratio, and rated it the second most important contributor to the overall discriminating power of his function. However, research by the Agency revealed that such a ratio severely discriminates against a number of industry categories (e.g., electric utilities; firms with large extractive interests, such as mining, gas, oil and timber).

4. Ratios Selected

Seven financial ratios were selected for detailed evaluation as candidates for inclusion in a financial test. These ratios were chosen from the many identified because they satisfied three primary conditions: (1) they had been quantitatively validated as significant predictive variables by previous research efforts; (2) they had been frequently identified by bond rating services and credit analysts as key parameters; and (3) their values could be readily obtained from Consolidated Income Account or Consolidated Balance Sheet data. The seven ratios selected were:

Cash flow/total liabilities (CF/TL)

Net income/total assets (NI/TA)

Total liabilities/net worth (TL/NW)

Current assets/current liabilities (CURRAT, or current ratio)

Quick assets/current liabilities (QRAT, or quick ratio)

Net working capital/total assets (NWK/TA)

Net sales/total assets (NS/TA)

D. Summary Financial Data for the Firm Samples

Financial data from the companies included in the bankrupt and non-bankrupt firm samples are summarized in Tables III-3 through III-6. Table III-3 summarizes the primary bankrupt sample; Table III-4, the primary non-bankrupt sample; Table III-5, the holdout bankrupt sample; and Table III-6, the holdout non-bankrupt sample. The three years of data collected for each sample are hereafter referred to as years x-1, x-2, and x-3. For each sample, values for eight financial parameters are detailed in the tables: net income (NI), cash flow (CF), quick assets (QA), current assets (CA), total assets (TA), current liabilities (CL), total liabilities (TL), and net worth (NW). The right-hand portions of tne Tables for the primary samples (Tables III-3 and III-4) indicate each firm's performance in the six major financial ratio categories used in this analysis: cash flow/total liabilities, total liabilities/net worth, net fixed assets/total assets, net income/total assets, current assets/current liabilities, and quick assets/current liabilities. Because the net income/total assets ratio was not included in any of the tests evaluated against the holdout samples, this ratio is not included in Tables III-5 and III-6.

TABLE III-3

FINANCIAL DATA FOR FIRMS IN PRIMARY BANKRUPT SAMPLE

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA 1/	CF/TL 2/	TL/NW 3/	CURRAT 4/	QRAT 5/	NI/TA 6/
Alan Wood Steel	1978(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	-15.0	-7.2	18.7	33.7	41.4	88.0	32.0	120.0	P	F	F	F	F	F
	(x-3)	-9.4	-1.4	18.4	34.1	29.2	79.0	47.0	126.0	P	F	1.7	F	F	F
Allied Leisure	1977(x-1)	-3.0	-2.8	0.3	2.2	4.4	4.4	-1.3	3.1	F	F	P	F	F	F
	(x-2)	-0.2	-0.1	1.2	2.3	2.0	2.0	2.1	4.0	F	F	P	F	F	F
	(x-3)	-0.3	-0.2	1.3	3.2	1.4	1.4	2.3	3.7	F	F	P	P	F	P
American Beef Packers	1975(x-1)	4.8	7.1	47.7	78.2	72.2	97.4	22.6	120.0	P	F	F	F	F	4.0
	(x-2)	3.4	5.3	49.6	82.0	74.8	90.3	17.7	108.0	23.6	F	F	F	F	3.1
	(x-3)	1.1	2.3	31.3	40.4	35.4	45.7	14.3	60.0	P	F	F	F	F	F
American Book	1973(x-1)	0	1.2	8.8	9.9	15.5	12.2	6.6	18.8	P	F	1.8	F	F	F
	(x-2)	-2.4	-1.2	11.0	12.9	6.3	17.5	6.6	24.1	P	F	F	P	P	F
	(x-3)	0.1	1.3	13.6	15.5	6.9	16.5	12.8	29.3	P	F	1.3	P	P	F
Armac Industries	1976(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	-6.8	NA	13.2	29.5	24.0	27.3	5.9	33.2	F	F	F	F	F	F
	(x-3)	2.4	3.0	10.7	30.5	17.7	22.3	11.7	34.0	F	13.5	1.9	1.7	F	P
Astrodata	1970(x-1)	0.2	0.7	10.7	10.6	5.8	11.1	2.3	13.4	F	F	F	1.8	P	F
	(x-2)	-6.7	-6.4	11.4	11.7	18.0	23.3	-8.7	14.6	F	F	F	F	F	F
	(x-3)	-5.9	0	9.5	16.7	17.4	21.7	-1.0	20.7	F	F	F	F	F	F
Barrington Industries	1976(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	0.3	NA	3.6	5.9	5.6	7.7	1.2	8.9	F	F	F	F	F	3.4
	(x-3)	0.1	NA	3.6	5.6	6.9	9.6	2.5	12.1	F	F	F	F	F	F
Bishop Industries	1970(x-1)	-3.4	-3.0	4.7	8.7	4.5	14.0	2.3	16.3	F	F	F	1.9	1.0	F
	(x-2)	-7.6	-7.3	4.5	11.1	10.2	16.3	2.2	18.5	F	F	F	F	F	F
	(x-3)	0.2	0.4	12.2	17.7	9.1	15.2	7.0	22.2	F	F	F	1.9	P	F
Bowmar Instruments	1975(x-1)	-25.6	-24.1	20.9	43.9	20.4	51.5	3.5	55.0	F	F	F	P	1.0	F
	(x-2)	7.6	8.1	24.0	42.7	30.1	33.9	14.8	48.7	F	P	F	F	F	P
	(x-3)	2.0	2.4	10.7	18.2	10.5	13.4	7.1	20.5	F	17.9	1.9	1.7	1.0	P
Computer Applications	1970(x-1)	-2.1	-1.4	14.4	17.4	13.3	33.2	1.0	34.3	F	F	F	F	1.1	F
	(x-2)	0.6	1.2	14.2	17.2	17.1	23.0	11.2	34.2	23.6	F	F	F	F	F
	(x-3)	0.7	1.6	9.9	11.3	7.6	14.6	7.2	21.8	25.2	11.0	F	F	P	3.2
Diversa	1969(x-1)	6.7	6.9	0.7	0.7	7.6	39.3	6.6	46.4	F	17.3	F	F	F	P
	(x-2)	-7.3	-6.4	17.1	22.2	32.5	73.1	3.0	76.1	F	F	F	F	F	F
	(x-3)	-7.4	-6.8	6.0	13.7	27.7	80.3	10.4	90.7	F	F	F	F	F	F

1/ P > 30.0 (passes all tests); F < 20.0 (fails all tests)

2/ P > 20.0 (passes all tests); F < 10.0 (fails all tests)

3/ P < 1.0 (passes all tests); F > 2.0 (fails all tests)

4/ P > 2.0 (passes all tests); F < 1.5 (fails all tests)

5/ P > 1.2 (passes all tests); F < 1.0 (fails all tests)

6/ P > 4.0 (passes all tests); F < 2.0 (fails all tests)

TABLE III-3
(continued)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[1/]	CF/TL[2/]	TL/NW[3/]	CURRAT[4/]	QRAT[5/]	NI/TA[6/]
Dolly Madison	1970(x-1)	-3.5	-0.1	22.5	48.2	46.5	68.1	24.3	92.4	P	F	F	F	F	F
	(x-2)	4.6	6 9	18.4	41.4	30.9	48.0	25.8	73.8	P	14.4	1.9	F	F	P
	(x-3)	0.8	2.4	7.4	14.1	7.1	20.4	14.9	35.3	P	11.8	1.4	2.0	1.0	2.3
Esgro Corporation	1973(x-1)	-4.6	-4.3	8.4	20.9	16.1	26.0	1.6	27.6	F	F	F	F	F	F
	(x-2)	-1.5	-1.0	11.2	24.4	15.5	24.3	6.2	30.5	F	F	F	1.6	F	F
	(x-3)	0.7	1.0	9.5	22.7	10.6	20.3	7.6	27.9	F	F	F	P	F	2.5
Fotochrome Industries	1970(x-1)	0.5	1.0	3.7	6.0	4.0	7.6	4.7	12.3	P	13.2	1.6	1.5	F	P
	(x-2)	0.1	0.6	2.6	5.1	3.7	8.0	3.0	11.0	P	F	F	F	F	F
	(x-3)	-1.8	-1.3	1.8	4.3	3.2	6.6	2.4	9.0	P	F	F	F	F	F
General Alloys	1973(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	-0.7	-0.6	0.6	1.4	2.0	2.1	0.4	2.5	P	F	F	F	F	F
	(x-3)	-0.1	0	1.0	2.0	1.9	2.3	1.0	3.3	P	F	F	F	F	F
GF Industries	1970(x-1)	-1.3	o	3.5	5.1	1.9	4.4	5.2	9.6	F	F	P	P	P	F
	(x-2)	-0.6	-0.4	4.7	5.8	1.5	1.5	5.8	7.3	F	F	P	P	P	F
	(x-3)	0.3	0	2.0	3.4	1.4	1.5	2.5	4.0	F	F	P	P	P	P
Gray Manufacturing	1975(x-1)	-3.0	-2.6	7.0	17.3	13.3	18.3	6.1	24.4	F	F	F	F	F	F
	(x-2)	0.1	0.4	8.1	16.8	7.5	13.6	9.8	23.4	F	F	1.4	P	1.1	F
	(x-3)	0.9	1.1	7.3	10.7	3.2	9.4	8.0	17.4	F	11.7	1.2	P	P	P
Gruen Industries	1977(x-1)	-0.2	0	5.2	14.7	7.8	10.5	4.7	15.2	F	F	F	1.9	F	F
	(x-2)	-2.5	-2.4	5.0	12.2	7.7	7.8	4.8	12.6	F	F	1.6	1.6	F	F
	(x-3)	0.2	0.3	5.0	13.8	6.4	6.7	7.5	14.2	F	F	P	P	F	F
Harvard Industries	1972(x-1)	-7.8	-5.5	13.8	24.5	17.1	43.7	4.3	48.0	P	F	F	F	F	F
	(x-2)	-11.0	-8.4	21.9	42.8	30.2	59.0	12.0	71.0	P	F	F	F	F	F
	(x-3)	1.6	3.8	21.4	53.0	36.0	59.3	23.1	82.4	29.6	F	F	F	F	F
King Resources	1971(x-1)	-53.0	-42.8	30.4	30.4	64.7	103.7	24.3	128.0	F	F	F	F	F	F
	(x-2)	25.5	28.0	30.4	72.0	68.0	106.1	70.9	177.0	F	P	1.5	F	F	P
	(x-3)	12.0	13.2	30.4	59.1	20.9	66.4	39.6	106.0	F	19.9	1.7	P	P	P
Maule Industries	1976(x-1)	-8.7	-1.4	10.9	24.9	60.7	121.8	67.2	189.0	P	F	1.8	F	F	F
	(x-2)	2.5	8.6	22.0	33.5	40.6	114.0	76.0	190.0	P	F	1.5	F	F	F
	(x-3)	10.2	15.4	17.6	27.5	21.6	57.5	65.5	123.0	P	P	P	F	F	P
Michigan Bakeries	1971(x-1)	-0.1	0.1	0.6	0.7	1.1	1.4	0.4	1.8	F	F	F	F	F	F
	(x-2)	-0.5	-0.3	0.7	0.8	1.2	1.6	0.5	2.1	F	F	F	F	F	F
	(x-3)	-0.3	-0.1	0.8	0.9	1.0	1.1	0.9	2.0	F	F	1.2	F	F	F
Milo Electronics	1970(x-1)	-0.9	-0.8	3.0	11.8	6.7	8.3	4.9	13.2	F	F	1.7	1.8	F	F
	(x-2)	0.1	0.2	2.7	11.4	5.3	7.1	5.9	13.0	F	F	1.2	P	F	F
	(x-3)	0.2	0	2.8	10.0	4.9	6.9	4.2	11.1	F	F	1.6	P	F	F
National Radio	1967(x-1)	-0.6	NA	3.5	5.0	3.3	4.3	2.4	6.7	F	P	1.8	1.5	P	F
	(x-2)	0.1	NA	4.0	5.2	3.3	4.3	2.6	6.9	F	P	1.7	1.6	P	F
	(x-3)	0.8	NA	2.2	3.5	0.6	2.0	2.6	4.6	F	P	P	P	P	P

TABLE III-3
(continued)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA 1/	CF/TL 2/	TL/NW 3/	CURRAT 4/	QRAT 5/	NI/TA 6/
National Video	1969(x-1)	-5.3	-2.1	5.7	12.7	5.2	8.2	19.3	27.5	P	F	P	P	1.1	F
	(x-2)	2.2	5.8	7.8	13.3	3.8	4.5	24.5	29.0	P	P	P	P	P	P
	(x-3)	7.3	9.3	16.1	23.6	14.1	14.9	23.8	38.7	P	P	P	1.7	1.1	P
Omega Alpha	1973(x-1)	41.7	47.4	27.9	50.8	40.5	145.9	33.1	179.0	P	P	F	F	F	P
	(x-2)	0.6	2.4	54.4	95.9	65.5	156.5	31.5	188.0	P	F	F	F	F	F
	(x-3)	2.0	6.7	39.1	74.5	41.9	111.8	63.2	175.0	P	F	1.8	1.8	F	F
Paterson Parchment	1974(x-1)	-2.2	0	4.4	10.3	5.4	11.2	7.3	18.5	P	F	1.5	1.9	F	F
	(x-2)	-0.8	0	5.0	11.2	4.6	10.2	9.5	19.7	P	F	1.1	P	P	F
	(x-3)	-1.3	-0.5	6.1	12.1	5.0	11.1	10.6	21.7	P	F	1.0	P	P	F
Permaneer Company	1976(x-1)	-15.7	-12.2	7.8	19.0	13.9	67.2	-11.6	55.6	P	F	F	F	F	F
	(x-2)	-17.2	-13.6	14.1	36.1	19.1	74.6	4.1	78.7	P	F	F	1.9	P	F
	(x-3)	-3.0	-0.4	18.5	42.5	14.7	62.0	21.3	83.3	P	F	F	P	P	F
Photon	1972(x-1)	1.3	1.8	16.0	34.9	8.7	23.0	17.5	40.5	F	F	1.3	P	P	3.2
	(x-2)	-1.0	-0.6	14.0	31.3	6.2	20.5	15.1	35.6	F	F	1.4	P	P	F
	(x-3)	1.0	1.2	17.4	32.4	5.6	21.9	15.7	37.6	F	F	1.4	P	P	2.7
Polarad Electronics	1970(x-1)	0.4	0.6	1.7	4.0	1.5	3.6	1.5	5.1	F	16.7	F	1.6	F	P
	(x-2)	-1.5	-1.4	2.3	5.4	4.5	4.6	1.8	6.4	F	F	F	F	F	F
	(x-3)	0.2	0.4	2.0	5.1	2.8	2.9	3.1	6.0	F	13.8	P	1.8	F	3.3
Reading Industries	1976(x-1)	-2.1	-1.2	3.2	9.2	14.2	16.5	3.8	20.3	P	F	F	F	F	F
	9x-2)	-3.3	-2.4	4.9	11.1	3.6	16.9	5.9	22.8	P	F	F	P	P	F
	(x-3)	1.1	2.0	8.8	16.6	5.8	20.1	9.2	29.3	P	F	F	P	P	3.8
Redcor Corporatio n	1972(x-1)	-5.6	-4.6	2.4	7.3	4.8	8.7	2.0	10.7	F	F	F	1.5	F	F
	(x-2)	-4.8	-4.6	2.9	11.0	8.0	8.7	3.9	12.6	F	F	F	F	F	F
	(x-3)	-0.1	0	2.3	4.3	1.7	2.8	3.7	6.5	F	F	P	P	P	F
Remco Industries	1971(x-1)	-10.8	-8.8	10.0	14.0	13.0	16.3	1.3	17.6	F	F	F	F	F	F
	(x-2)	-0.7	1-0	11.4	17.8	13.7	16.9	8.1	25.0	24.3	F	F	F	F	F
	(x-3)	2.0	3.5	10.7	13.6	6.8	9.4	8.9	18.3	22.5	P	1.1	P	P	P
Scottex	1973(x-1)	-2.4	0	10.1	19.3	12.1	22.7	8.0	30.7	P	F	F	P	F	F
	(x-2)	1.1	0	6.0	13.8	7.5	13.4	10.4	23.8	P	F	1.3	1.8	F	P
	(x-3)	0.8	1.1	3.8	7.7	6.7	9.9	2.9	12.8	P	11.1	F	F	F	P
Sequoyah Industries	1973(x-1)	-0.6	0.3	5.7	13.3	8.4	29.0	2.8	31.8	P	F	F	1.6	F	F
	(x-2)	-9.5	-8.3	3.5	12.5	12.9	27.0	3.8	30.8	P	F	F	F	F	F
	(x-3)	-10.4	-9.2	15.0	29.1	24.3	39.7	15.5	55.2	P	F	F	F	F	F
Sheffield Watch	1971(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	0.7	0.8	9.6	21.6	12.2	17.2	5.3	22.5	F	F	F	1.8	F	3.1
	(x-3)	0.4	0.7	5.6	15.6	9.3	10.7	5.6	16.3	F	F	1.9	1.7	F	2.5
Stellar Industries	1975(x-1)	-1.7	-1.3	2.4	3.8	4.5	7.9	0.1	8.0	P	F	F	F	F	F
	(x-2)	-4.0	-3.5	2.0	3.9	4.7	10.4	-0.8	9.6	P	F	F	F	F	F
	(x-3)	-1.7	-1.3	3.5	7.0	6.6	10.8	2.7	13.5	28.6	F	F	F	F	F

TABLE III-3
(concluded)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA 1/	CF/TL 2/	TL/NW 3/	CURRAT 4/	QRAT 5/	NI/TA 6/
Technical Measurements	1968(x-1)	1.9	2.8	6.7	10.0	2.7	3.1	16.5	19.6	P	P	P	P	P	P
	(x-2)	-2.1	-1.8	2.6	5.0	4.5	6.0	0.5	6.5	F	F	F	F	F	F
	(x-3)	-1.8	-1.5	4.9	9.1	5.6	7.5	5.5	13.0	F	F	1.3	1.6	F	F
Trans-Beacon	1970(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(x-2)	0.2	0.3	1.5	1.6	1.5	2.6	0.7	3.3	25.2	F	F	F	1.0	P
	(x-3)	0.3	0.4	1.3	1.4	1.2	3.7	-0.8	2.9	P	F	F	F	1.1	P
Waltham Industries	1971(x-1)	-13.9	0	8.9	27.0	30.8	43.9	1.1	45.0	26.8	F	F	F	F	F
	(x-2)	0.3	1.8	13.8	34.7	21.9	47.9	15.3	63.2	28.1	F	F	1.6	F	F
	(x-3)	1.6	2.4	9.6	18.6	8.1	21.1	11.2	32.3	29.2	11.4	1.9	P	1.2	P
Westgate California	1972(x-1)	-2.6	2.7	22.8	41.3	34.0	143.6	30.4	174.0	P	F	F	F	F	F
	(x-2)	2.8	7.2	46.3	63.8	76.9	182.0	33.0	215.0	P	F	F	F	F	F
	(x-3)	3.6	6.8	19.6	32.1	32.2	116.7	34.3	151.0	P	F	F	F	F	2.4

TABLE III-4

FINANCIAL DATA FOR FIRMS IN THE PRIMARY NON BANKRUPT SAMPLE

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]	NI/TA[7]
Alcoa	(x-1)	65	235	400	1021	377	1845	1575	3420	P	12.8	1.17	P	1.06	F
	(x-2)	173	338	474	1040	472	1651	1547	3198	P	P	1.06	P	1.00	P
	(x-3)	104	263	453	905	308	1412	1409	2821	P	18.6	1.00	P	P	3.7
Allegheny Ludlum	(x-1)	30	50	119	325	141	318	320	638	P	15.8	P	P	F	P
	(x-2)	45	64	153	379	184	352	304	656	P	18.2	1.16	P	F	P
	(x-3)	31	49	135	320	146	317	270	588	P	15.5	1.17	P	F	P
Altamil	(x-1)	1	2	8	16	3	4	17	21	22.3	P	P	P	P	P
	(x-2)	.7	2	13	26	12	16	15	31	F	10.3	1.01	P	1.05	2.3
	(x-3)	3	3	9	21	8	12	15	27	20.9	P	P	P	1.10	P
Alumax	(x-1)	21	23	117	217	54	183	279	462	P	12.5	P	P	P	P
	(x-2)	36	36	99	179	60	118	259	377	F	P	P	P	P	P
	(x-3)	16	16	81	139	51	71	201	272	F	P	P	P	P	P
Amax	(x-1)	134	193	451	677	333	1116	1364	2480	P	17.3	P	P	P	P
	(x-2)	148	194	261	404	207	826	942	1768	P	P	P	1.95	P	P
	(x-3)	105	142	417	535	209	812	840	1652	P	17.5	P	P	P	P
Ameron	(x-1)	8	14	41	70	29	67	68	135	P	P	P	P	P	P
	(x-2)	7	12	48	87	39	82	62	144	P	14.9	1.32	P	P	P
	(x-3	6	11	35	60	25	56	58	114	P	18.6	P	P	P	P
Ametek	(x-1)	13	16	43	85	35	54	67	121	29.6	P	P	P	P	P
	(x-2)	11	15	32	78	36	57	59	117	P	P	P	P	F	P
	(x-3)	9	13	30	70	29	48	53	102	29.2	P	P	P	1.03	P
Ampco-Pittsburgh	(x-1)	6	8	14	3 8	12	15	50	65	25.8	P	P	P	P	P
	(x-2)	9	10	16	43	17	22	45	67	20.7	P	P	P	1.04	P
	(x-3)	5	6	13	35	13	18	38	56	21.4	P	P	P	1.02	P
Amsted	(x-1)	35	45	98	157	75	79	179	258	P	P	P	1.54	P	P
	(x-2)	17	26	71	129	61	65	153	218	P	P	P	P	1.16	P
	(x-3)	15	24	63	117	50	61	144	205	P	P	P	P	P	P
Anken	(x-1)	.7	1	4	7	2	2	10	12	P	P	P	P	P	P
	(x-2)	.6	1	4	7	3	3	9	12	P	P	P	P	P	P
	(x-3)	1	2	4	7	3	3	9	12	P	P	P	P	P	P
Armco Steel	(x-1)	117	209	438	1003	415	1276	1330	2606	P	16.3	P	P	1.06	P
	(x-2)	204	290	601	1124	554	1268	1274	2542	P	P	P	P	1.08	P
	(x-3)	107	190	438	853	372	1114	1145	2259	P	17.1	P	P	1.18	P
ASARCO	(x-1)	26	62	195	442	174	641	861	1502	P	F	P	P	1.12	F
	(x-2)	126	161	182	408	234	466	863	1329	P	P	P	1.74	F	P
	(x-3)	113	140	171	364	196	375	774	1149	P	P	P	1.86	F	P

[1] For all firms, x-1 is 1975, x-2 is 1974, and x-3 is 1973

[2] P > 30.0 (passes all tests); F < 20.0 (fails all tests)

[3] P > 20.0 (passes all tests); F < 10.0 (fails all tests)

[4] P < 1.0 (passes all tests); F > 2.0 (fails all tests)

[5] P > 2.0 (passes all tests); F < 1.5 (fails all tests)

[6] P > 1.2 (passes all tests); F < 1.0 (fails all tests)

[7] P > 4.0 (passes all tests); F < 2.0 (fails all tests)

TABLE III-4
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
ASPRO	(x-1)	2	4	13	23	12	23	15	38	P	16.3	1.53	1.95	1.06	P
	(x-2)	2	3	11	19	9	21	13	34	P	13.7	1.55	P	P	P
	(x-3)	2	3	10	18	8	18	12	30	P	15.6	1.48	P	P	P
Athlone	(x-1)	12	15	43	85	32	109	50	159	27.5	13.7	F	P	P	P
	(x-2)	13	16	50	96	45	122	48	170	24.1	13.3	F	P	1.11	P
	(x-3)	7	10	32	77	30	112	40	152	25.7	F	F	P	1.07	P
Basic	(x-1)	3	5	10	25	8	22	27	49	P	P	P	P	P	P
	(x-2)	4	6	14	27	9	21	25	46	P	P	P	P	P	P
	(x-3)	2	5	11	24	8	23	22	45	P	P	1.02	P	P	P
Bernz-O-Matic	(x-1)	-2	-1	4	12	4	10	8	18	P	F	1.30	P	1.05	F
	(x-2)	.8	1	7	14	5	11	9	20	23.5	11.7	1.19	P	P	3.9
	(x-3)	2	2	6	14	6	9	9	17	F	P	1.01	P	1.11	P
Bethlehem Steel	(x-1)	242	476	768	1388	719	1180	2612	4592	P	P	P	1.93	1.07	P
	(x-2)	342	553	1172	1682	1032	2023	2490	4513	P	P	P	1.63	1.14	P
	(x-3)	207	403	934	1376	713	1677	2242	3919	P	P	P	1.93	P	P
Bliss & Laughlin	(x-1)	10	14	37	64	14	52	68	120	21.9	P	P	P	P	P
	(x-2)	9	14	24	56	19	50	62	112	24.1	P	P	P	P	P
	(x-3)	8	12	29	56	16	56	57	113	23.6	P	P	P	P	P
Brooks & Perkins	(x-1)	1	1	5	11	4	7	6	13	F	18.6	1.17	P	1.15	P
	(x-2)	.5	.8	4	8	4	5	5	10	F	17.4	P	1.83	F	P
	(x-3)	.5	.8	3	7	3	3	6	8	20.2	P	P	P	P	P
Bundy Corporation	(x-1)	4	8	19	29	10	21	50	71	P	P	P	P	P	P
	(x-2)	.3	4	19	29	11	23	49	72	P	16.2	P	P	P	F
	(x-3)	8	11	21	33	13	25	52	78	P	P	P	P	P	P
Carpenter	(x-1)	22	23	47	113	34	55	139	194	P	P	P	P	P	P
	(x-2)	17	24	49	117	40	65	124	189	P	P	P	P	P	P
	(x-3)	14	20	40	100	28	55	112	167	P	P	P	P	P	P
Ceco	(x-1)	9	14	60	98	26	58	92	150	P	P	P	P	P	P
	(x-2)	11	17	50	100	31	63	87	150	30.0	P	P	P	P	P
	(x-3)	10	15	46	92	31	65	80	145	P	P	P	P	P	P
Cerro	(x-1)	-2	11	208	311	147	380	341	721	NA	F	P	P	P	P
	(x-2)	16	24	247	338	154	396	369	765	F	11.1	1.07	P	P	2.1
	(x-3)	15	22	185	253	80	298	362	660	F	F	P	P	P	2.3
CF&I	(x-1)	38	64	85	127	71	127	182	309	P	P	P	1.78	1.20	P
	(x-2)	35	60	79	115	46	107	181	288	P	P	P	P	P	P
	(x-3)	14	33	62	92	53	117	168	285	P	P	P	1.72	1.15	P
Cleveland-Cliffs	(x-1)	31	34	58	75	32	68	216	284	F	P	P	P	P	P
	(x-2)	26	26	72	81	30	56	203	259	F	P	P	P	P	P
	(x-3)	21	21	70	78	18	33	185	218	F	P	P	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
Commercial Metals	(x-1)	9	12	58	99	38	62	59	120	F	P	1.05	P	P	P
	(x-2)	19	22	77	124	81	95	50	145	F	P	1.90	1.54	F	P
	(x-3)	5	8	52	81	55	66	32	98	F	11.7	F	F	F	P
Consyne	(x-1)	1	2	4	8	2	3	9	12	F	P	P	P	P	P
	(x-2)	1	2	4	8	2	3	9	12	F	P	P	P	P	P
	(x-3)	1	2	4	7	3	3	8	11	F	P	P	P	P	P
Copper Range	(x-1)	-14	-6	28	62	19	58	128	186	P	F	P	P	P	F
	(x-2)	18	26	55	86	15	61	119	180	P	P	P	P	P	P
	(x-3)	11	19	44	61	12	54	106	160	P	P	P	P	P	P
Copperweld	(x-1)	23	38	199	466	213	340	267	607	F	11.2	1.27	P	F	3.8
	(x-2)	17	21	47	97	42	69	89	158	P	P	P	P	1.12	P
	(x-3)	13	17	30	73	27	55	77	132	P	P	P	P	1.11	P
Crown Industries	(x-1)	.8	1	5	8	3	4	7	11	23.3	P	P	P	P	P
	(x-2)	1	2	5	9	4	5	7	12	22.0	P	P	P	P	P
	(x-3)	2	2	5	8	4	5	6	11	21.9	P	P	P	P	P
Cyclops	(x-1)	-7	7	70	173	88	166	138	304	P	F	1.20	1.97	F	F
	(x-2)	20	23	87	206	115	183	157	340	P	18.1	1.17	1.79	F	P
	(x-3)	9	22	77	180	91	165	145	310	P	13.2	1.14	1.98	F	P
Driver Harris	(x-1)	2	3	10	23	11	16	18	33	29.5	17.3	P	P	F	P
	(x-2)	2	3	10	23	11	16	18	33	29.5	17.3	P	P	F	P
	(x-3)	1	2	11	20	9	14	16	30	P	15.0	P	P	1.20	3.7
Earth Resources	(x-1)	10	13	38	48	38	58	32	90	P	P	1.84	F	1.02	P
	(x-2)	7	11	32	41	37	47	24	71	P	P	1.92	F	F	P
	(x-3)	2	5	15	19	13	24	18	42	P	P	1.31	F	1.15	P
EASCO	(x-1)	7	11	26	64	27	52	46	97	P	P	1.13	P	F	P
	(x-2)	6	10	30	71	29	64	41	105	P	14.8	1.56	P	1.03	P
	(x-3)	6	9	27	58	37	53	36	89	P	16.6	1.47	1.57	F	P
Eastern	(x-1)	3	4	6	14	2	6	19	25	P	P	P	P	P	P
	(x-2)	3	3	8	17	5	9	18	27	P	P	P	P	P	P
	(x-3)	2	2	6	12	3	4	15	19	P	P	P	P	P	P
ELTRA	(x-1)	37	53	184	376	142	237	298	535	20.5	P	P	P	P	P
	(x-2)	35	49	192	373	146	242	273	515	F	P	P	P	P	P
	(x-3)	32	44	157	309	102	181	249	431	F	P	P	P	P	P
Florida Steel	(x-1)	7	10	17	40	11	24	53	77	P	P	P	P	P	P
	(x-2)	11	13	24	47	15	28	43	76	P	P	P	P	P	P
	(x-3)	6	8	19	36	9	21	39	60	P	P	P	P	P	P
General Steel	(x-1)	5	7	14	27	11	37	15	52	P	18.8	F	P	P	P
	(x-2)	5	7	14	28	11	41	10	51	P	16.3	F	P	P	P
	(x-3)	3	5	19	29	18	56	5	61	P	F	F	1.64	1.07	P

TABLE III-4
(continued)

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]	NI/TA[7]
Hanna	(x-1)	47	57	79	100	49	92	293	385	F	P	P	P	P	P
	(x-2)	21	30	75	97	49	114	283	397	F	P	P	1.96	P	P
	(x-3)	23	33	60	81	31	86	274	360	F	P	P	P	P	P
Harsco	(x-1)	36	59	135	224	59	152	206	358	P	P	P	P	P	P
	(x-2)	25	48	98	194	90	137	182	319	P	P	P	P	1.09	P
	(x-3)	22	42	91	162	64	107	164	271	P	P	P	P	P	P
Hofmann Industries	(x-1)	.7	2	7	18	12	16	14	30	P	12.5	1.16	1.58	F	2.3
	(x-2)	3	3	8	16	9	14	13	27	P	P	1.04	1.89	F	P
	(x-3)	1	2	8	16	11	16	11	27	P	11.9	1.43	1.56	F	P
Hoover Ball & Bearing	(x-1)	12	21	60	87	37	69	79	149	P	P	P	P	P	P
	(x-2)	11	17	39	72	31	70	73	143	P	P	P	P	P	P
	(x-3)	14	21	33	58	27	59	62	122	P	P	P	P	P	P
INCO	(x-1)	166	199	267	469	284	630	458	1088	P	P	1.38	1.65	F	P
	(x02)	57	79	267	346	150	435	309	744	P	18.2	1.41	P	P	P
	(x-3)	26	41	183	260	128	305	250	555	P	13.4	1.22	P	P	P
Inland Steel	(x-1)	83	164	309	627	243	896	971	1867	P	18.3	P	P	P	P
	(x-2)	148	222	323	664	302	819	939	1758	P	P	P	P	1.07	P
	(x-3)	83	154	250	515	243	710	849	1559	P	P	P	P	1.03	P
Inspiration Consolidated	(x-1)	-4	7	28	60	13	54	115	169	P	13.3	P	P	P	F
	(x-2)	10	20	18	39	17	65	91	156	P	P	P	P	1.07	P
	(x-3)	15	21	36	47	15	68	88	156	P	P	P	P	P	P
Interlake	(x-1)	34	54	98	216	107	216	264	480	P	P	P	P	F	P
	(x-2)	39	55	124	250	155	254	242	496	P	P	1.05	1.61	F	P
	(x-3)	17	32	87	164	66	148	214	362	P	P	P	P	P	P
Kaiser Aluminum & Chemical	(x-1)	95	149	354	825	446	1304	798	2102	P	11.4	1.63	1.85	F	P
	(x-2)	104	157	401	799	452	855	1202	2057	P	18.4	P	1.77	F	P
	(x-3)	45	95	312	618	394	754	1060	1814	P	12.7	P	1.57	F	2.5
Kaiser Industries	(x-1)	79	213	212	305	189	657	632	1289	P	P	1.04	1.61	1.12	P
	(x-2)	31	91	219	334	202	692	577	1269	P	13.1	1.20	1.65	1.08	2.4
	(x-3)	45	97	219	313	191	688	550	1238	P	14.1	1.25	1.64	1.15	3.6
Kaiser Steel	(x-1)	80	113	134	216	125	329	458	787	P	P	P	1.72	1.07	P
	(x-2)	67	111	143	244	134	394	395	789	P	P	P	1.83	1.07	P
	(x-3)	53	96	144	224	135	422	336	758	P	P	1.26	1.66	1.07	P
Katy Industries	(x-1)	10	15	35	75	34	98	68	167	20.9	15.4	1.44	P	1.02	P
	(x-2)	10	15	35	75	34	98	68	167	20.9	15.4	1.44	P	1.02	P
	(x-3)	12	17	38	70	40	97	60	156	20.8	17.8	1.64	1.74	F	P
Kawecki-Berylco	(x-1)	-1	3	22	74	18	64	53	116	P	F	1.21	P	P	F
	(x-2)	7	10	21	72	14	57	55	112	29.0	17.3	1.64	P	P	P
	(x-3)	5	8	21	61	15	40	50	90	26.6	19.3	1.03	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
Kennecott	(x-1)	49	71	171	446	183	812	1411	2223	P	F	P	P	F	F
	(x-2)	211	302	317	606	287	767	1442	2209	P	P	P	P	1.10	P
	(x-3)	159	240	331	550	241	670	1307	1295	P	P	P	P	P	P
Keystone Consolidated	(x-1)	11	20	41	135	41	128	112	240	P	15.9	1.14	P	1.01	P
	(x-2)	10	15	39	124	55	122	103	225	P	12.2	1.18	P	F	P
	(x-3)	5	12	37	102	36	108	95	202	P	10.8	1.14	P	1.01	2.4
Kerr-McGee	(x-1)	131	190	338	567	285	579	809	1388	P	P	P	1.99	1.19	P
	(x-2)	116	187	298	496	294	510	655	1164	P	P	P	1.69	1.01	P
	(x-3	63	120	200	333	128	308	559	867	P	P	P	P	P	P
Kewanee	(x-1)	28	43	101	181	63	174	183	357	P	P	P	P	P	P
	(x-2)	29	42	66	116	42	74	170	244	P	P	P	P	P	P
	(x-3)	17	29	49	86	30	60	147	207	P	P	P	P	P	P
Kimberly-Clark	(x-1)	103	150	237	493	219	575	730	1305	P	P	P	P	1.08	P
	(x-2)	95	143	249	486	199	562	668	1229	P	P	P	P	P	P
	(x-3)	82	124	228	402	169	458	610	1068	P	P	P	P	P	P
Kin-Ark	(x-1)	.9	2	4	7	4	15	12	27	P	14.6	1.25	1.81	1.08	3.3
	(x-2)	1	2	4	7	6	17	11	27	P	13.9	1.54	F	F	P
	(x-3)	1	2	3	4	7	16	10	25	P	14.2	1.60	F	F	P
Koppers	(x-1)	60	91	214	369	150	311	368	680	P	P	P	P	P	P
	(x-2)	48	81	193	339	144	336	312	648	P	P	1.08	P	P	P
	(x-3)	30	58	151	255	107	246	274	520	P	P	P	P	P	P
Kraftco	(x-1)	140	192	318	1024	466	658	1009	1667	P	P	P	P	F	P
	(x-2)	95	144	337	1130	582	860	850	1710	P	16.7	1.01	1.94	F	P
	(x-3)	103	151	295	854	411	583	808	1391	P	P	P	P	F	P
Lehigh Valley Industries	(x-1)	2	4	8	32	18	53	6	59	23.7	F	F	1.81	F	3.9
	(x-2)	2	4	8	32	18	53	6	59	23.8	F	F	1.81	F	3.9
	(x-3)	3	4	8	32	19	55	4	59	23.1	F	F	1.74	F	P
Lilly & Co.	(x-1)	181	212	633	947	436	476	958	1434	P	P	P	P	P	P
	(x-2)	179	207	553	850	390	417	849	1265	29.3	P	P	P	P	P
	(x03)	156	182	450	667	268	290	730	1020	P	P	P	P	P	P
LTV Corporation	(x-1)	13	70	367	848	585	1602	361	1963	P	F	F	F	F	F
	(x-2)	112	197	645	1097	647	1686	344	2031	P	11.7	F	1.69	F	P
	(x-3)	50	130	498	871	515	1552	233	1785	P	F	F	1.69	F	2.8
Lubrizol	(x-1)	47	59	116	193	64	74	231	305	P	P	P	P	P	P
	(x-2)	51	61	112	191	80	89	203	292	P	P	P	P	P	P
	(x-3)	37	46	101	138	49	55	170	225	P	P	P	P	P	P
Lukens Steel	(x-1)	11	12	33	60	27	54	109	163	P	P	P	P	P	P
	(x-2)	11	NA	39	73	36	66	102	168	P	15.0	P	P	1.09	P
	(x-3)	7	NA	31	58	25	55	94	149	P	15.0	P	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]	NI/TA[7]
MacAndrews	(x-1)	3	6	7	28	2	25	31	56	P	P	P	P	F	P
Forbes	(x-2)	2	5	8	26	10	23	29	52	P	P	P	P	F	P
	(x-3)	6	8	10	27	12	27	28	54	P	P	P	P	F	P
Mangood	(x-1)	.2	.5	4	7	4	8	4	12	P	F	1.86	P	1.20	F
Corporation	(x-2)	.1	F	6	9	5	9	4	13	P	F	F	1.84	P	F
	(x-3)	.2	F	5	7	3	6	5	11	P	F	1.33	P	P	F
Marathon	(x-1)	14	22	42	126	64	132	81	213	P	16.4	1.63	1.97	F	P
Manufacturing	(x-2)	7	13	42	138	68	160	68	228	P	F	F	P	F	3.1
	(x-3)	-19	-12	52	106	66	137	61	198	P	F	F	1.61	F	F
Martin	(x-1)	55	115	207	393	161	530	609	1139	P	P	P	P	P	P
Marietta	(x-2)	81	139	215	392	169	538	584	1121	P	P	P	P	P	P
	(x-3)	57	109	225	371	145	569	503	1072	P	19.2	1.13	P	P	P
McIntosh	(x-1)	1	3	10	15	5	7	23	30	P	P	P	P	P	P
Corporation	(x-2)	4	5	10	18	9	13	22	36	P	P	P	P	1.18	P
	(x-3)	4	5	10	15	5	9	20	28	P	P	P	P	P	P
McLouth	(x-1)	6	23	55	136	79	154	175	329	P	14.8	P	1.70	F	P
	(x-2)	22	41	75	130	65	144	177	321	P	P	P	P	1.15	P
	(x-3)	16	35	68	118	55	138	162	299	P	P	P	P	P	P
McNeil	(x-1)	4	6	33	95	36	61	71	131	25.1	10.5	P	P	F	2.7
Corporation	(x-2)	5	7	37	92	35	55	69	124	23.2	13.0	P	P	1.04	3.7
	(x-3)	6	8	30	77	27	40	66	106	23.9	P	P	P	1.13	P
Mead	(x-1)	53	94	245	371	192	560	532	1092	P	16.8	1.05	1.93	P	P
	(x-2)	82	120	219	381	213	552	509	1061	P	P	1.09	1.79	1.03	P
	(x-3)	50	82	190	336	152	486	459	945	P	16.8	1.06	P	P	P
Merck	(x-1)	229	281	447	857	355	624	950	1574	P	P	P	P	P	P
	(x-2)	211	257	332	723	363	420	823	1243	P	P	P	1.99	F	P
	(x-3)	183	223	335	580	238	279	710	989	P	P	P	P	P	P
Michigan Seamless	(x-1)	10	13	14	32	15	23	42	65	P	P	P	P	F	P
Tube	(x-2)	7	P	15	29	10	27	34	60	P	P	P	P	P	P
	(x-3)	4	P	13	26	9	19	29	48	P	P	P	P	P	P
Midland-Ross	(x-1)	21	31	140	209	104	169	182	351	26.1	18.5	P	P	P	P
	(x-2)	21	32	99	186	89	157	167	324	27.6	P	P	P	1.11	P
	(x-3)	12	21	76	141	57	130	152	282	P	15.8	P	P	P	P
Miles	(x-1)	15	19	81	144	77	200	146	346	P	13.1	1.37	1.88	1.06	P
Laboratories	(x-2)	16	26	60	149	105	198	137	335	P	13.2	1.45	F	F	P
	(x-3)	17	26	74	124	80	171	128	299	P	15.3	1.34	1.55	F	P
3M	(x-1)	262	417	795	1589	620	1194	1823	3017	P	P	P	P	P	P
	(x-2)	302	431	675	1577	921	1146	1695	2841	P	P	P	1.71	F	P
	(x-3)	296	405	743	1310	565	768	1513	2281	P	P	P	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]	NI/TA[7]
Mirro Aluminum	(x-1)	3	5	26	51	10	28	43	71	27.8	19.2	P	P	P	P
	(x-2)	3	5	17	49	9	27	42	69	29.0	19.1	P	P	P	P
	(x-3)	4	6	16	43	18	22	40	62	P	P	P	P	F	P
Mobil Oil	(x-1)	810	1522	3954	6156	5234	8209	6841	15050	P	18.5	1.20	F	F	P
	(x-2)	1047	1560	3863	5827	5206	7638	6436	14074	P	P	1.19	F	F	P
	(x-3)	849	1282	2986	3939	3375	4976	5715	10690	P	P	P	F	F	P
Molycorp	(x-1)	8	16	10	30	8	42	92	134	P	P	P	P	1.14	P
	(x-2)	14	22	12	32	15	50	77	127	P	P	P	P	F	P
	(x-3)	8	14	14	30	13	42	75	117	P	P	P	P	1.12	P
Morton Norwich	(x-1)	18	35	107	201	59	222	238	460	P	15.7	P	P	P	3.8
	(x-2)	25	41	105	191	89	208	231	439	P	19.7	P	P	1.17	P
	(x-3)	24	39	96	164	61	186	217	403	P	P	P	P	P	P
Nalco Chemical	(x-1)	32	44	77	118	47	58	158	216	P	P	P	P	P	P
	(x-2)	27	36	58	100	41	49	138	187	P	P	P	P	P	P
	(x-3)	25	32	71	100	30	35	122	157	27.4	P	P	P	P	P
National Chemsearch	(x-1)	17	19	64	86	34	43	74	117	20.0	P	P	P	P	P
	(x-2)	14	14	50	67	21	29	59	88	P	P	P	P	P	P
	(x-3)	10	10	42	52	15	20	48	68	P	P	P	P	P	P
National Distillers	(x-1)	62	89	328	629	163	429	595	1024	P	P	P	P	P	P
	(x-2)	90	117	315	641	181	454	565	1019	P	P	P	P	P	P
	(x-3)	72	101	341	629	174	504	505	1009	P	P	P	P	P	P
National Industries	(x-1)	15	22	93	182	110	189	92	281	F	11.7	F	1.65	F	P
	(x-2)	17	NA	100	197	143	219	86	305	F	10.0	F	F	F	P
	(x-3)	14	NA	66	154	101	182	81	263	21.2	10.0	F	1.53	F	P
National Service	(x-1)	18	29	87	139	45	74	155	229	P	P	P	P	P	P
	(x-2)	23	33	90	161	74	104	148	252	P	P	P	P	P	P
	(x-3)	23	32	87	138	55	85	140	225	P	P	P	P	P	P
National Starch & Chem.	(x-1)	19	25	58	100	32	84	130	214	P	P	P	P	P	P
	(x-2)	18	25	42	89	33	69	116	185	P	P	P	P	P	P
	(x-3)	17	23	36	70	28	47	102	149	P	P	P	P	P	P
National Steel	(x-1)	58	171	318	763	503	1201	1209	2410	P	14.2	P	1.52	F	2.4
	(x-2)	176	286	578	857	581	1096	1192	2289	P	P	P	F	F	P
	(x-3)	98	207	423	681	431	958	1067	2024	P	P	P	1.58	F	P
New England Nuclear	(x-1)	3	4	8	11	3	4	19	23	P	P	P	P	P	P
	(x-2)	3	4	11	13	3	4	16	20	P	P	P	P	P	P
	(x-3)	2	3	9	11	3	3	13	16	28.8	P	P	P	P	P
Newmont Mining	(x-1)	53	85	129	298	126	481	648	1129	P	17.7	P	P	1.02	P
	(x-2)	114	140	123	266	124	440	637	1077	P	P	P	P	F	P
	(x-3)	103	123	110	186	72	379	564	944	P	P	P	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
NL Industries	(x-1)	46	80	223	493	178	540	520	1060	P	14.9	1.04	P	P	P
	(x-2)	78	110	221	494	210	535	499	1034	P	P	1.07	P	1.05	P
	(x-3)	47	76	268	459	190	544	444	988	P	14.0	1.22	P	P	P
Northwest Industries	(x-1)	101	131	296	572	189	601	583	1184	29.9	P	1.03	P	P	P
	(x-2)	82	108	290	554	171	585	504	1089	24.9	18.5	1.16	P	P	P
	(x-3)	57	79	269	457	140	536	429	965	24.0	14.7	1.25	P	P	P
NW Steel & Wire	(x-1)	27	34	56	121	19	65	173	238	P	P	P	P	P	P
	(x-2)	34	40	102	140	32	66	175	240	P	P	P	P	P	P
	(x-3)	27	32	109	137	28	58	155	213	P	P	P	P	P	P
Norton Co.	(x-1)	21	34	159	288	88	193	255	448	P	18.0	P	P	P	P
	(x-2)	25	38	127	279	120	185	244	429	P	P	P	P	1.06	P
	(x-3)	21	33	115	235	80	141	228	369	P	P	P	P	P	P
Nucor Corporation	(x-1)	8	12	19	45	18	48	45	93	P	P	1.08	P	1.07	P
	(x-2)	10	13	26	45	24	45	37	82	P	P	1.21	1.87	1.07	P
	(x-3)	6	8	22	39	19	41	27	68	P	19.3	1.54	1.99	1.12	P
Oakite Products	(x-1)	3	3	9	17	6	6	17	24	26.7	P	P	P	P	P
	(x-2)	3	3	9	17	7	8	16	24	27.0	P	P	P	P	P
	(x-3)	2	3	8	14	4	5	15	20	29.1	P	P	P	P	P
Occidental Petroleum	(x-1)	172	310	1015	1328	783	2302	1201	3503	P	13.5	1.92	1.70	P	P
	(x-2)	281	393	1048	1372	907	2231	1094	3326	P	17.6	F	1.51	1.16	P
	(x-3)	72	214	913	1172	858	1991	847	2838	P	10.7	F	F	1.06	2.5
Olin Corporation	(x-1)	59	118	305	531	221	478	536	1014	P	P	1.08	P	P	P
	(x-2)	84	NA	277	498	215	465	488	953	P	18.1	P	P	P	P
	(x-3)	61	NA	297	472	246	528	560	1088	P	11.6	P	1.92	P	P
P&F Industries	(x-1)	.1	1	14	27	11	26	13	39	21.9	F	1.97	P	P	F
	(x-2)	1	3	16	37	24	34	13	47	F	F	F	1.51	F	3.0
	(x-3)	-.5	.6	15	26	15	26	12	38	F	F	F	1.80	F	F
Park Chemical	(x-1)	.5	.6	2	2	.5	.6	3	3	24.2	P	P	P	P	P
	(x-2)	.5	.6	2	2	.8	.8	3	4	22.8	P	P	P	P	P
	(x-3)	.3	.4	1	2	.6	.6	2	3	26.7	P	P	P	P	P
Park Electrochemical	(x-1)	-.2	.5	5	9	4	5	10	14	P	10.8	P	P	P	P
	(x-2)	1	2	7	10	5	5	10	15	P	P	P	P	P	P
	(x-3)	.6	1	6	8	3	4	9	13	P	P	P	P	P	P
Peerless Tube	(x-1)	.5	1	3	5	2	3	10	13	P	P	P	P	P	3.9
	(x-2)	.8	2	2	5	2	3	10	13	P	P	P	P	F	P
	(x-3)	.9	2	2	4	2	2	9	11	P	P	P	P	F	P
Pennwalt	(x-1)	34	55	159	309	100	275	266	541	P	19.8	1.03	P	P	P
	(x-2)	27	45	146	298	149	273	246	519	P	16.3	1.11	P	P	P
	(x-3)	20	37	125	247	90	216	222	438	P	17.1	P	P	P	P

TABLE III-4
(continued)

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]	NI/TA[7]
Pennzoil	(x-1)	107	215	297	445	247	1453	573	2026	P	14.8	F	1.80	1.20	2.7
	(x-2)	128	218	218	338	146	1283	515	1798	P	17.0	F	P	P	P
	(x-3)	84	155	245	323	228	1135	628	1762	P	13.7	1.81	F	1.07	P
Phelps Dodge	(x-1)	71	106	145	336	189	759	893	1652	P	13.9	P	1.78	F	P
	(x-2)	122	158	121	324	231	601	892	1493	P	P	P	F	F	P
	(x-3)	109	145	229	362	145	454	815	1269	P	P	P	P	P	P
Pgh-Des Moines Steel	(x-1)	4	7	62	73	48	56	39	96	20.6	11.7	1.42	1.51	P	P
	(x-2)	2	4	58	73	51	59	36	95	F	F	1.64	F	1.14	2.0
	(x-3)	3	5	49	57	42	43	35	78	20.6	10.9	1.23	F	1.17	3.5
Pittsburgh Forgings	(x-1)	9	12	25	52	26	42	42	84	F	P	1.00	P	F	P
	(x-2)	3	6	24	52	31	42	36	78	F	13.8	1.18	1.68	F	3.5
	(x-3)	2	5	16	37	18	30	32	62	F	18.2	P	P	F	3.9
Plant Industries	(x-1)	2	5	11	20	19	33	16	48	P	L$.I.	F	F	F	P
	(x-2)	1	4	10	18	16	28	16	44	P	12.4	1.81	F	F	3.2
	(x-3)	1	3	8	16	11	20	16	36	P	13.5	1.28	F	F	3.1
Portec	(x-1)	6	7	18	41	11	22	35	56	25.3	P	P	P	P	P
	(x-2)	5	6	17	44	18	28	29	57	21.1	P	P	P	F	P
	(x-3)	2	4	8	27	10	19	24	43	27.9	18.9	P	P	F	P
Redman Industries	(x-1)	-23	-22	22	33	20	89	11	100	F	F	F	1.68	1.13	F
	(x-2)	-24	-22	22	33	20	89	11	101	F	F	F	1.65	1.10	F
	(x-3)	-15	-13	31	45	39	110	35	146	F	F	F	F	F	F
Republic Steel	(x-1)	72	157	282	614	269	792	1279	2071	P	19.8	P	P	1.05	3.5
	(x-2)	171	252	502	759	409	810	1232	2042	P	P	P	1.86	P	P
	(x-3)	87	166	352	613	333	755	1107	1862	P	P	P	1.84	1.06	P
Revere Copper & Brass	(x-1)	-31	-15	64	189	88	321	137	458	P	F	F	P	F	F
	(x-2)	17	34	61	194	83	329	170	499	P	10.4	1.94	P	F	3.4
	(x-3)	3	19	84	173	84	333	153	486	P	F	F	P	1.01	F
Reynolds Metals	(x-1)	60	133	294	845	292	1373	831	2204	P	F	1.65	P	1.01	P
	(x-2)	111	188	399	902	340	1525	799	2324	P	12.3	1.91	P	1.17	P
	(x-3)	45	120	221	717	250	1409	709	2118	P	F	1.99	P	P	2.1
Roblin Industries	(x-1)	2	5	21	31	13	36	18	54	28.0	12.8	1.97	P	P	P
	(x-2)	5	7	20	32	14	38	17	55	28.3	17.2	F	P	P	P
	(x-3)	-3	-2	21	37	18	49	13	61	26.0	F	F	1.99	1.14	F
Rusco Industries	(x-1)	.4	1	9	21	9	22	7	30	24.3	F	F	P	1.02	F
	(x-2)	.2	1	10	22	9	24	7	32	24.1	F	F	P	1.07	F
	(x-3)	.9	2	10	19	9	22	7	29	26.2	F	F	P	1.05	3.1
Season-All Industries	(x-1)	.8	1	4	8	4	6	6	12	P	20.0	1.05	P	1.11	P
	(x-2)	.8	1	3	7	3	6	5	12	P	16.7	1.21	P	F	P
	(x-3)	.6	1	3	6	3	5	5	10	P	19.6	1.11	1.84	F	P

TABLE III-4
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
Sharon Steel	(x-1)	15	25	89	146	56	96	182	278	P	P	P	P	P	P
	(x-2)	47	58	140	189	86	137	171	308	P	P	P	P	P	P
	(x-3)	12	22	62	104	49	89	127	216	P	P	P	P	P	P
Signal Companies	(x-1)	1	78	485	1149	443	1058	808	1866	21.5	F	1.31	P	1.09	2.2
	(x-2)	176	201	464	1038	403	747	786	1533	F	P	P	P	1.15	P
	(x-3)	59	80	254	684	273	672	686	1358	F	11.9	P	P	F	P
Signode	(x-1)	17	32	70	157	39	99	174	273	P	P	P	P	P	P
Corporation	(x-2)	24	39	69	165	54	115	164	279	27.8	P	P	P	P	P
	(x-3)	22	35	75	127	39	100	146	247	27.2	P	P	P	P	P
St. Joe	(x-1)	82	113	126	200	107	195	361	556	P	P	P	1.87	1.18	P
Minerals	(x-2)	89	113	146	190	119	197	299	496	P	P	P	1.60	P	P
	(x-3)	38	56	82	112	65	151	229	380	P	P	P	1.72	P	P
Standard	(x-1)	2	2	10	20	10	19	14	33	22.7	F	1.38	1.99	F	P
Alliance	(x-2)	3	3	13	25	12	22	13	35	F	11.2	1.76	1.99	1.01	P
	(x-3)	2	2	12	22	11	21	11	32	F	11.3	1.99	P	1.10	P
Std. Pressed	(x-1)	2	8	26	80	27	56	75	131	P	13.8	P	P	F	F
Steel	(x-2)	12	16	37	98	43	71	75	146	P	P	P	P	F	P
	(x-3)	7	12	27	72	34	54	66	120	P	P	P	P	F	P
Sunbeam	(x-1)	23	38	199	466	213	340	267	607	F	11.2	1.27	P	F	3.8
Corporation	(x-2)	31	45	188	398	198	272	256	528	F	16.4	1.06	P	F	P
	(x-3)	28	41	152	322	126	207	237	444	F	19.7	P	P	P	P
Sunshine	(x-1)	4	5	26	36	9	31	27	58	21.8	16.8	1.15	P	P	P
Mining	(x-2)	5	6	21	36	11	34	25	59	20.8	17.9	1.33	P	P	P
	(x-3)	3	4	24	32	9	30	23	53	20.4	14.1	1.28	P	P	P
Synalloy	(x-1)	3	3	9	20	6	12	17	30	22.3	P	P	P	P	P
	(x-2)	2	2	8	20	8	15	15	30	22.7	15.4	P	P	1.04	P
	(x-3)	.9	2	6	16	5	13	14	26	26.5	13.6	P	P	P	P
Tennessee	(x-1)	1	2	7	17	8	29	13	42	P	F	F	P	F	3.1
Forging	(x-2)	4	.6	9	17	13	24	11	35	P	P	F	F	F	P
	(x-3)	1	2	4	7	6	13	5	18	P	15.3	F	F	F	P
Texasgulf	(x-1)	103	129	118	291	105	527	628	1155	P	P	P	P	1.12	P
	(x-2)	147	188	229	327	142	417	560	977	P	P	P	P	P	P
	(x-3)	74	109	103	182	68	336	440	776	P	P	P	P	P	P
U.S. Reduction	(x-1)	8	10	14	28	16	19	25	44	P	P	P	1.78	F	P
Company	(x-2)	8	10	22	34	23	29	17	46	2.52	P	1.69	F	F	P
	(x-3)	1	3	8	18	12	19	9	28	P	13.5	F	F	F	P
Utah	(x-1)	12	160	118	193	176	505	541	1046	P	P	P	F	F	P
International	(x-2)	97	135	80	132	118	461	448	909	P	P	1.03	F	F	P
	(x-3)	55	91	60	110	84	428	380	828	P	P	1.13	F	F	P

TABLE III-4
(concluded)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]	NI/TA[7/]
Valley Industries	(x-1)	15	16	20	54	18	22	43	66	F	P	1.95	P	1.12	P
	(x-2)	25	26	53	71	49	54	27	81	F	P	1.97	F	1.08	P
	(x-3)	5	6	17	31	16	26	14	40	21.1	P	1.82	1.98	1.11	P
Van Dorn Company	(x-1)	3	6	21	46	12	38	32	69	P	14.9	1.18	P	P	4.0
	(x-2)	4	7	13	43	12	36	30	66	P	18.9	1.20	P	1.12	P
	(x-3)	4	6	24	46	16	40	27	68	P	16.0	1.48	P	P	P
Vulcan Materials	(x-1)	28	51	73	120	40	153	173	326	P	P	P	P	P	P
	(x-2)	30	60	61	105	52	120	157	277	P	P	P	P	1.17	P
	(x-3)	23	42	63	93	39	96	143	239	P	P	P	P	P	P
Washington Steel	(x-1)	3	3	11	26	9	27	35	62	P	12.5	P	P	1.18	P
	(x-2)	6	6	13	26	11	19	33	52	P	P	P	P	1.20	P
	(x-3)	4	4	14	26	8	15	29	44	P	P	P	P	P	P
Wheeling-Pittsburgh	(x-1)	.6	31	148	258	116	311	365	676	P	F	P	P	P	F
	(x-2)	73	102	223	347	199	351	371	722	P	P	P	1.74	1.12	P
	(x-3)	7	37	133	258	123	304	302	606	P	12.1	1.01	P	1.08	F
Youngstown Steel Door	(x-1)	1	2	11	20	6	14	24	38	P	15.6	P	P	P	2.6
	(x-2)	3	4	10	23	8	17	24	41	P	P	P	P	P	P
	(x-3)	2	3	11	20	6	15	23	37	P	19.9	P	P	P	P

TABLE III-5

FINANCIAL DATA FOR FIRMS IN THE HOLDOUT BANKRUPT SAMPLE

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[1]	CF/TL[2]	TL/NW[3]	CURRAT[4]	QRAT[5]
Acme-Hamilton Mfg.	1977(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1976(x-2)	-0.9	-0.4	5.1	11.2	9.0	15.3	4.3	19.6	P	F	F	F	F
	1975(x-3)	0.1	0.5	4.0	10.4	7.3	13.0	5.2	18.2	P	F	F	F	F
Aerodex	1975(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1974(x-2)	.006	0.6	2.5	8.8	6.5	13.4	0.9	14.3	F	F	F	F	F
	1973(x-3)	0.3	1.0	5.2	11.2	7.8	15.8	0.8	16.6	22.9	F	F	F	F
AIM Companies	1970(x-1)	-2.9	NA	4.1	13.4	9.6	19.6	6.9	26.5	21.7	NA	F	F	F
	1969(x-2)	1.3	2.1	4.6	8.5	4.0	10.6	7.6	18.2	25.6	19.8	1.39	P	1.15
	1968(x-3)	-1.1	-0.6	4.5	8.5	4.5	14.2	6.4	20.6	24.8	F	F	1.89	1.00
Capehart Corporation	1974(x-1)	-4.0	-2.7	14.5	41.0	43.1	33.9	7.1	41.0	F	F	F	F	F
	1973(x-2)	3.2	3.9	15.2	39.0	32.9	39.3	11.1	50.4	F	F	F	F	F
	1972(x-3)	1.8	2.3	8.6	14.1	7.9	10.1	7.9	18.0	F	P	1.28	1.78	1.09
Commodore Corporation	1973(x-1)	1.1	1.9	17.0	26.6	21.4	37.1	9.8	46.9	F	F	F	F	F
	1972(x-2)	0.8	1.6	13.6	20.4	14.2	29.9	8.6	38.5	F	F	F	F	F
	1971(x-3)	-3.0	-2.2	9.3	17.3	12.0	27.0	9.4	36.4	F	F	F	F	F
Commonwealth Oil Refining	1977(x-1)	-18.0	-6.1	129.0	232.6	401.9	409.1	127.5	536.6	P	F	F	F	F
	1976(x-2)	-32.1	-19.8	110.0	248.2	221.2	420.9	145.2	566.1	P	F	F	F	F
	1975(x-3)	-24.2	-13.3	151.0	252.6	208.5	394.2	179.3	573.5	P	F	F	F	F
Dynamics Corporation	1971(x-1)	-6.3	-4.3	43.3	63.7	39.8	29.9	50.0	79.9	F	F	P	1.60	1.09
	1970(x-2)	-9.9	-7.4	51.1	80.9	51.7	26.7	73.9	100.6	F	F	P	1.56	F
	1969(x-3)	2.3	4.3	51.6	82.0	40.9	63.7	37.1	100.8	F	F	1.72	P	1.26
Ecological Science	1969(x-1)	2.8	3.6	18.4	26.8	16.9	66.1	22.7	88.8	P	F	F	1.59	1.09
	1968(x-2)	2.5	3.0	13.5	18.1	7.9	37.6	16.2	53.8	P	F	F	P	P
	1967(x-3)	0	0.3	3.1	3.5	1.2	20.6	7.3	27.9	P	F	F	P	P
Elcor Chemical	1970(x-1)	-39.5	-38.6	2.9	2.9	11.4	43.5	-32.0	11.5	P	F	F	F	F
	1969(x-2)	-8.8	-7.4	6.7	8.2	11.6	53.9	6.5	60.4	P	F	F	F	F
	1968(x-3)	-4.7	NA	9.7	11.5	12.4	62.7	3.9	66.6	P	NA	F	F	F
Electrospace	1972(x-1)	1.8	4.0	NA	33.9	19.4	30.5	13.8	44.3	F	13.1	F	1.75	F
	1971(x-2)	2.0	2.5	11.1	30.1	18.3	29.7	11.9	41.6	F	F	F	1.64	F
	1970(x-3)	0.9	1.2	8.1	27.1	15.8	27.0	10.1	37.1	F	F	F	1.72	F
FDI, Inc.	1977(x-1)	1.6	3.6	23.7	36.3	14.0	44.2	10.8	55.0	F	P	F	P	P
	1976(x-2)	0.8	2.9	21.8	31.7	12.7	40.3	10.4	50.7	F	F	F	P	P
	1975(x-3)	-8.7	-7.8	21.2	33.8	15.9	44.4	9.8	54.2	20.7	F	F	P	P
Garcia Corporation	1977(x-1)	-10.0	-7.6	28.5	61.9	55.7	68.7	12.1	80.8	F	P	F	F	F
	1977(x-2)	-4.5	-2.4	33.0	61.0	46.5	59.8	22.1	81.9	F	F	F	F	F
	1975(x-3)	0.3	2.2	40.4	75.7	60.0	68.6	26.7	95.3	F	P	F	F	F

1/ P > 30.0 (passes all tests); F < 20.0 (fails all tests)

2/ P > 20.0 (passes all tests); F < 10.0 (fails all tests)

3/ P < 1.0 (passes all tests); F > 2.0 (fails all tests)

4/ P > 2.0 (passes all tests); F < 1.5 (fails all tests)

5/ P > 1.2 (passes all tests); F < 1.0 (fails all tests)

TABLE III-5
(concluded)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[1]	CF/TL[2]	TL/NW[3]	CURRAT[4]	QRAT[5]
GRT Corporation	1978(x-1)	0	.8	14.1	18.7	15.6	18.2	5.6	23.8	F	F	F	F	F
	1977(x-2)	1.5	2.2	14.4	18.3	14.7	16.4	6.1	22.5	F	F	F	F	F
	1976(x-3)	-0.7	-0.1	11.2	13.5	11.5	13.9	2.9	16.9	F	F	F	F	F
Leisure Group, Inc.	1970(x-1)	-31.4	-29.8	23.4	32.6	26.7	40.9	17.9	58.8	F	F	F	F	F
	1969(x-2)	0.2	1.0	31.9	51.0	39.4	58.9	33.2	92.1	F	F	1.77	F	F
	1968(x-3)	1.7	2.3	17.9	30.6	21.2	39.0	14.0	53.0	F	F	F	F	F
Meister Brau	1970(x-1)	-1.9	-0.7	4.1	9.2	9.0	25.8	6.1	31.9	P	F	F	F	F
	1969(x-2)	0.1	1.0	4.3	8.3	6.0	16.1	8.2	24.3	P	F	1.96	F	F
	1968(x-3)	0.2	1.1	2.7	5.4	2.9	12.9	7.5	20.4	P	F	1.72	1.86	F
Potter Instruments	1974(x-1)	-11.4	NA	7.3	25.1	36.3	39.3	4.5	43.8	F	NA	F	F	F
	1973(x-2)	-2.2	3.4	10.6	36.2	27.2	44.3	15.9	60.2	P	F	F	F	F
	1972(x-3)	-13.1	-8.6	10.3	32.5	17.9	39.1	18.2	57.3	P	F	F	1.82	F
R. Hoe	1968(x-1)	2.0	2.9	22.9	32.3	26.1	30.6	22.6	53.2	24.2	F	1.35	F	F
	1967(x-2)	2.4	3.0	18.3	24.9	15.4	18.1	18.5	36.6	23.4	16.6	P	1.62	1.19
	1966(x-3)	1.3	1.7	12.3	17.1	12.1	14.1	11.8	25.9	25.1	12.1	1.19	F	1.02
Sitkin	1977(x-1)	-0.3	0.2	7.6	18.4	15.4	16.8	4.4	21.2	F	F	F	F	F
	1976(x-2)	-0.9	-0.5	5.2	14.0	11.1	13.1	5.2	18.3	F	F	F	F	F
	1975(x-3)	0.1	0.5	11.4	20.1	15.3	19.1	5.1	24.2	F	F	F	F	F
TMA Co.	1970(x-1)	-1.3	-1.2	0.7	3.2	1.2	2.8	0.7	3.5	F	F	F	P	F
	1969(x-2)	-1.7	-1.6	1.2	5.5	1.8	3.5	2.4	5.9	F	F	1.46	P	F
	1968(x-3)	-0.1	0	2.3	5.1	1.4	3.6	2.2	5.8	F	F	1.64	P	P
Transogram	1970(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1969(x-2)	0.2	0.5	7.4	12.1	8.2	16.7	4.8	21.5	24.3	F	F	F	F
	1968(x-3)	-3.2	-3.0	5.7	9.7	7.6	10.2	1.5	11.7	F	F	F	F	F
Wilcox-Gibbs	1976(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1975(x-2)	-11.5	-10.8	10.7	42.4	17.3	51.4	8.1	59.5	F	F	F	F	F
	1974(x-3)	-1.5	-0.9	16.3	48.6	28.6	41.7	20.0	61.7	F	F	F	1.70	F
Roberts Company	1969(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1968(x-2)	0.5	1.3	11.8	23.4	15.3	24.6	12.2	36.8	23.9	F	F	1.53	F
	1967(x-3)	1.5	2.4	6.9	16.7	10.6	20.3	7.6	27.9	29.7	11.8	F	1.58	F
Steiber	1975(x-1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1974(x-2)	-13.2	-10.5	18.5	50.0	67.1	72.1	6.3	78.4	24.8	F	F	F	F
	1973(x-3)	2.3	NA	15.0	45.6	36.5	53.5	14.8	68.3	26.8	F	F	F	F
Piedmont Industries	1978(x-1)	0.4	0.8	3.5	13.9	7.1	10.3	6.4	16.7	F	F	1.61	1.96	F
	1977(x-2)	-0.1	0.3	2.6	12.1	4.9	6.7	8.0	14.7	F	F	P	P	F
	1976(x-3)	1.0	1.4	2.6	12.2	4.5	8.7	6.1	14.8	F	16.1	1.43	P	F

TABLE III-6

FINANCIAL DATA FOR FIRMS IN THE HOLDOUT NON-BANKRUPT SAMPLE

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]
Adams Millis Corp.	x-1	1.7	3.8	10.0	20.3	8.8	16.6	19.0	35.4	P	P	P	P	P
	x-2	-5.9	-3.6	7.1	19.8	7.8	24.0	17.0	41.1	P	F	1.41	P	F
	x-3	1.3	3.5	11.2	24.8	8.3	26.5	23.0	49.8	P	11.5	1.15	P	P
Air Products & Chemicals	x-1	54.2	107.6	171.0	248.0	193.0	475.0	301.0	776.0	P	P	1.58	F	F
	x-2	39.7	85.5	168.0	223.0	162.0	411.0	248.0	659.0	P	P	1.66	F	1.04
	x-3	24.1	61.6	111.0	144.0	106.0	309.0	211.0	520.0	P	19.9	1.46	F	1.05
Akzona	x-1	7.9	41.3	124.0	265.0	94.0	341.0	315.0	656.0	P	12.1	1.08	P	P
	x-2	33.4	63.4	99.0	258.0	80.0	301.0	323.0	624.0	P	P	P	P	P
	x-3	35.7	63.6	118.0	228.0	87.0	264.0	304.0	568.0	P	P	P	P	P
Amerace	x-1	8.1	15.5	44.0	101.2	49.3	92.6	90.0	182.6	P	16.7	1.03	P	F
	x-2	13.5	20.3	40.7	93.5	35.4	79.1	86.8	165.9	P	P	P	P	1.15
	x-3	9.8	16.7	44.3	88.1	33.2	75.2	84.8	160.0	P	P	P	P	P
American Petrofina	x-1	40.2	71.3	177.0	282.0	155.0	238.0	364.0	602.0	P	P	P	1.82	1.14
	x-2	86.7	117.2	170.0	280.0	148.0	230.0	345.0	575.0	P	P	P	1.89	1.15
	x-3	37.0	56.2	118.0	172.0	100.0	175.0	276.0	451.0	P	P	P	1.72	1.18
Atlas Corp.	x-1	3.0	4.8	12.9	27.8	21.2	25.6	27.2	52.8	P	18.8	P	F	F
	x-2	1.6	3.1	12.7	26.5	17.6	22.1	24.3	46.4	P	14.0	P	1.51	F
	x-3	-2.4	-0.8	9.5	20.8	11.8	16.0	23.1	39.1	P	F	P	1.76	F
Avondale Mills	x-1	4.0	11.8	40.0	66.8	32.9	35.4	74.5	109.9	P	P	P	P	P
	x-2	6.3	14.2	49.8	74.2	41.6	43.8	74.3	118.1	P	32.4	P	1.79	1.20
	x-3	8.1	16.0	38.4	65.7	33.8	36.0	70.3	106.3	P	P	P	1.94	1.14
Ball Corporation	x-1	14.1	23.3	58.6	129.6	71.5	122.3	102.8	225.1	P	19.0	1.19	1.81	F
	x-2	9.5	18.2	40.6	105.1	54.3	89.4	91.7	181.1	P	20.4	P	1.94	F
	x-3	7.2	NA	35.7	75.1	33.4	64.8	84.8	149.6	P	11.1	P	P	1.07
Belding-Heminway	x-1	3.2	5.1	20.2	45.9	14.0	29.0	33.1	62.1	20.7	17.6	P	P	P
	x-2	2.8	4.7	15.1	42.9	13.4	29.4	30.8	60.2	22.5	16.0	P	P	1.13
	x-3	2.5	4.2	18.0	41.0	17.2	29.7	29.4	59.1	25.3	P	1.01	P	1.05
Borg Warner	x-1	44.5	87.3	253.0	590.0	244.0	504.0	689.0	1193.0	P	17.3	P	P	1.04
	x-2	50.8	93.9	245.0	688.0	264.0	615.0	670.0	1285.0	P	15.3	P	P	F
	x-3	71.3	111.8	271.0	642.0	291.0	530.0	642.0	1172.0	P	P	P	P	F
Buehler Corporation	x-1	0.7	1.5	3.5	11.8	4.0	10.5	5.3	15.8	23.0	14.3	1.98	P	F
	x-2	1.1	1.9	4.5	12.7	5.1	12.3	4.6	16.9	22.0	15.4	F	P	F
	x-3	0.9	1.7	4.5	9.6	5.4	10.4	3.5	13.9	26.0	16.3	F	1.78	F

1/ For all firms, x-1 is 1975, x-2 is 1974, and x-3 is 1973.
2/ P > 30.0 (passes all tests); F < 20.0 (fails all tests)
3/ P > 20.0 (passes all tests); F < 10.0 (fails all tests)
4/ P < 1.0 (passes all tests); F > 2.0 (fails all tests)
5/ P > 2.0 (passes all tests); F < 1.5 (fails all tests)
6/ P > 1.2 (passes all tests); F < 1.0 (fails all tests)

TABLE III-6
(continued)

Name of Firm	Year[1]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2]	CF/TL[3]	TL/NW[4]	CURRAT[5]	QRAT[6]
Burlington	x-1	39.8	132.9	485.0	853.0	237.0	671.0	895.0	1566.0	P	19.8	P	P	P
	x-2	99.5	191.7	496.0	932.0	319.0	757.0	887.0	1644.0	P	25.3	P	P	P
	x-3	82.4	173.1	459.0	880.0	293.0	756.0	825.0	1581.0	P	22.9	P	P	P
Carter Wallace	x-1	8.4	11.1	52.7	83.0	20.5	30.9	124.3	155.2	F	P	P	P	P
	x-2	3.1	5.6	71.5	94.0	25.3	19.9	119.0	138.9	20.9	P	P	P	P
	x-3	10.4	12.5	68.7	99.0	24.7	22.5	118.7	141.2	F	P	P	P	P
Chemetron	x-1	30.4	46.9	99.0	190.2	54.0	161.9	209.4	371.3	P	P	P	P	P
	x-2	22.3	38.1	92.1	173.5	60.1	158.6	183.6	342.2	P	P	P	P	P
	x-3	10.4	26.1	68.5	146.3	55.4	141.4	167.4	308.8	P	18.4	P	P	P
Clark Oil	x-1	5.2	19.1	60.0	120.7	95.3	208.3	100.5	308.8	P	F	F	F	F
	x-2	-7.1	6.1	76.7	141.1	123.6	202.9	98.8	301.7	P	F	F	F	F
	x-3	30.5	43.2	84.4	143.4	101.5	253.5	109.5	263.0	P	17.0	F	F	F
Colt Industries	x-1	52.1	79.8	205.0	497.0	187.0	491.0	375.0	866.0	P	16.3	1.31	P	1.10
	x-2	77.3	103.8	227.0	497.0	172.0	438.0	340.0	778.0	P	P	1.29	P	P
	x-3	26.7	52.2	205.0	422.0	139.0	396.0	275.0	671.0	P	13.2	1.44	P	P
Conchemco	x-1	0.3	1.3	11.1	19.3	6.8	12.3	22.5	34.8	P	F	P	P	P
	x-2	1.8	2.7	11.1	26.0	11.4	19.5	22.5	42.0	27.1	13.8	P	P	F
	x-3	1.8	2.6	10.5	21.1	7.2	15.0	21.2	36.2	29.0	17.3	P	P	P
Cone Mills Corp.	x-1	24.2	37.8	73.5	162.2	51.5	96.0	177.5	273.5	P	P	P	P	P
	x-2	15.3	27.3	78.7	163.3	65.5	95.5	156.4	241.9	P	P	P	P	P
	x-3	9.7	21.6	81.9	162.3	67.9	102.8	145.6	248.4	P	21.0	P	P	P
Crompton Co.	x-1	-2.6	1.5	29.1	43.7	24.2	51.9	38.9	90.8	P	F	1.33	1.81	P
	x-2	0.1	2.5	22.6	34.9	11.8	42.1	41.5	83.6	P	F	1.01	P	P
	x-3	5.8	7.9	26.4	33.8	12.5	21.4	42.7	64.1	P	P	P	P	P
Crown Central	x-1	5.5	13.0	50.6	82.7	79.0	134.6	71.7	206.3	P	F	1.88	F	F
	x-2	10.2	16.6	50.0	76.9	69.3	112.2	66.2	178.4	P	14.8	1.69	F	F
	x-3	8.4	14.4	38.3	63.1	47.2	91.2	57.0	148.2	P	15.8	1.60	F	F
Dahlstrom Corporation	x-1	0.9	1.5	4.5	9.5	6.5	14.5	6.9	21.4	P	10.3	F	F	F
	x-2	1.8	2.2	3.5	6.0	2.8	7.6	6.0	13.6	P	P	1.27	P	P
	x-3	-4.1	-3.5	5.4	9.1	5.5	12.5	4.2	16.7	P	F	F	1.65	F
Damon Corporation	x-1	1.8	4.5	52.3	73.3	20.5	44.0	62.5	106.5	25.1	10.2	P	P	P
	x-2	8.1	10.7	59.0	81.0	25.3	48.9	61.8	110.7	22.4	P	P	P	P
	x-3	9.7	11.9	55.5	72.1	24.7	49.4	52.7	102.1	24.4	P	P	P	P
Daniel Industries	x-1	4.4	5.2	13.0	32.6	16.6	22.5	21.9	44.4	25.5	P	1.03	1.96	F
	x-2	3.0	3.6	9.6	23.9	11.4	15.6	16.9	32.5	26.2	P	P	P	F
	x-3	1.3	1.9	7.8	16.7	8.5	9.6	14.3	23.9	29.3	19.8	P	1.96	F
Dan River Inc.	x-1	-2.9	11.0	89.4	188.7	57.2	163.6	144.0	308.0	P	6.7	1.13	F	F
	x-2	7.0	19.7	79.2	198.7	76.9	166.9	148.0	315.0	P	11.8	1.13	F	F
	x-3	10.4	22.1	88.3	210.4	73.3	165.6	144.0	310.0	P	13.3	1.15	F	F

TABLE III-6
(continued)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4]	CURRAT[5]	QRAT[6/]
De Soto, Inc.	x-1	2.8	9.2	32.3	75.4	51.7	64.9	70.1	135.0	P	14.2	P	F	F
	x-2	0.6	6.5	32.0	87.5	62.2	75.7	69.2	144.9	P	F	1.09	F	F
	x-3	8.3	13.9	31.3	97.0	62.4	74.8	72.0	146.8	P	18.6	1.04	1.55	F
Diversa	x-1	4.0	6.4	23.4	35.6	21.5	33.3	22.6	55.9	24.5	19.2	1.47	1.66	1.09
	x-2	3.6	5.5	18.7	32.2	21.9	31.2	19.5	50.7	23.5	17.6	1.6	F	F
	x-3	2.5	4.1	16.0	24.6	14.5	23.0	16.7	39.7	22.4	17.8	1.38	1.7	1.1
Eagle-Picher	x-1	18.7	27.8	74.9	131.1	41.5	81.8	136.9	218.7	P	P	P	P	P
	x-2	18.0	27.2	60.0	129.0	46.7	88.5	124.0	212.5	P	P	P	P	P
	x-3	14.8	23.4	57.1	111.2	38.4	81.0	111.1	192.1	P	P	P	P	P
Elcor Chemical Corp.	x-1	5.2	6.1	15.9	16.7	9.2	14.7	12.2	26.9	P	P	1.21	1.82	P
	x-2	2.5	3.1	9.3	10.0	7.0	14.2	7.0	21.2	23.3	P	F	F	F
	x-3	0.4	0.8	12.0	12.3	10.4	21.7	4.6	26.3	22.8	F	F	F	F
Emery Industries	x-1	10.7	15.2	35.8	61.8	23.6	61.4	81.7	143.1	P	P	P	P	P
	x-2	10.2	14.7	30.5	52.1	21.2	49.1	74.3	123.4	P	P	P	P	P
	x-3	7.0	11.1	26.7	45.7	13.7	40.8	67.4	108.2	P	P	P	P	P
Ethyl Corp.	x-1	61.0	103.3	246.0	371.0	105.0	440.0	436.0	876.0	P	P	1.01	P	P
	x-2	74.3	113.1	179.0	328.0	128.0	383.0	400.0	783.0	P	P	P	P	P
	x-3	52.9	85.3	274.0	365.0	95.0	348.0	348.0	691.0	P	P	1.00	P	P
Fab Ind.	x-1	2.1	3.3	15.2	24.7	24.7	10.2	14.6	19.8	P	32.4	P	P	P
	x-2	0.9	2.0	9.9	20.5	6.2	11.7	17.8	29.5	P	17.1	P	P	P
	x-3	1.9	3.0	10.5	19.7	6.5	11.9	17.2	29.1	P	P	P	P	P
Fairmont Chemical	x-1	0.3	0.5	1.4	2.9	0.5	0.7	4.0	4.7	27.6	P	P	P	P
	x-2	1.1	1.3	2.6	4.2	1.8	2.1	3.8	5.9	20.3	P	P	P	P
	x-3	0.2	0.5	1.3	2.4	0.7	1.1	2.8	3.9	P	P	P	P	P
Ferro	x-1	15.2	21.8	84.7	139.8	54.7	88.0	126.3	212.3	29.9	P	P	P	P
	x-2	19.9	25.9	77.3	147.3	69.9	101.4	115.1	216.5	27.6	P	P	P	1.11
	x-3	15.9	21.1	73.3	121.6	54.1	86.1	99.4	185.5	28.8	P	P	P	P
Filtrol	x-1	5.5	7.6	17.6	26.0	9.9	28.6	31.8	60.4	P	P	P	P	P
	x-2	4.4	5.6	13.6	20.0	6.2	24.4	27.9	52.3	P	P	P	P	P
	x-3	3.1	3.6	22.0	25.2	5.0	5.0	26.1	31.1	P	P	P	P	P
Foote Mineral Co.	x-1	9.8	14.8	18.7	49.8	15.8	52.4	74.4	126.8	P	P	P	P	1.18
	x-2	11.3	15.6	26.7	45.2	21.3	26.7	67.2	93.9	P	P	P	P	P
	x-3	2.8	6.9	24.0	45.0	19.1	29.5	58.7	88.2	P	P	P	P	P
Forest Laboratories	x-1	0.7	0.8	2.9	4.5	0.7	0.8	5.2	6.0	F	P	P	P	P
	x-2	-4.8	-4.6	4.1	5.4	2.5	2.6	4.4	7.0	F	F	P	P	P
	x-3	-1.0	-0.5	5.1	6.4	2.3	2.5	9.1	11.6	F	F	P	P	P

TABLE III-6
(concluded)

Name of Firm	Year[1/]	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[2/]	CF/TL[3/]	TL/NW[4/]	CURRAT[5/]	QRAT[6/]
Gulf Resources & Chemical	x-1	28.7	40.7	80.6	135.9	63.1	158.9	118.4	277.3	P	P	1.34	P	P
	x-2	36.2	43.7	79.0	111.0	46.6	142.3	76.1	218.4	P	P	1.87	P	P
	x-3	7.4	12.7	36.9	63.4	24.3	102.6	41.7	144.3	P	12.4	F	P	P
Handy & Harman	x-1	12.7	15.7	56.6	111.5	59.6	90.1	56.4	146.5	21.6	17.4	1.60	1.87	F
	x-2	12.2	14.8	54.5	127.0	82.0	111.9	45.4	157.2	F	13.2	F	1.55	F
	x-3	5.4	7.8	50.1	100.7	72.0	92.4	35.1	127.5	F	F	F	F	F
Hunt Chemical Corp.	x-1	3.6	NA	19.0	28.9	6.5	6.5	38.7	45.2	P	P	P	P	P
	x-2	6.1	NA	18.0	26.9	6.9	6.9	36.7	43.6	P	P	P	P	P
	x-3	6.1	NA	15.2	24.4	5.6	5.6	32.1	37.7	P	P	P	P	P
Hydrometals, Inc.	x-1	3.4	4.8	14.4	50.2	14.3	28.1	33.2	61.3	F	17.1	P	P	1.01
	x-2	3.7	5.2	12.8	52.2	18.7	34.1	29.7	63.8	F	15.2	1.15	P	F
	x-3	3.0	4.5	15.3	45.8	13.8	30.0	26.5	56.5	F	15.0	1.13	P	1.11
Jim Walter	x-1	69.3	98.4	618.0	833.0	519.0	875.0	432.0	1309.0	P	11.2	F	1.60	1.19
	x-2	62.9	88.6	618.0	824.0	627.0	862.0	398.0	1260.0	P	10.3	F	F	F
	x-3	53.6	76.2	528.0	693.0	498.0	731.0	351.0	1082.0	P	10.4	F	F	1.06
Youngstown Sheet & Tube	x-1	40.9	105.2	208.0	471.0	250.0	546.0	713.0	1259.0	P	19.3	P	1.88	F
	x-2	96.4	156.8	339.0	520.0	304.0	560.0	692.0	1252.0	P	P	P	1.71	1.12
	x-3	43.3	97.9	251.0	399.0	198.0	561.0	664.0	1125.0	P	17.4	P	P	P

IV. EVALUATION CRITERIA AND DEVELOPMENT OF RATIO TESTS

All test alternatives were initially evaluated against both the primary non-bankrupt and bankrupt samples. In this evaluation the Agency assumed that a firm would have to meet the financial criteria required by a test for its most recent fiscal year in order to pass the test (i.e., a one-year eligibility requirement). The seven financial ratios selected for detailed analysis were first individually tested; for each ratio examined several different pass-fail cutoff points were investigated. The most promising individual ratio tests were then combined into a series of 120 two-ratio tests (a firm must pass both ratio elements to pass), three-ratio tests (a firm must pass all ratio elements to pass), and contingent three-ratio tests (a firm must pass two of three ratio elements to pass).

To further validate whether these tests represent the most effective indicators of future firm viability, the Agency performed a supplementary analysis. Other financial variables identified in the preliminary literature review but not included in the set of 120 tests were evaluated against a subset of 32 non-bankrupt and 12 bankrupt firms from the primary sample that had proven particularly difficult to classify. The ratio that performed best in this supplementary analysis, net fixed assets/total assets, was then combined with the other candidate financial ratios, and 31 additional three- and four-ratio tests were evaluated.

All ratio tests were examined with two variants: a one-year eligibility requirement and a three-year eligibility requirement. The former requires that a firm meet the requirements of a financial test based on its most recent annual report in order to pass the test. The latter requires that a firm meet the requirements of a financial test based on its three most recent annual reports in order to pass the test.

A. Evaluation Criteria

Five evaluation criteria have been developed to assist the Agency in comparing the test results. These measures are defined and described below.

(1) A_{NB} represents the percentage of sampled non-bankrupt firms that pass a given test. For tests with a one-year eligibility requirement, A_{NB} is measured as the percentage of firms in the non-bankrupt firm sample which passed the test in the year 1975. For tests with a three-year eligibility requirement, A_{NB} is measured as the percentage of firms in the non-bankrupt firm sample which passed the test for all of the years 1973-1975.

Because the non-bankrupt firm sample created for this analysis is composed of companies from industry categories which are most likely to have on-site treatment, storage and/or disposal facilities requiring financial assurance, and contains a representative sample of firms from all size classes, the Agency believes that the A_{NB} results can be used as a reasonable surrogate measure of the overall percentage of viable firms that would be able to pass a financial test. Therefore, tests which have a very low A_{NB} will generate large private sector expenditures, because many viable firms will be required to establish alternative forms of financial assurance. Alternatively, tests with a high A_{NB} will result in low private costs of complying with RCRA.

(2) M represents the percentage of sampled bankrupt firms which would fail a given financial test with insufficient time remaining prior to bankruptcy to ensure that alternative financial mechanisms are available for facility closure, post-closure, and liability requirements.

Because firms in financial distress often suffer a rapid deterioration in their liquid assets in the two to three years prior to bankruptcy, and because of possible delays in enforcement and litigation, the Agency has concluded that a one-year lead time would not be sufficient to guarantee that sufficient funds would be available to cover the costs of closure, post-closure, and liability requirements. Three different assumptions as to what constituted "sufficient lead time" were analyzed by the Agency:

<u>Best case</u> - If a test fails a firm at least two years prior to bankruptcy, there will still be sufficient time to ensure the funding of alternative mechanisms; for this case the value of M is designated as M_B.

<u>Worst case</u> - If a test fails a firm at least three years prior to bankruptcy, there will still be sufficient time to ensure the funding of alternative mechanisms; for this case the value of M is designated as M_W.

<u>Most probable case</u> - All firms that are first eliminated by a test three years prior to bankruptcy will provide alternative financial assurance. One-half of the firms that are first eliminated two years prior to bankruptcy will provide alternative financial assurance. For this case the value of M is designated as M_P.

The implications of all three of these assumptions on the interpretation of possible classification results are presented in Table IV-1. Although the posibility of injunctive relief under Section 7003 of RCRA might render all three of these assumptions conservative estimates, the Agency has decided to use the "most probable case" definition of lead time requirements. (<u>See</u>, Hazardous Waste Section, Land and Natural Resources Division, United States Department of Justice, <u>Annual Report</u> (October 1980.)

(3) C represents the percentage of sampled bankrupt firms that fail a financial test with sufficient time remaining prior to bankruptcy to ensure that alternative financial mechanisms are available for facility closure, post-closure, and liability requirements. C is thus measured as:

$$C = 100 - M_P$$

(4) D represents the difference between the percentage of non-bankrupt firms passing a test and the percentage of bankrupt firms passing the test, and is called the "discriminating power" of a test. D is calculated according to the formula:

$$D = A_{NB} - M_W$$

The higher the D score, the better the test discriminates between bankrupt and non-bankrupt firms. A test receiving a D score of 100 would perfectly discriminate between bankrupt and non-bankrupt firms, passing all non-bankrupt firms and failing all bankrupt firms. A D score of zero would indicate that the same percentage of bankrupt firms pass a test as non-bankrupt firms, suggesting that the test does not discriminate between bankrupt and non-bankrupt firms. A negative D score indicates that more bankrupt firms pass a test than non-bankrupt firms.

TABLE IV-1

ESTIMATED PROBABILITY THAT A FIRM WILL NOT SET UP ALTERNATIVE FINANCIAL MECHANISMS FOR VARIOUS PATTERNS OF PASSING AND FAILING FINANCIAL TESTS

Test Result[1/]			Worst Case		Most Probable Case		Best Case	
1 Year Prior to Bankruptcy	2 Years Prior to Bankruptcy	3 Years Prior to Bankruptcy	Probability for One-Year Eligibility Requirement	Probability for Three-Year Eligibility Requirement	Probability for One-Year Eligibility Requirement	Probability for Three-Year Eligibility Requirement	Probability for One-Year Eligibility Requirement	Probability for Three-Year Eligibility Requirement
P	P	P	1.0	1.0	1.0	1.0	1.0	1.0
P	P	F	1.0	0	1.0	0	1.0	0
P	F	P	1.0	1.0	1.0	.5	1.0	0
P	F	F	1.0	0	1.0	0	1.0	0
F	P	P	1.0	1.0	1.0	1.0	1.0	1.0
F	P	F	1.0	0	1.0	0	1.0	0
F	F	P	1.0	1.0	.5	.5	0	0
F	F	F	0	0	0	0	0	0

1/ P = Passes Test; F = Fails Test.

(5) E represents the number of firms per 10,000 which pass a given financial test and will enter bankruptcy without providing alternative financial assurances. E, like M, can be calculated for three different assumptions as to what constitutes sufficient lead time.

<u>Best case</u> - If a test fails a firm at least two years prior to bankruptcy, there will still be sufficient time to ensure the funding of alternative mechanisms; for this case the value of E is designated as E_B.

<u>Worst case</u> - If a test fails a firm at least three years prior to bankruptcy, there will still be sufficient time to ensure the funding of alternative mechanisms; for this case the value of E is designated as E_W.

<u>Most probable case</u> - All firms that are first eliminated by a test three years prior to bankruptcy will provide alternative financial assurance. One-half of the firms that are first eliminated two years prior to bankruptcy will provide alternative financial assurance. For this case, the value of E is designated as E_P.

E_P is used for most analytic purposes. A detailed formula for E_P, as noted in Section I, is:

$$E_P = \frac{F(M_P)}{((1-F) \times A_{NB}) + (F \times M_P)}$$

However, because of the very small values of F, a less complicated formula approximates this completely correct measure with an error of less than 1 percent for all tests examined. E_P is therefore calculated as:

$$E_P = \frac{F \times M_P}{A_{NB}}$$

B. Development of Ratio Tests

1. Evaluation of Single Ratio Tests

Each ratio listed in Section III.C.4 was tested against the primary bankrupt and non-bankrupt samples. Several pass-fail cutoff points were analyzed for each ratio since the midpoint values used in the historical literature often vary widely between studies. These single-ratio tests are summarized in Table IV-2.

In choosing ratios and cutoff points to employ in further tests, the Agency did not use the same sample as it used in the rest of this study. As noted in Section III, a larger primary sample which contained retail firms was employed in the earlier phases of this study. The evaluations of individual ratios and cutoff points shown in Table IV-2 were conducted using this larger sample and are reported in terms of that larger sample in this Section. This sample consisted of 60 bankrupt firms and 147 non bankrupt firms. M and C were evaluated using a three-year eligibility assumption, whereas A_{NB} was evaluated using a one-year eligibility assumption. However, results for the tests presented in Sections V and VIII are derived from the sample with retail firms removed.

As Table IV-2 illustrates, the cash flow/total liability ratio is the most significantly predictive single ratio, attaining the two highest D scores, the three highest C scores, and the four highest E ratings (i.e., the lowest number of firms per 10,000 that will fail without providing alternative financial assurance). The margins of

TABLE IV-2

PERFORMANCE OF SINGLE-RATIO TESTS[1/]

Test Description	M_P [2/]	M_W [2/]	A_{NB} [3/]	C [2/]	D [4/]	E_P [4/]
CF/TL > .05	30.4	58.9	88.5	55.3	29.6	11.1
CF/TL > .1	12.5	32.1	83.8	77.7*	51.7*	5.9*
CF/TL > .15	5.4	17.9	69.9	88.3*	52.0*	3.7*
CF/TL > .2	5.4	8.9	52.0	92.8*	43.1*	3.0*
CF/TL > .3	5.4	3.6	24.5	95.5*	20.9	4.0*
TL/NW < 3.0	61.7	81.7	96.0	28.3	14.3	16.4
TL/NW < 2.0	35.0	61.7	90.7	51.7	29.0	11.7
TL/NW < 1.5	26.7	41.7	83.4	65.8	41.7*	9.0*
TL/NW < 1.2	16.7	31.7	67.5	75.8*	35.8	7.9*
TL/NW 1.0	11.7	25.0	60.9	81.6*	35.9	6.6*
NI/TA > 0	50.0	68.3	92.1	40.9	23.8	14.1
NI/TA > .02	21.7	43.3	83.4	67.5	40.1*	8.6*
NI/TA > .04	11.6	31.6	72.8	78.4*	41.2	6.5*
NWK/TA > 0	83.3	90.0	100.0	13.3	10.0	19.1
NWK/TA > .2	46.7	60.0	74.8	46.6	14.8	15.7
NWK/TA > .25	30.0	50.0	63.6	60.0	13.6	13.8
CURRAT > 1.2	66.7	76.7	98.7	28.3	22.0	16.0
CURRAT > 1.5	36.7	55.0	97.3	54.1	42.3*	10.4*
CURRAT > 2.0	18.3	31.6	74.9	75.0*	43.3*	7.3*
QRAT > 1.0	18.7	33.9	76.2	73.7*	42.3*	7.6*
QRAT > 1.2	13.6	25.5	53.1	80.4*	27.6	8.1*
NS/TA > 1.0	71.7	80.0	77.4	24.1	[-2.6]	21.6
NS/TA > 1.5	41.7	48.4	36.9	54.9	[-11.5]	26.9

[1/] All values expressed in % terms except E_P which represents the number of firms (per 10,000 passing the test) that will fail without providing alternate financial assurance. All results are based on the original samples that included retail firms.

[2/] Based on three-year eligibility requirement.

[3/] Based on one-year eligibility requirement.

[4/] Based on three-year eligibility requirement for M and one-year eligibility requirement for A_{NB}.

*Exceeds minimum performance cutoff point.

difference between the scores of the best cash flow ratios and those of other ratios are also substantial. Thirteen of the ratios tested reduced the normal failure rate for large (greater than $10 M in net worth) firms by more than 50 percent (from 22 per 10,000 to less than 11 per 10,000). Ten ratios eliminated more than 70 percent of bankrupt firms in sufficient time to establish alternative financial guarantee mechanisms; nine had a discriminatory power (D) of greater than 40 percent. If these three conditions are viewed to be the minimum acceptable values of test effectiveness, TL/NW, NI/TA, CURRAT, and QRAT all have cutoff scores that satisfy these criteria; only the net working capital to total assets and net sales to total assets ratios failed to provide significant results.

Those parametric values which satisfied one or more of the above minimum criteria (13 in all) were used to develop multi-ratio tests; the others were dropped from further consideration. There were two exceptions to this general classification rule: (1) the cash flow/total liability greater than .3 ratio was dropped, because the E ratings demonstrated that this test was already dominated by the .2 and .15 cash flow cutoff points, and its extremely high rate of non-bankrupt firm rejections made it a poor candidate for use in multi-ratio tests and (2) the total liabilities/net worth cutoff point of 2.0 was added to the list of ratios for detailed consideration, despite the fact that it failed to meet the minimum requirements, because preliminary investigations revealed that this ratio was one of the few that could be used effectively to classify electric utilities (see Section IV. B).

2. Evaluation of Multi-Ratio Tests

The 13 financial ratios selected from the initial evaluation process were linked in various combinations and then retested against the primary bankrupt and non-bankrupt samples. The ratios were combined in three ways: two-ratio tests (firm must pass both elements of the test to pass the test), three-ratio tests (firms must pass all elements to pass the test), and three-ratio contingent tests (firms must pass 2 of 3 elements to pass the test). Since CF/TL and NI/TA are alternative methods of measuring a firm's rate of return on its assets, these ratios were not included within the same test; the same procedure was followed with CURRAT and QRAT, the two liquidity measures being evaluated.

In all, 120 alternative tests were investigated in this phase. Section VIII presents the results of all tests both with one-year and three year liability requirements in Tables VIII-1 to VIII-4 and VIII-5 to VIII-8, respectively.

As illustrated in these Tables, two-ratio tests are more accurate than single-ratio tests in the C and E ratings. This pattern continues, at a somewhat lower rate of increase, for the more stringent three-ratio tests (passage of all elements required to pass). The three-ratio (pass 2 out of 3) tests evaluated barely out-performed the single-ratio cash flow tests on the C, D, and E measures. Although test formulations of the three-ratio type greatly increase the eligibility of firms in the non-bankrupt sample, they also increase misclassifications of bankrupt firms by a similar (and sometimes greater) amount.

The major problem with the multi-ratio tests evaluated in this phase is that the discriminating power (D score) of the best tests does not increase greatly. The greater levels of bankrupt firm identification and overall test effectiveness indicated in these results apparently are attained mainly by excluding a larger number of viable firms. Consequently, the Agency performed supplementary tests to establish whether there were other financial variables that could be added to these tests to improve their discriminating power, while retaining high levels of bankrupt firm detection.

3. Test of Supplementary Financial Ratios

Based on the results of the initial round of testing, a set of 32 non-bankrupt and 12 bankrupt firms was identified that were consistently misclassified by the tests evaluated in the first phase. The results achieved in testing this set of firms against a second set of financial ratios are summarized below.

The following ratios used in this auxiliary analysis were selected from the financial ratios tested in prior bankruptcy forecasting studies:

Retained earnings/total assets (RE/TA)

Earnings before interest and taxes/total assets (EBIT/TA)

Cash flow/net sales (CF/NS)

Balance sheet value of preferred and common stock/net worth (PC/NW)

Balance sheet value of preferred and common stock/current and long-term debt (PC/CL + LTL)

Net fixed assets/total assets (NFA/TA)

Cash/total assets (Cash/TA)

Cash/current liabilities (Cash/CL)

Net sales/total assets (NS/TA)

Net working capital/total assets (NWK/TA)

Values of each of the ratios were computed for the firms described above. The data were then analyzed to determine the values for each ratio that would provide the most accurate overall classification of the tested firms. The percentage of bankrupt and non-bankrupt firms that passed the resulting test were then compared to derive an estimate of the discriminating power (D') of each ratio. For this analysis, the value of D', defined as the difference between A_{NB} and M_P, was used. (This is similar to D, but substitutes M_P for M_W). These results are presented in Table IV-3.

In many cases, the ratio tested had higher values of M_P than of A_{NB}, resuitng in negative values for D'. A single ratio test with a negative discriminating power would not be likely to add to the overall effectiveness of financial tests combining several ratios. Three ratios -- RE/TA, NS/TA, and Cash/CL -- had some positive impact on firm categorization, with D' values of 15 to 24 percent. These results, however, were far exceeded by the classification results achieved by using the NFA/TA ratio. Three different cutoff points for NFA/TA were tested, with resulting D' ratings of 30 to 44 percent. More significantly, the ratio of NFA/TA greater than .3 correctly classified 9 of the 12 bankrupt firms as non-viable three years prior to bankruptcy.

TABLE IV-3

TESTS OF SUPPLEMENTARY FINANCIAL RATIOS[1]

Test Variables	M_P	A_{NB}	D'[2]
RE/TA > .2	41.7	62.5	20.8
RE/TA > .25	25.0	37.5	12.5
EBIT/TA > .12	41.7	43.8	2.1
NS/TA > 1.25	41.7	65.6	23.9
NS/TA > 1.4	41.7	50.0	8.3
CF/NS > .04	91.7	62.5	-29.2
CF/NS > .05	83.3	43.8	-39.5
PC/NW > .1	66.7	40.6	-26.1
PC/TL > .1	50.0	40.6	-9.4
NFA/TA > .15	50.0	93.5	43.5
NFA/TA > .25	33.3	61.3	28.0
NFA/TA > .3	25.0	54.8	29.8
Cash/TA > .04	50.0	65.6	15.6
Cash/CL > .15	50.0	46.9	-3.1
Cash/CL > .2	33.3	34.4	1.1
NWK/TA > .25	75.0	56.3	-18.7

1/ Tests run against a portion of the EPA primary bankrupt and non-bankrupt samples comprising 32 non-bankrupt and 12 bankrupt firms that were frequently misclassified by the initial set of candidate financial tests.

2/ D' = Difference between the percentage of viable firms passing a test and the percentage of non-viable firms passing the same test in year x-3.

The NFA/TA ratio represents the portion of a firm's assets tied to long-term tangible property, excluding the portion of these fixed assets that has already been depreciated. It represents the reserve of assets that a company can call on in a time of financial difficulties, either as a reliable source of earnings or a potential source (through sale) of needed capital. This ratio has not been extensively evaluated in previous bankruptcy forecasting studies; however, several studies have examined the ratio that represents to some extent its inverse -- current assets/total assets (CA/TA), the fraction of total assets in the form of cash, inventories, and short term receivables. Both Edmister (1972) and Deakin (1972) have found CA/TA to be a significant indicator of financial stability; and both studies have indicated that a high CA/TA is negatively correlated with continued firm solvency. A NFA/TA test also can be readily passed by almost all electric utilities, a category of hazardous waste disposers that encounters great problems in passing candidate tests using other more common financial ratios (see Section VI). For these reasons, the Agency decided to evaluate a number of tests incorporating NFA/TA as a variable against the entire primary sample. The results of these tests with one-year and three-year eligibility requirements are presented in Section VIII, Tables VIII-4 and VIII-8, respectively. As will be discussed in the next Section, most of the tests incorporating NFA/TA (Tests 121-151) dominate tests which do not incorporate this ratio.

V. TEST PERFORMANCE

A. Construction of the Performance Curves

The performance of a test is measured by two values: E_P, the number of firms per 10,000 which pass the test that later enter bankruptcy without providing alternative financial assurance; and A_{NB}, the percentage of non-bankrupt firms passing the test. Both of these values are used to determine the relative costs of alternative tests. In order to determine the best tests, the Agency ascertained, for particular values of E_P, the test which allows the highest value of A_{NB}. A test which, for any given value of E_P has the highest value of A_{NB}, is termed a dominant test.

Using the results for all tests of a given type (see Section VIII for complete test results), a graph was constructed for each of the eligibility requirements, depicting on one axis the number of bankrupt firms per 10,000 which pass the test, (E_P) and on the other axis the percentage of non-bankrupt firms which pass the test (A_{NB}).

Figure V-1 illustrates the method used to determine if a point C is on the performance curve. If a test is to be on the performance curve, there must be no other tests which dominate that test.

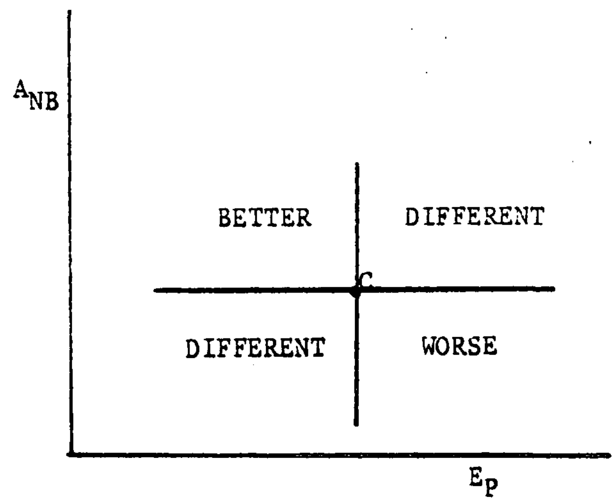

FIGURE V-1

TECHNIQUE FOR DETERMINING IF A POINT IS ON THE PERFORMANCE CURVE

For example, a particular test which passes 6 per 10,000 of bankrupt firms and passes 70 percent of non-bankrupt firms would have the coordinates of (6, 70%) in Figure V-1. To compare the performance of other tests to this test, as illustrated in the Figure, any tests represented by points in the northwest quadrant, using point C as the point of origin, dominate point C because both the value of E_p is lower (i.e., fewer bankrupt firms pass the test) and the value of A_{NB} is higher (i.e., a higher percentage of non-bankrupt firms pass the test.) A test with the coordinates (4, 80%) would fall in the northwest quadrant, and would indicate that 4 of 10,000 bankrupt firms and 80 percent of non-bankrupt firms pass the test. This makes it superior to the test represented by point C. Thus, if there were any tests with coordinates in the northwest quadrant, the test represented by point C would not be on the performance curve. Similarly, any point in the southeast quadrant is absolutely inferior to point C.

Points in the other two quadrants cannot be classified as dominating point C, but can only be classified as different. For example, a point with coordinates (8, 80%) means that 80 percent of non-bankrupt firms pass the test, which is absolutely superior to point C; however, 8 out of 10,000 bankrupt firms also pass, which is inferior to point C. There is thus no way to classify any points in the northeast or southwest quadrants as dominant to point C. Points in those quadrants may or may not be on the performance curve; they would have to be evaluated in the same manner as point C.

Once the performance curve is constructed, it is sometimes useful to compare specific tests to the performance curve as a whole. If a test is plotted above the performance curve, then it dominates at least one test on the performance curve. If it is below the performance curve, then it is dominated by at least one test on the performance curve.

B. Performance Curves for the Primary Sample

Figure V-2 shows the performance curve for the set of 151 ratio tests with one-year eligibility requirements. Table V-1 lists the components of the tests and the values of E_P and A_{NB} for each test. Seventeen tests lie on the performance curve, thus reducing the set of tests that need to be further considered from 151 to 17. The performance curve includes tests ranging from a test with an E_P of 0 and an A_{NB} of 49 percent to one with an E_P of 10.1 and an A_{NB} of 96 percent.

FIGURE V-2

PERFORMANCE CURVE FOR TESTS WITH
ONE-YEAR ELIGIBILITY REQUIREMENTS

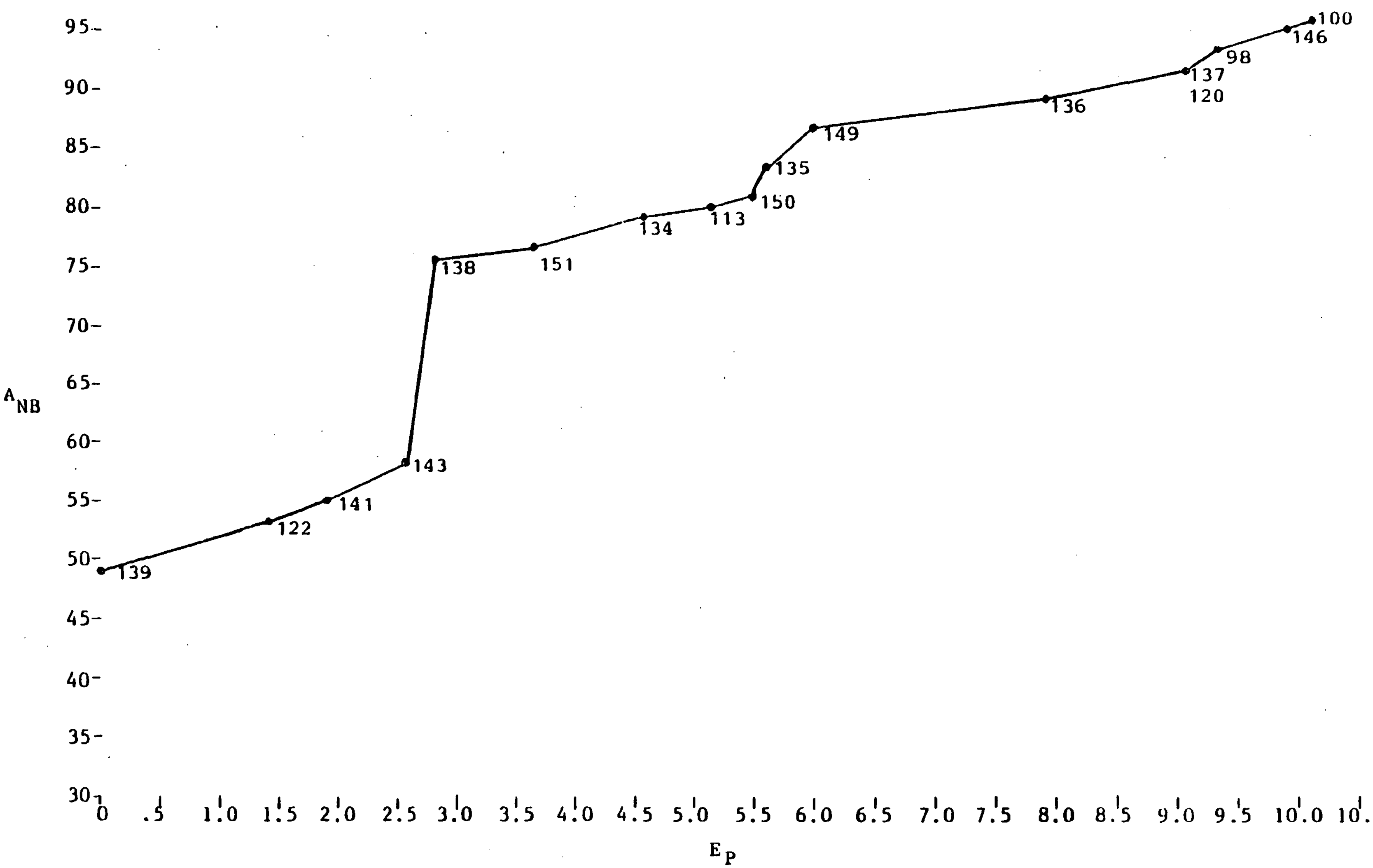

TABLE V-1

DOMINANT TESTS

(One-Year Eligibility Requirement)

Test Number	Test Variables	Number of Variables Required To Pass	E_P	A_{NB} (%)
139	NFA/TA > .3 CF/TL > .1 CURRAT >2.0	All	0	49
122	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	All	1.4	53
141	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	1.9	55
143	NFA/TA > .2 TL/NW < 1.2 QRAT > 1.0	All	2.6	58
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	2.8	76
151	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	3 of 4	3.7	77
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	4.6	79
113	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	2 of 3	5.2	80
150	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	3 of 4	5.5	81

TABLE V-1
(concluded)

Test Number	Test Variables	Number of Variables Required To Pass	E_P	A_{NB} (%)
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	5.6	83
149	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	3 of 4	6.0	87
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	7.9	89
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	2 of 3	9.1	92
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	9.1	92
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	2 of 3	9.3	93
146	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	2 of 3	9.9	95
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	10.1	96

The tests on the performance curve had certain ratios in common. All tests on the performance curve included the cash flow to total liabilities ratio. Thirteen of the 17 tests on the performance curve included the net fixed assets to total assets ratio. Thirteen out of 17 tests included a total liabilities to net worth ratio.

Figure V-3 shows the performance curve (indicated by the heavy line) for the set of 151 ratio tests with a three-year eligibility requirement. The lighter line shows, for purposes of comparison, the performance curve for tests with a one-year eligibility requirement. Descriptions of these tests and their values for E_P and A_{NB} are given in Table V-2. Nine tests with a three-year eligibility requirement lie on this performance curve. The tests range from one with an E_P of 0 and an A_{NB} of 32 percent to one with an E_P of 7.3 and an A_{NB} of 86 percent. All of these tests include the cash flow to total liabilities ratio and the net fixed assets to total assets ratio.

Comparing these two curves shows that the general effect of a three-year eligibility requirement on any given test is to lower the values of both E_P and A_{NB}. The overall effect is relatively slight, with the following two exceptions: (1) Test 139 markedly improves with a one-year eligibility requirement; (2) only tests with a one-year eligibility requirement can achieve values of A_{NB} greater than 84 percent.

The choice between a one-year and three-year eligibility requirement cannot be based solely on performance, however, since the Agency must also consider the administrative burdens associated with different

FIGURE V-3

COMPARISON OF PERFORMANCE CURVE FOR TESTS WITH THREE-YEAR ELIGIBILITY REQUIREMENTS WITH PERFORMANCE CURVE FOR TESTS WITH ONE-YEAR ELIGIBILITY REQUIREMENTS

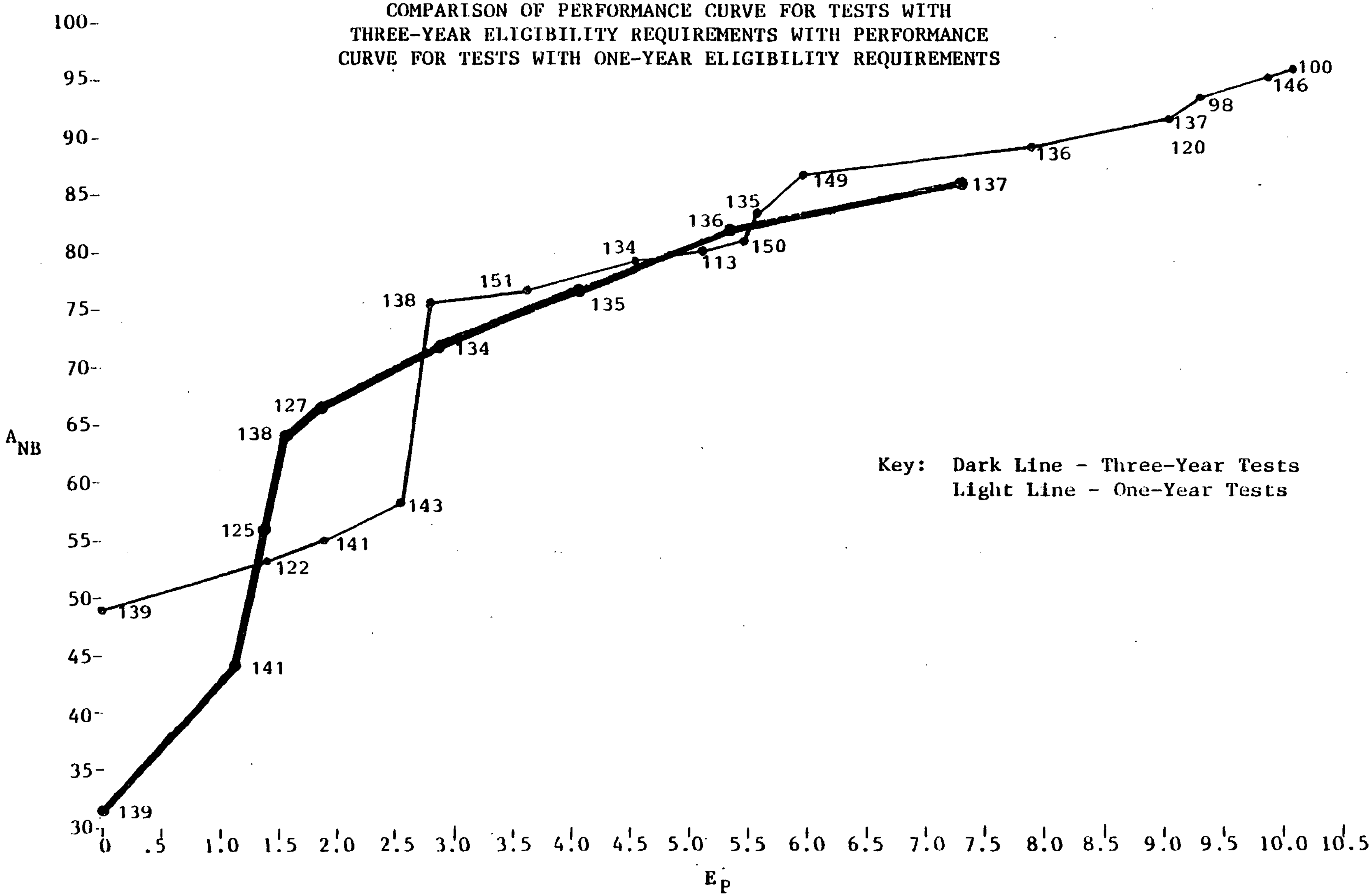

TABLE V-2

DOMINANT TESTS

(Three-Year Eligibility Requirement)

Test Number	Test Variables	Number of Variables Required To Pass	E_P	A_{NB} (%)
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	32
141	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	All	1.2	44
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	All	1.4	56
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	1.6	64
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	All	1.9	67
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	2.9	72
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	4.1	77
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	5.4	82
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	7.3	86

tests. In order to assess the performance of one-year and three-year tests together, a merged performance curve, consisting of all the dominant tests without regard to eligibility requirements, was constructed. Such a curve is the envelope curve of the two performance curves shown in Figure V-3. Figure V-4 presents this envelope curve and Table V-3 presents a full description of the tests on this curve. This merged performance curve contains 16 tests, of which four have a three-year eligibility requirement, and 12 have a one-year eligibility requirement.

C. Performance with Respect to the Holdout Sample

As noted in Section III.B. the Agency used a holdout sample in this study to help ensure the statistical validity of the results. Figure V-5 compares the performance on the primary sample and on the holdout sample of those one-year eligibility tests that appeared on the primary sample performance curve; Figure V-6 provides this same comparison for three-year eligibility tests. Table V-4 compares the results of all tests with a one-year eligibility requirement and Table V-5 of all tests with a three-year eligibility requirement. Tables V-6 and V-7 provide complete holdout sample results for a larger set of tests.

For one-year eligibility tests, 11 of the 17 tests yield results for the holdout sample which lie above the performance curve for the primary sample. The remaining six tests are only slightly below the primary sample performance curve. This result strongly suggests that search bias has not led to tests which are incapable of validly discriminating between bankrupt and non-bankrupt firms when applied to samples

FIGURE V-4

PERFORMANCE CURVE OF BEST FINANCIAL TESTS WITH EITHER ONE-YEAR OR THREE-YEAR ELIGIBILITY REQUIREMENTS

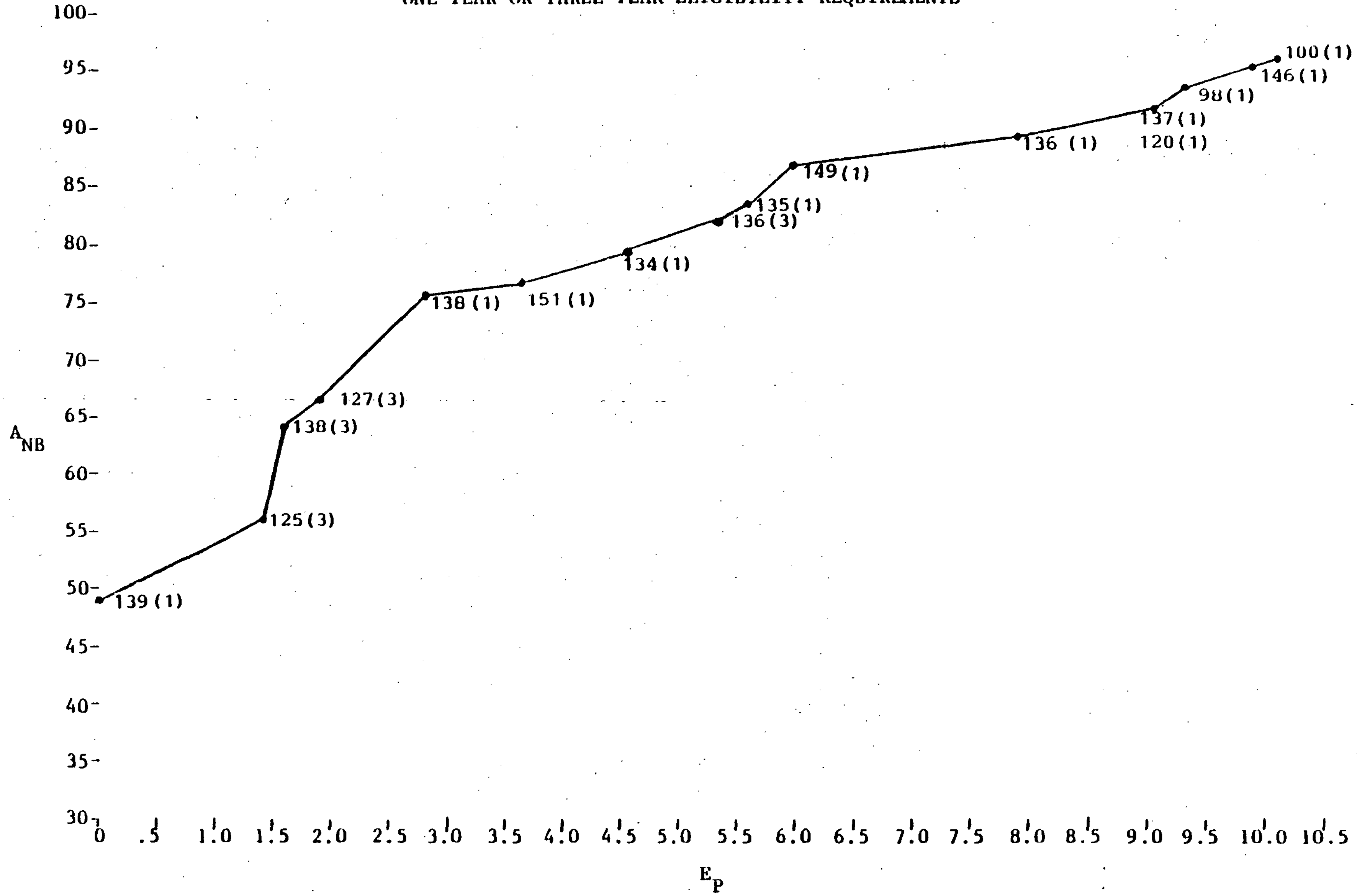

TABLE V-3

DOMINANT FINANCIAL TESTS WITH EITHER ONE-YEAR OR THREE-YEAR ELIGIBILITY REQUIREMENTS

Test Number	Number Of Years Required To Be Eligible	Test Variables	Number of Variables Required To Pass	E_P	A_{NB}
139	1	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	49
125	3	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	All	1.4	56
138	3	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	1.6	64
127	3	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	All	1.9	67
138	1	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	2.8	76
151	1	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	3 of 4	3.7	77
134	1	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	4.6	79
136	3	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	5.4	82
135	1	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	5.6	83

TABLE V-3
(concluded)

Test Number	Number Of Years Required To Be Eligible	Test Variables	Number of Variables Required To Pass	E_P	A_{NB}
149	1	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	3 of 4	6.0	87
136	1	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	7.9	89
120	1	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	2 of 3	9.1	92
137	1	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	9.1	92
98	1	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	2 of 3	9.3	93
146	1	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	2 of 3	9.9	95
100	1	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	10.1	96

FIGURE V-5

PERFORMANCE CURVE V. HOLDOUT SAMPLE PERFORMANCE
FOR TESTS WITH ONE-YEAR ELIGIBILITY REQUIREMENTS

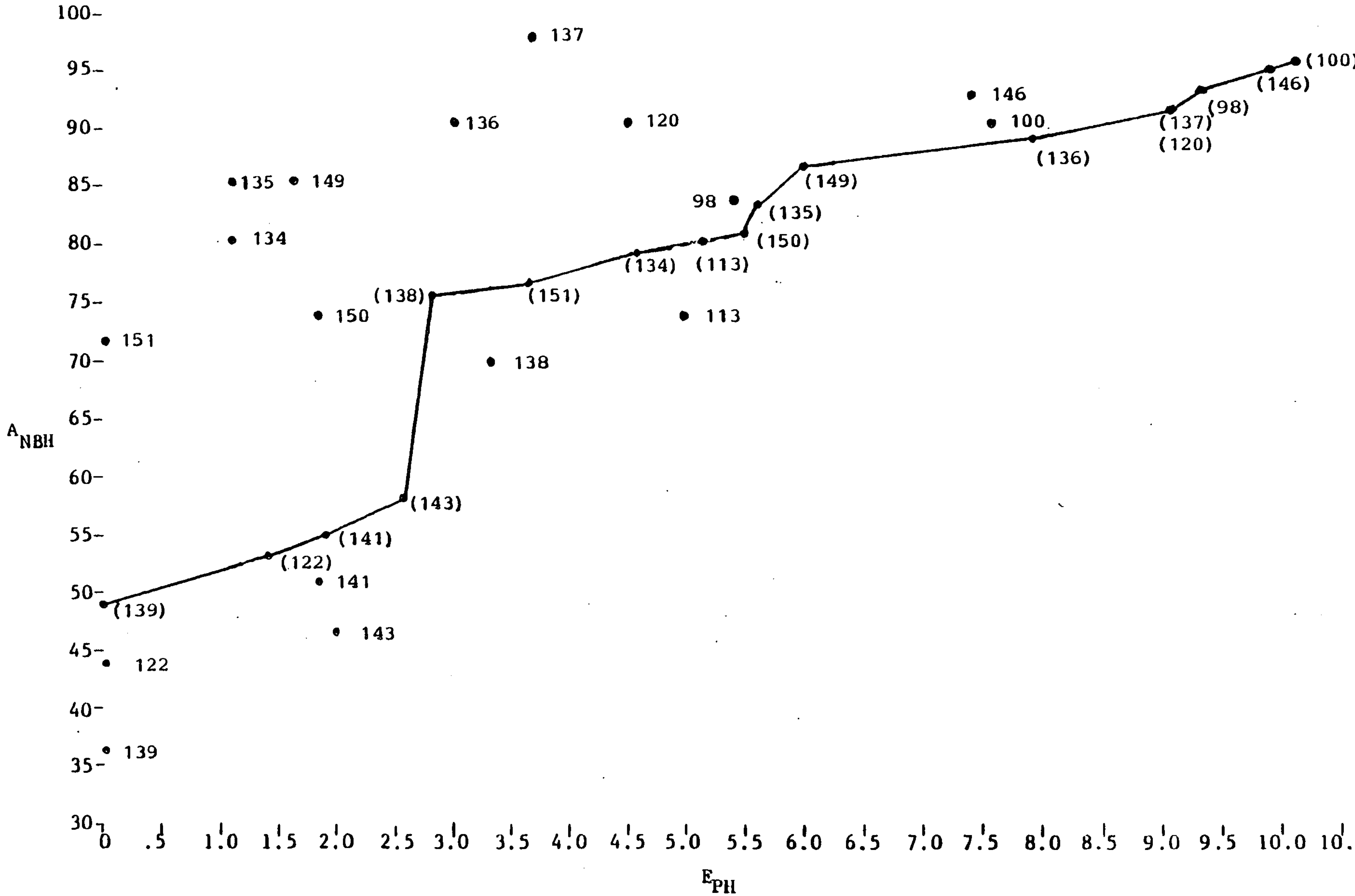

FIGURE V-6

PERFORMANCE CURVE V. HOLDOUT SAMPLE PERFORMANCE FOR TESTS WITH THREE-YEAR ELIGIBILITY REQUIREMENTS

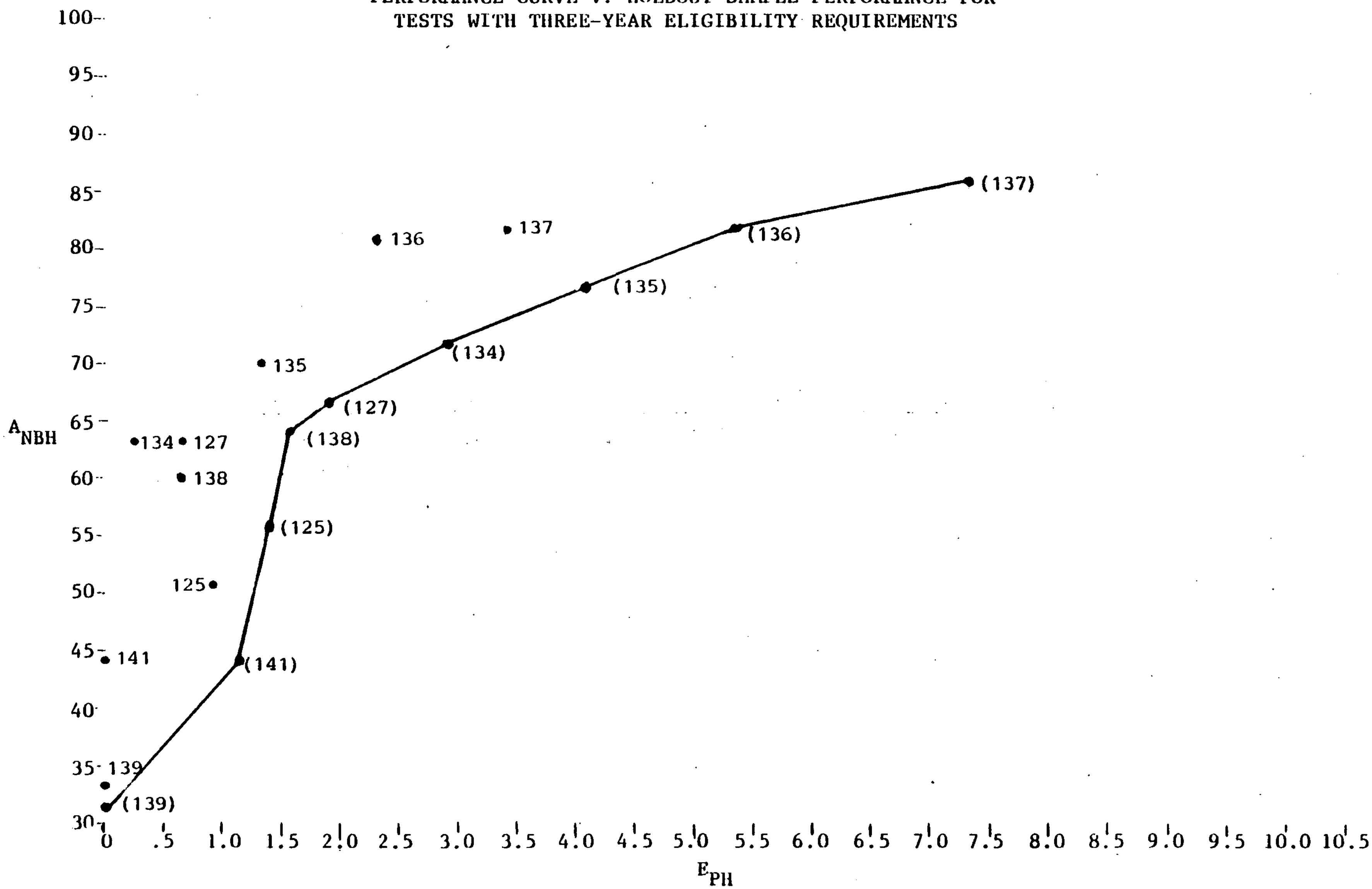

TABLE V-4

COMPARISON OF PRIMARY AND HOLDOUT SAMPLE PERFORMANCE FOR TESTS ON THE ONE-YEAR PERFORMANCE CURVE
(Subscript H Indicates Holdout Sample Result, No Subscript Indicates Primary Sample Result)

Test Number	Test Variables	Number of Variables Required To Pass	M_{PH}	M_P	Net Change* (M_P-M_{PH})	A_{NBH}	A_{NB}	Net Change* ($A_{NBH}-A_{NB}$)	E_{PH}	E_P	Net Change* (E_P-E_{PH})
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	2 of 3	20.8	39.2	+18.4	84	93	-9	5.4	9.3	+3.9
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	31.3	44.0	+12.7	91	96	-5	7.6	10.1	+2.5
113	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	2 of 3	14.6	19.0	+4.4	74	80	-6	4.3	5.2	+0.9
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	2 of 3	18.8	38.0	+19.2	91	92	-1	4.5	9.1	+4.6
122	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	All	0	3.5	+3.5	44	53	-9	0	1.4	+1.4
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	4.2	16.6	+12.4	81	79	+2	1.1	4.6	+3.5
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	4.2	21.4	+17.2	86	83	+3	1.1	5.6	+4.5
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	12.5	32.1	+19.6	91	89	+2	3.0	7.9	+4.9
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	16.7	38.0	+11.3	98	92	+6	3.7	9.1	+5.4
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	10.4	9.5	-0.9	70	76	-6	3.3	2.8	-0.5
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	0	0	37	49	-12	0	0	0

TABLE V-4
(concluded)

Test Number	Test Variables	Number of Variables Required To Pass	M_{PH}	M_P	Net Change* (M_P-M_{PH})	A_{NBH}	A_{NB}	Net Change* $(A_{NBH}-A_{NB})$	E_{PH}	E_P	Net Change* (E_P-E_{PH})
141	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	All	4.2	4.7	+0.5	51	55	-4	1.8	1.9	+0.1
143	NFA/TA > .2 TL/NW < 1.2 QRAT > 1.0	All	4.2	7.1	+2.9	47	58	-11	2.0	2.6	+0.6
146	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	2 of 3	31.3	42.8	+11.5	93	95	-2	7.4	9.9	+2.5
149	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	3 of 4	6.3	23.8	+17.5	86	87	-1	1.6	6.0	+4.4
150	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	3 of 4	6.3	20.2	+13.9	74	81	-7	1.8	5.5	+3.7
151	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	3 of 4	0	13.0	+13.0	72	77	-5	0	3.7	+3.7

*In all cases, a positive value in the Net Change column represents an improvement in test performance in the holdout over the primary sample.

TABLE V-5

COMPARISON OF PRIMARY AND HOLDOUT SAMPLE PERFORMANCE FOR TESTS ON THE THREE-YEAR ELIGIBILITY PERFORMANCE CURVE

Test Number	Test Variables	Number of Variables Required To Pass	M_{PH}	M_P	Net Change* (M_P-M_{PH})	A_{NBH}	A_{NB}	Net Change* ($A_{NBH}-A_{NB}$)	E_{PH}	E_P	Net Change* (E_P-E_{PH})
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	All	2.1	3.5	+1.4	51	56	-5	0.9	1.4	+0.5
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	All	2.1	5.9	+3.8	63	67	-4	0.7	1.9	+1.2
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	0	9.5	+9.5	63	72	-9	0	2.9	+2.9
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	4.2	14.3	+10.1	70	77	-7	1.3	4.1	+2.8
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	8.3	20.2	+11.9	81	82	-1	2.3	5.4	+3.1
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	12.5	28.5	+16.0	82	86	-4	3.4	7.3	+3.9
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	2.1	4.7	+2.6	60	64	-4	0.8	1.6	+0.8
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	0	0	33	32	+1	0	0	0
141	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	All	0	2.3	+2.3	44	44	0	0	1.2	+1.2

*In all cases, a positive value in the Net Change column represents an improvement in test performance in the holdout over the primary sample.

TABLE V-6

PERFORMANCE OF BEST TESTS AGAINST HOLDOUT SAMPLE

(One-Year Eligibility Requirement)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
11	CF/TL > .1 TL/NW < 1.5	All	2.4	3.6	4.8	77
12	CF/TL > .1 TL/NW < 2.0	All	2.2	3.3	4.4	84
26	CF/TL > .1 CURRAT > 1.5	All	3.5	5.2	7.0	79
67	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	All	2.5	3.8	5.1	72
68	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	All	2.4	3.6	4.8	77
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	2 of 3	4.4	5.4	6.5	84
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	6.0	7.6	9.1	91
110	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	2 of 3	2.0	4.0	6.0	91
113	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	2 of 3	3.7	4.3	5.0	74
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	2 of 3	3.0	4.5	6.0	91

TABLE V-6
(continued)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
122	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	All	0	0	0	44
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	All	1.6	2.4	3.1	58
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	All	2.5	3.1	3.7	74
132	NFA/TA > .3 CF/TL > .15 TL/NW < 1.2	2 of 3	1.3	1.3	1.3	72
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	1.1	1.1	1.1	81
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	1.1	1.1	1.1	86
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	2.0	3.0	4.0	91
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	2.8	3.7	4.7	98
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	2.6	3.3	3.9	70

TABLE V-6
(concluded)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	0	0	37
141	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	All	1.8	1.8	1.8	51
143	NFA/TA > .2 TL/NW < 1.2 QRAT > 1.0	All	2.0	2.0	2.0	47
146	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	2 of 3	4.9	7.4	10.8	93
149	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	3 of 4	1.1	1.6	2.1	86
150	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	3 of 4	1.2	1.8	2.5	74
151	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	3 of 4	0	0	0	72

TABLE V-7

PERFORMANCE OF BEST TESTS AGAINST HOLDOUT SAMPLE
(Three-Year Eligibility Requirement)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
11	CF/TL > .1 TL/NW < 1.5	All	1.5	2.9	4.4	63
12	CF/TL > .1 TL/NW < 2.0	All	1.4	2.7	4.1	67
26	CF/TL > .1 CURRAT > 1.5	All	0	2.1	4.2	65
67	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	All	0	1.5	3.0	60
68	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	All	0	1.5	3.0	60
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	3.6	4.8	5.9	77
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	4.5	6.2	7.9	81
110	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	2 of 3	1.2	3.7	6.2	74
113	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	2 of 3	1.7	2.5	3.3	56
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	2 of 3	1.2	4.3	6.2	74
122	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	All	0	0	0	40

TABLE V-7 (Continued)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	All	0	90	1.8	51
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	All	0	.73	1.5	63
132	NFA/TA > .3 CF/TL > .15 TL/NW < 1.2	2 of 3	0	0	0	58
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2 of 3	0	0	0	63
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2 of 3	1.3	1.3	1.3	70
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	2 of 3	1.1	2.3	3.4	81
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	2.2	3.4	4.5	82
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	All	0	.77	1.5	60
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	All	0	0	0	33

TABLE V-7 (Concluded)

Test Number	Test Variables	Number of Variables Required To Pass	E_B	E_P	E_W	A_{NB}
141	NFA/TA > .2 CF/TL > .1 CURRAT >2.0	All	0	0	0	44
143	NFA/TA > .2 TL/NW <1.2 QRAT >1.0	All	2.3	2.3	2.3	40
146	NFA/TA > .2 CF/TL > .1 CURRAT >1.5	2 of 3	4.5	7.4	10.2	81
149	NFA/TA > .3 CF/TL > .1 TL/NW <2.0 CURRAT >2.0	3 of 4	0	.66	1.3	70
150	NFA/TA > .3 CF/TL > .1 TL/NW <1.5 CURRAT >2.0	3 of 4	0	.71	1.4	65
151	NFA/TA > .3 CF/TL > .1 TL/NW <1.2 CURRAT <2.0	3 of 4	0	0	0	63

other than the sample used in the test selection. The results for the three-year eligibility tests further confirm the validity of the tests selected. All nine three-year eligibility tests for the holdout sample lie above the primary sample performance curve. For the tests on the merged performance curve, only three of the 16 tests on the performance curve lie below the merged primary sample performance curve.

Although the holdout sample results attest to the validity of the selection procedure for the tests on the primary sample performance curve, they are less encouraging with respect to the accuracy of the estimates of E_P and A_{NB}. When one-year eligibility tests on the primary sample performance curve are tested against the holdout sample, A_{NB} falls by an average of four percentage points while E_P falls by an average of 2.6. Similar results are obtained for tests with a three-year eligibility requirement. While small changes in the values of A_{NB} are not surprising given the sample size, the changes in E_P are unexpectedly high, given that the primary and holdout sample were randomly assigned from the same original sample of firms. Apparently, the resulting holdout sample contained firms with much weaker financial performance two to three years prior to bankruptcy than the primary sample.

If the results of the primary sample are used, Test 100 (one-year) has the highest value of A_{NB} of any of the ratio tests examined. If the results of the holdout sample are used, Test 137 (one-year) is superior to Test 100 (one-year), with both a higher A_{NB} and a lower E_P.

As a further check on the relative performance of these tests, E_P and A_{NB} were calculated using a weighted average of the performance for the primary and holdout samples. These results are shown in Table V-8. Using these weighted average results, all three tests would lie on a performance curve, with none absolutely dominating the others.

D. Comparison to the Results of Other Tests

1. Other tests examined

This Section reports the performance of the other types of tests which were examined in this study in addition to the ratio tests.

One of the other tests evaluated was the financial test proposed by the Agency on May 19, 1980. That test consisted of the following elements:

Total liabilities to net worth < 3

Net working capital > 2 X closure plus post-closure costs

Net worth $>$ \$10 million

This test had a one-year eligibility requirement. The effect of the net worth requirement and the total liabilities to net worth ratio in eliminating bankrupt firms while admitting viable firms was evaluated using the same methodology used for deriving the performance of the ratio tests. The effect of the multiple requirement on the performance of the test is more difficult to evaluate. A requirement that net working capital be a multiple of total financial responsibility obligations means that net working capital must be positive. As a result, the May 19 test was evaluated as a test which required a ratio of total liabilities to net worth of less than three and a current ratio of greater

TABLE V-8

PERFORMANCE OF SELECTED LESS STRINGENT TESTS USING WEIGHTED AVERAGES OF HOLDOUT AND PRIMARY SAMPLE TO DETERMINE E_P AND A_{NB}

Test Number	Number of Years Required To Be Eligible	Test Variables	Number of Variables Required To Pass	E_P	A_{NB}
137	1	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	2 of 3	7.1	93
146	1	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	2 of 3	9.0	94
100	1	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	2 of 3	9.2	95

than one (i.e., the ratio of current assets to current liabilities must be greater than one for there to be positive net working capital).

The Agency also evaluated tests which were composed only of multiple elements. In this report, the term "Ability to Pay Test" refers to those tests that required that net worth and net working capital each exceed six times the total financial responsibility obligation to be covered through a financial test. The performance of those tests was evaluated in the same manner as the performance of the May 19, 1980 tests. That is, the net worth multiple was ignored as implicitly accounted for by the $10 million in net worth requirement, and the current ratio was required to be greater than one. The Agency evaluated the Ability to Pay test using both one-year and three-year eligibility requirements.

The performances of the May 19, 1980 and Ability to Pay tests are shown in Table V-9. Neither the proposed May 19, 1980 test nor the two Ability to Pay tests are dominated by other tests, and therefore all are added to the performance curve. These tests pass almost all viable firms, but also have very high values of E_P.

The presence in a test of multiple elements of the type included in the Ability to Pay Tests does not influence the E_P or A_{NB} results. All ratio tests of any importance fail firms that would have failed a test including a requirement that the current ratio be greater than 1. As a result, the addition of such a requirement to a ratio test does not alter either the A_{NB} or E_P of the test.

TABLE V-9

PERFORMANCE OF SELECTED TESTS
WITH RESPECT TO THE PRIMARY SAMPLES

Test Description	Parameters Tested	Eligibility Requirement	A_{NB}	E_P
May 19, 1980 Test	TL/NW < 1 CURRAT > 1	One-Year	97	15.1
Ability to Pay Test	CURRAT > 1	One-Year	100	20.2
Ability to Pay Test	CURRAT > 1	Three-Year	99	18.4

2. Comparison to Results Obtained by Other Investigators

As noted in Section II, a number of studies have been published on methods for forecasting bankruptcies. The most commonly used method in these studies has been multi-discriminant analysis. The disadvantage to this approach is that tests based upon multi-discriminant analysis would require much more extensive reporting forms and would be more difficult to check. Nevertheless, the Agency concluded that if multi-discriminant analysis would lead to results clearly superior to those of the tests adopted in this study, it should consider adopting one of the tests from the published literature rather than one of the tests it had developed. The Agency therefore compared its results to the results reported in the literature.

Four of the studies which utilized multi-discriminant analysis were further examined: Altman (1968), Altman et al. (1977), Deakin (1972) and Deakin (1976). All of these studies examined the same basic problem as that examined here: forecasting bankruptcies for relatively large firms engaged in manufacturing and, in some cases, retail trade.

The first step in the comparison was to examine the results of these studies as reported, and to use the baseline failure rate employed in this study to derive a measure of E_p comparable to that used in reporting the results of this study. Multi-discriminant analysis is particularly prone to search bias, with the result that performance with respect to the holdout sample is almost always weaker than that with the primary sample. Whenever possible, the performance reported for these studies is that obtained against a holdout sample. (This was not possible for Altman et al. (1977) because no holdout sample was employed.)

The results for these studies are shown in Table V-10. The A_{NB} and E_P for each study are plotted on a graph showing the performance curve and holdout results for one-year eligibility tests in Figure V-7. As can be seen from the Figure, the reported result for Deakin (1976), is dominated by both the primary sample performance curve and by many of the results from the holdout sample. The Deakin (1972) result is, however, extremely strong and would be a dominant test even on a performance curve consisting only of results from the holdout sample.

The problem with these comparisons is that each study reported used a different sample of bankrupt and non-bankrupt firms, with the result that comparisons of performance may simply reflect different sample characteristics rather than the actual relative strength of the tests. Table V-11 compares the means of the samples used in various studies with the mean of the samples for the Agency primary and holdout samples. As shown in the Table, the means of the key financial variables for the Agency bankrupt firm sample are higher than those of firms used in other studies, which indicates that the firms used by the Agency had greater average financial strength. This difference could be expected to result in higher E_P scores for the other tests if the Agency bankrupt samples had been used in evaluating those other tests. The non-bankrupt sample of firms shows more mixed results. In some cases the means of the EPA samples show greater financial strength; in other cases, other studies show greater financial strength. Thus no strong conclusion is possible about how A_{NB} for other studies would change if applied to the Agency samples.

TABLE V-10

ESTIMATED PERFORMANCE OF TESTS DEVELOPED BY PRIOR BANKRUPTCY FORECASTING STUDIES

Study Name	Type of Test	M_B	M_W	A_{NB}	E_P
Altman (1968)[1/]	5-Variable MDA	17.0	29.4	87.1	5.8
Altman (1977)[2/]	7-Variable MDA	15.1	25.5	89.1	5.0
Deakin (1972)[3/]	14-Variable MDA	8.0	18.0	94.0	3.0
Deakin (1976)[4/]	5-Variable MDA	NA	17.0	75.0	5.0

[1/] Performance based upon results reported in Altman (1977). No Holdout Sample was used in Altman (1968), but this test was evaluated against the new sample developed in Altman (1977). Note that Altman (1977) Bankrupt Sample contains 5 firms which did not fail.

[2/] Primary Sample Performance from Altman (1977). No Holdout Sample was used.

[3/] Holdout Sample results are reported in Deakin (1972).

[4/] M_W based on results reported for M for all firms passing the test and entering bankruptcy from 1-3 years following passing the test.

FIGURE V-7

RESULTS OF OTHER STUDIES PLOTTED WITH EPA ONE-YEAR PERFORMANCE CURVE AND HOLDOUT SAMPLE RESULTS

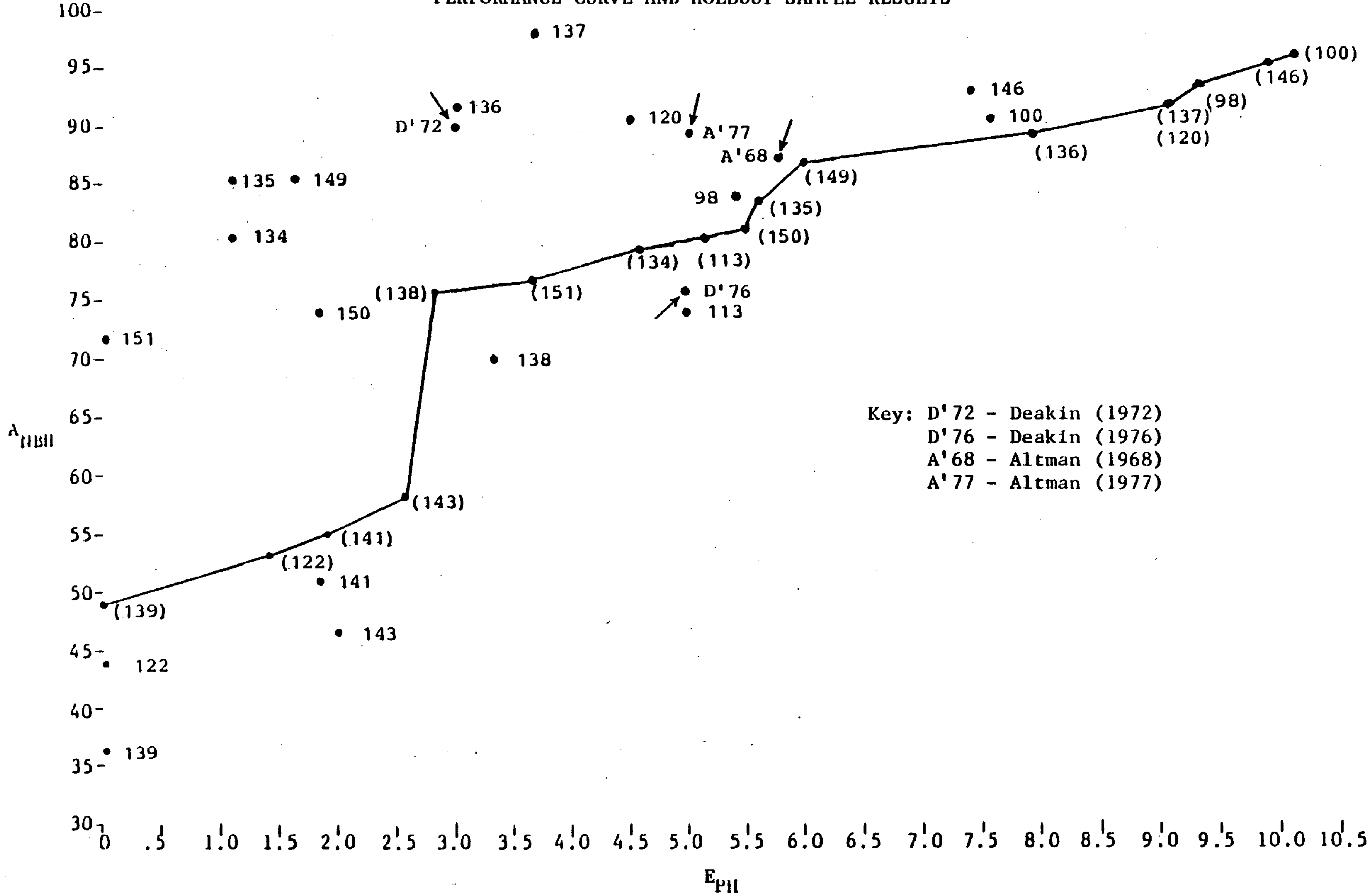

TABLE V-11

COMPARISON OF SAMPLE MEANS FOR EPA AND OTHER BANKRUPTCY FORECASTING STUDIES

A. Bankrupt Firms Samples:

Financial Parameter	Data Year: x-1				x-2				x-3			
	EPA Primary	EPA Holdout	Deakin (1972)	Altman (1968)	EPA Primary	EPA Holdout	Deakin (1972)	Altman (1968)	EPA Primary	EPA Holdout	Deakin (1972)	Altman (1968)
CF/TL	-.046	-.117	-.088	NA	.017	-.007	-.052	NA	.049	.008	-.001	NA
TL/NW	7.78	3.22	-51.00	26.78	3.67	3.67	10.66	3.35	1.84	3.99	8.52	1.58
CURRAT	1.51	1.35	.70	1.33	1.58	1.60	.89	1.31	1.97	1.72	1.44	1.62
QRAT	.77	.67	.35	NA	.87	.77	.48	NA	1.07	.90	.53	NA
NWK/TA	.13	.09	-.21	-.06	.18	.22	-.07	.02	.25	.23	.18	.18

B. Non-Bankrupt Firm Samples:

Financial Parameter	Data Year: x-1					x-2				x-3			
	EPA Primary	EPA Holdout	Deakin (1972)	Altman (1968)	Altman (1977)	EPA Primary	EPA Holdout	Deakin (1972)	EPA Utilities	EPA Primary	EPA Holdout	Deakin (1972)	EPA Utilities
CF/TL	.261	.239	.132	NA	.314	.278	.172	.150	.114	.271	.232	.115	.113
TL/NW	1.08	.997	1.15	NA	NA	1.18	1.07	.89	1.41	1.20	1.17	.91	1.41
CURRAT	2.75	2.61	2.33	NA	2.60	2.29	2.26	2.37	1.26	2.42	2.50	2.51	1.11
QRAT	1.38	1.40	1.13	NA	NA	1.22	1.26	1.18	.91	1.37	1.45	1.24	.74
NWK/TA	.30	.32	.33	.41	NA	.29	.30	.33	.02	.28	.32	.35	.01

SOURCE: Moody's Industrial Manual and company annual Form 10-K reports for EPA samples; original articles cited for other samples.

In order to provide better methods of comparing tests, Deakin (1972) tests were evaluated using the Agency holdout sample using E_W rather than E_P. The Agency used E_W because it required gathering only one year rather than two years of additional data. The result of this evaluation is shown in Figure V-8 and the results of the Deakin test are summarized in tabular form in Table V-12. When both the Agency's and Deakin's tests are compared against the same sample of firms, the performance is comparable. Seven of the Agency's tests fall below the performance curve for Deakin's test and seven are above it. Two of the one-year eligibility tests are not comparable. (If the line connecting the last two points representing Deakin's tests were extended, both of these noncomparable tests would be above this hypothetical performance curve.)

FIGURE V-8

COMPARISON OF EPA AND DEAKIN (1972) TESTS USING EPA HOLDOUT SAMPLE

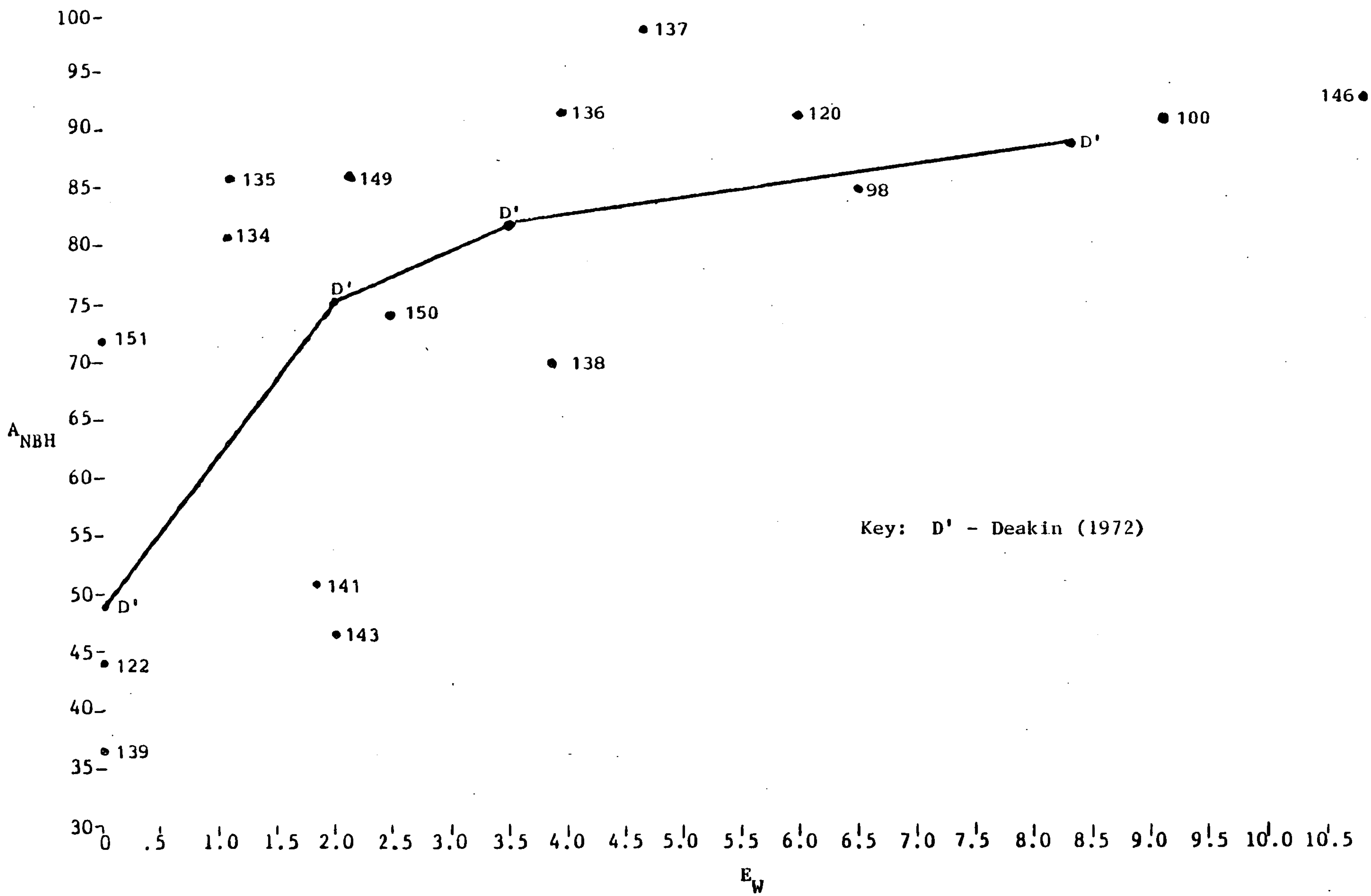

TABLE V-12

PERFORMANCE OF DEAKIN 14-VARIABLE TEST
VERSUS EPA HOLDOUT SAMPLES*

Test Cutoff Score	E_{PH} (x-3)	A_{NBH}	D	E_W
20.0	0	49	49	0
25.0	9.4	74	66	2.4
27.0	12.9	81	68	3.5
30.0	31.2	88	55	8.3

*C and E_P scores cannot be computed because only one year of data, x-3, was analyzed against the Deakin test.

VI. THE NEED FOR ALTERNATIVE TESTS FOR SPECIFIC INDUSTRIES

A number of commenters argued that no single financial test could be selected as an appropriate indicator of firm viability, because financial ratios varied greatly among industries. Many of these same commenters proposed that separate financial tests should be formulated for each industry category. The Agency was generally opposed to such a concept, because such a structure would greatly increase the administrative complexity of the financial responsibility regulations. Initially, it would be a difficult task to determine the number and type of categories that would be appropriate for this purpose. For many industries, data on bankrupt firms would be so limited that the statistical validity of a test derived from such data would be very questionable. Furthermore, even if a framework and set of tests could be established, many large firms with diversified facilities would not fit easily into any classification scheme. For example, if a parent firm primarily involved in chemicals manufacturing attempted to use the financial test provision to guarantee the waste disposal operations of its subsidiary, a pulp mill, a decision rule would have to be developed on whether the firm should be classified under the chemicals or paper category. The Agency believes that the addition of such complexities could only be justified if there is compelling evidence that the financial test alternatives evaluated in this analysis <u>all</u> discriminated against specific industries.

This Section examines the need for industry specific tests for three categories of industry: manufacturing firms by two digit SIC classification; utilities; and hazardous waste management firms.

A. Manufacturing Industries

To test the hypothesis that specific manufacturing industries may be unable to pass a general financial test, the Agency collected financial data for all the firms listed in the Expanded Coverage section of the 1980 Moody's Industrial Manual (Volume 1). Using the Dun and Bradstreet Million Dollar Directory, the Agency identified the 2-digit SIC classifications corresponding to each firm's major manufacturing activities. Table VI-1 shows the number of firms examined by 2-digit SIC classification activities. The Agency then tested this sample against the four financial ratios which consistently provided the best classification performance in the initial evaluation of test alternatives: cash flow/total liabilities, total liabilities/net worth, net fixed assets/total assets, and current assets/current liabilities.

The results of this evaluation, as shown in Tables VI-2 through VI-5, do not in any way support the argument for industry-specific tests. Although there are some isolated differences between industries in cases where stringent ratio cutoff points are assumed, each of the four ratios has at least one commonly used cutoff value (NFA/TA > .2, CF/TL > .1, TL/NW < 2.0, CURRAT > 1.5) which at least 75 percent of the firms in each 2-digit SIC can pass. The discrimination among industry groups resulting from the use of a single test therefore appears slight and well within the boundaries of difference illustrated by other financial indicators (e.g., bond ratings). Consequently, there is no justification for requiring industry specific tests for manufacturing industries.

TABLE VI-1

NUMBER OF FIRMS BY SIC CLASSIFICATION
USED IN TABLES VI-2 THROUGH VI-6

SIC	Description of Industry	Number of Firms
20	Food and kindred products	33
22	Textile mill products	8
24	Lumber and wood products, except furniture	15
26	Paper and allied products	17
28	Chemicals and allied products	51
29	Petroleum refining and related industries	13
30	Rubber and miscellaneous plastics products	29
32	Stone, clay, glass, and concrete products	19
33	Primary metal industries	26
34	Fabricated metal products, except machinery and transportation products	44
35	Machinery, except electrical	65
36	Electrical and electronic machinery, equipment and supplies	38
37	Transportation equipment	33
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	20
39	Miscellaneous manufacturing industries	14

TABLE VI-2

PERCENTAGES OF FIRMS IN MANUFACTURING INDUSTRIES PASSING OR FAILING GIVEN CASH FLOW/TOTAL LIABILITY (CF/TL) REQUIREMENTS
(Based on Sample Described in Text)

SIC	Description of Industry	CF/TL			
		< .10	>.10	>.15	>.20
20	Food and kindred products	9.1	90.9	72.7	48.5
22	Textile mill products	18.7	81.3	62.5	50.0
24	Lumber and wood products, except furniture	13.3	86.7	73.3	60.0
26	Paper and allied products	-	100.0	88.2	64.7
28	Chemicals and allied products	9.8	90.2	72.5	47.1
29	Petroleum refining and related industries	7.7	92.3	76.9	53.8
30	Rubber and miscellaneous plastics products	3.4	96.6	75.9	55.2
32	Stone, clay, glass, and concrete products	10.5	89.5	84.2	68.4
33	Primary metal industries	3.8	96.2	61.5	42.3
34	Fabricated metal products, except machinery and transportation products	6.8	93.2	68.2	40.9
35	Machinery, except electrical	7.7	92.3	72.3	50.8
36	Electrical and electronic machinery, equipment, and supplies	10.5	89.5	81.6	57.9
37	Transportation equipment	9.1	90.9	66.7	24.2
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	-	100.0	75.0	55.0
39	Miscellaneous manufacturing industries	7.1	92.9	64.3	57.1

TABLE VI-3

PERCENTAGE OF FIRMS IN MANUFACTURING INDUSTRIES PASSING OR FAILING GIVEN NET FIXED ASSETS/TOTAL ASSETS (NFA/TA) REQUIREMENTS
(Based on Sample Described in Text)

SIC	Description of Industry	NFA/TA			
		<.20	>.20	>.25	>.30
20	Food and kindred products	9.1	90.9	75.8	66.7
22	Textile mill products	-	100.0	93.8	87.5
24	Lumber and wood products, except furniture	13.3	86.7	73.3	66.7
26	Paper and allied products	-	100.0	100.0	94.1
28	Chemicals and allied products	7.8	92.2	80.4	72.5
29	Petroleum refining and related industries	-	100.0	92.3	92.3
30	Rubber and miscellaneous plastics products	10.3	89.7	89.7	86.2
32	Stone, clay, glass, and concrete products	10.5	89.5	78.9	78.9
33	Primary metal industries	3.8	96.2	84.6	76.9
34	Fabricated metal products, except machinery and transportation products	13.6	86.4	72.7	63.6
35	Machinery, except electrical	18.5	81.5	70.8	50.8
36	Electrical and electronic machinery, equipment, and supplies	21.1	78.9	71.1	47.4
37	Transportation equipment	12.1	87.9	75.8	51.5
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	20.0	80.0	65.0	55.0
39	Miscellaneous manufacturing industries	28.6	71.4	50.0	42.9

TABLE VI-4

PERCENTAGE OF FIRMS IN MANUFACTURING INDUSTRIES PASSING OR FAILING GIVEN TOTAL LIABILITIES/NET WORTH (TL/NW) REQUIREMENTS
(Based on Sample Described in Text)

SIC	Description of Industry	TL/NW				
		>2.0	< 2.0	< 1.5	< 1.2	< 1.0
20	Food and kindred products	9.1	90.9	78.8	69.7	42.4
22	Textile mill products	-	100.0	93.8	75.0	56.3
24	Lumber and wood products, except furniture	20.0	80.0	73.3	73.3	46.7
26	Paper and allied products	5.9	94.1	88.2	76.5	52.9
28	Chemicals and allied products	3.9	96.1	80.4	47.1	31.4
29	Petroleum refining and related industries	7.7	92.3	61.5	46.2	15.4
30	Rubber and miscellaneous plastics products	3.4	96.6	86.2	65.5	48.3
32	Stone, clay, glass, and concrete products	10.5	89.5	84.2	63.2	57.9
33	Primary metal industries	3.8	96.2	73.1	57.7	38.5
34	Fabricated metal products, except machinery and transportation products	6.8	93.2	75.0	52.3	36.4
35	Machinery, except electrical	6.2	93.8	83.1	58.5	46.2
36	Electrical and electronic machinery, equipment, and supplies	5.3	94.7	81.6	63.2	44.7
37	Transportation equipment	6.1	93.9	69.7	39.4	24.2
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	-	100.0	85.0	80.0	40.0
39	Miscellaneous manufacturing industries	14.3	85.7	78.6	64.3	57.1

TABLE VI-5

PERCENTAGE OF FIRMS IN MANUFACTURING INDUSTRIES PASSING OR FAILING GIVEN CURRENT RATIO (CURRAT) REQUIREMENTS
(Based on Sample Described in Text)

SIC	Description of Industry	CURRAT		
		< 1.5	>1.5	>2.0
20	Food and kindred products	6.1	93.9	48.5
22	Textile mill products	6.2	93.8	68.8
24	Lumber and wood products, except furniture	6.7	93.3	53.3
26	Paper and allied products	5.9	94.1	70.6
28	Chemicals and allied products	9.8	90.2	56.9
29	Petroleum refining and related industries	23.1	76.9	15.4
30	Rubber and miscellaneous plastics products	3.4	96.6	69.0
32	Stone, clay, glass, and concrete products	5.3	94.7	68.4
33	Primary metal industries	3.8	96.2	53.8
34	Fabricated metal products, except machinery and transportation products	6.8	93.2	68.2
35	Machinery, except electrical	9.2	90.8	58.5
36	Electrical and electronic machinery, equipment, and supplies	13.2	86.8	50.0
37	Transportation equipment	15.2	84.8	54.5
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	-	100.0	70.0
39	Miscellaneous manufacturing industries	-	100.0	64.3

B. Electric Utilities

In their comments on the proposed financial test of May 19, 1980, firms in the electric utility industry asserted that utilities could not be analyzed using "normal" financial logic, and should be judged under alternative criteria. Utilities objected to the use of net working capital as a required component of a financial test, since many firms in each category operate regularly from a negative net working capital position. Both the data submitted by the commenters and an independent check by the Agency verified that utilities do operate with negative net working capital. As a result, any test which requires that net working capital be some multiple of financial responsibility obligations will fail most utilities.

The Agency also examined the question of the extent to which specific ratio requirements might consistently fail viable utilities. To examine this issue, a sample of 26 electric utilities were drawn from the 1978 and 1979 Moody's Public Utilities Manual (see Table VI-6). Table VI-7 illustrates the performance of this sample against the key single-ratio tests identified in Section IV. As can be seen, a number of these ratios are totally unsuited for analyzing utility viability. The following financial ratios and pass-fail cutoff points were identified as potentially acceptable tests:

CF/TS > .1

TL/NW < 2.0, < 1.5

NI/TA > .02, > .04

NFA/TA > .2, > .25, > .3

TABLE VI-6

FINANCIAL DATA FOR THE ELECTRIC UTILITY SAMPLE

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[1]	CF/TL[2]	TL/NW[3]	CURRAT[4]	QRAT[5]
Black Hills Power and Light	1977(x-1)	3.7	6.7	4.3	6.5	14.5	84.6	38.8	123.4	P	F	F	F	F
	1976(x-2)	3.2	5.3	2.5	3.6	11.5	55.7	38.4	94.1	P	F	1.45	F	F
	1975(x-3)	3.0	4.9	2.3	3.8	11.6	40.8	27.4	68.2	P	12.0	1.49	F	F
Boston Edison	1977(x-1)	37.6	82.5	105.0	126.0	177.0	948.0	520.0	1468.0	P	F	1.82	F	F
	1976(x-2)	39.8	82.7	91.0	112.0	155.0	899.0	473.0	1372.0	P	F	1.90	F	F
	1975(x-3)	33.8	72.2	95.0	112.0	163.0	878.0	432.0	1310.0	P	F	F	F	F
Carolina Power and Light	1977(x-1)	121.0	192.1	91.0	181.0	120.0	1542.0	1186.0	2778.0	P	12.5	1.30	1.51	F
	1976(x-2)	111.0	173.4	61.0	123.0	102.0	1411.0	1145.0	2556.0	P	12.3	1.23	F	F
	1975(x-3)	92.2	138.8	56.0	140.0	91.0	1356.0	1049.0	2405.0	P	10.2	1.29	1.54	F
Central Hudson Gas and Electric	1977(x-1)	17.8	31.1	27.3	41.9	51.4	233.0	186.0	419.0	P	13.4	1.25	F	F
	1976(x-2)	15.9	28.8	24.3	37.8	47.8	229.0	167.0	396.0	P	12.6	1.37	F	F
	1975(x-3)	14.4	27.0	20.0	31.8	30.8	214.0	162.0	376.0	P	12.6	1.32	F	F
Central Illinois Light Company	1977(x-1)	21.6	49.2	58.0	81.0	63.0	490.0	288.0	758.0	P	10.0	1.70	F	F
	1976(x-2)	23.5	46.7	54.0	70.0	87.0	484.0	252.0	736.0	P	F	1.92	F	F
	1975(x-3)	18.0	36.9	51.0	72.0	106.0	451.0	230.0	681.0	P	F	1.96	F	F
Central Illinois Public Service Co.	1977(x-1)	37.1	63.8	63.0	102.0	98.0	629.0	389.0	1018.0	P	10.1	1.62	F	F
	1976(x-2)	30.6	54.7	34.0	60.0	62.0	518.0	322.0	840.0	P	10.6	1.61	F	F
	1975(x-3)	27.8	49.6	35.0	59.0	77.0	465.0	288.0	753.0	P	10.7	1.61	F	F
Central Louisiana Electric Co.	1977(x-1)	25.8	40.6	58.0	71.0	95.0	329.0	190.0	519.0	P	12.3	1.73	F	F
	1976(x-2)	25.5	38.7	38.0	46.0	47.0	275.0	179.0	454.0	P	14.1	1.54	F	F
	1975(x-3)	22.2	33.5	30.0	39.0	44.0	245.0	167.0	412.0	P	13.7	1.47	F	F
Central Maine Power	1977(x-1)	21.0	35.7	36.0	51.0	65.0	326.0	238.0	564.0	P	11.0	1.37	F	F
	1976(x-2)	16.9	30.2	28.0	42.0	47.0	301.0	185.0	486.0	P	10.0	1.63	F	F
	1975(x-3)	14.7	27.0	34.0	48.0	41.0	260.0	169.0	429.0	P	10.4	1.54	F	F
Con Edison of New York	1977(x-1)	323.6	493.2	876.0	1031.0	436.0	3552.0	3206.0	6758.0	P	13.9	1.11	P	P
	1976(x-2)	301.4	466.3	796.0	953.0	360.0	3539.0	3050.0	6589.0	P	13.2	1.16	P	P
	1975(x-3)	251.4	406.7	689.0	826.0	270.0	3424.0	2891.0	6315.0	P	11.9	1.18	P	P
El Paso Electric	1977(x-1)	11.4	17.9	31.0	40.0	65.0	222.0	109.0	331.0	P	F	F	F	F
	1976(x-2)	11.5	20.7	21.0	32.0	44.0	161.0	97.0	258.0	P	12.9	1.66	F	F
	1975(x-3)	10.1	15.4	25.0	35.0	43.0	158.0	83.0	241.0	P	F	1.90	F	F
Empire District Electric Co.	1977(x-1)	5.9	10.6	11.0	16.0	124.0	84.0	60.0	144.0	P	12.6	1.40	F	F
	1976(x-2)	4.3	8.6	7.0	11.0	104.0	69.0	50.0	119.0	P	12.5	1.38	F	F
	1975(x-3)	3.9	8.0	4.0	7.0	97.0	65.0	40.0	105.0	P	12.3	1.63	F	F

1/ P 30.0 (passes all tests); F < 20.0 (fails all tests)

2/ P > 20.0 (passes all tests); F < 10.0 (fails all tests)

3/ P < 1.0 (passes all tests); F > 2.0 (fails all tests)

4/ P > 2.0 (passes all tests); F < 1.5 (fails all tests)

5/ P > 1.2 (passes all tests); F < 1.0 (fails all tests)

TABLE VI-6 (Continued)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA[1/]	CF/TL[2/]	TL/NW[3/]	CURRAT[4/]	QRAT[5/]
Florida Power and Light	1977(x-1)	180.4	305.4	105.0	237.0	237.0	314.0	2536.0	4072.0	P	12.0	1.65	F	F
	1976(x-2)	116.8	205.3	142.0	264.0	274.0	2417.0	1450.0	3867.0	P	F	1.67	F	F
	1975(x-3)	145.2	227.5	102.0	210.0	282.0	2149.0	1269.0	3418.0	P	1.06	1.69	F	F
General Public Utility Corp.	1977(x-1)	142.8	240.0	156.0	261.0	190.0	2478.0	1827.0	4305.0	P	F	1.36	F	F
	1976(x-2)	121.2	209.6	163.0	238.0	188.0	2352.0	1643.0	3955.0	P	F	1.43	F	F
	1975(x-3)	107.4	190.8	142.0	209.0	155.0	2061.0	1584.0	3645.0	P	F	1.30	F	F
Ohio Edison	1977(x-1)	111.6	170.2	119.0	190.0	148.0	1277.0	1166.0	2443.0	P	13.3	1.10	F	F
	1976(x-2)	103.2	151.2	79.0	136.0	126.0	1147.0	934.0	2081.0	P	13.2	1.23	F	F
	1975(x-3)	83.4	123.5	58.0	107.0	204.0	1031.0	805.0	1836.0	P	12.0	1.28	F	F
Pennsylvania Power and Light	1978(x-1)	149.0	222.1	NA	291.0	364.0	1814.0	1525.0	3339.0	P	12.2	1.19	F	F
	1977(x-2)	149.8	217.8	NA	330.0	215.0	1704.0	1346.0	3050.0	P	12.8	1.27	1.53	NA
	1976(x-3)	112.1	174.6	NA	259.0	211.0	1503.0	1164.0	2667.0	P	11.6	1.29	F	NA
Peoples Gas Co.	1978(x-1)	130.5	254.7	NA	581.0	449.0	1882.0	924.0	2806.0	P	13.5	F	F	NA
	1977(x-2)	115.7	229.6	NA	418.0	369.0	1639.0	858.0	2497.0	P	14.0	1.91	F	NA
	1976(x-3)	113.0	216.9	NA	290.0	345.0	1592.0	744.0	2336.0	P	13.6	F	F	F
Philadelphia Electric Company	1978(x-1)	184.9	301.4	NA	363.0	292.0	2791.0	2059.0	4850.0	P	10.8	1.36	F	NA
	1977(x-2)	173.4	281.2	NA	342.0	224.0	2577.0	1971.0	4548.0	P	10.9	1.31	1.53	NA
	1976(x-3)	164.6	261.1	NA	311.0	214.0	2356.0	1861.0	4217.0	P	11.1	1.27	F	NA
Piedmont Natural Gas	1978(x-1)	5.1	9.4	NA	36.7	30.4	109.0	50.0	159.0	P	F	F	F	NA
	1977(x-2)	5.1	9.3	NA	30.3	20.3	100.0	49.0	149.0	P	F	F	F	NA
	1976(x-3)	6.3	10.5	NA	23.2	28.8	89.0	49.0	138.0	P	11.8	1.81	F	F
Pioneer Corporation	1978(x-1)	34.0	59.2	NA	155.0	116.0	321.0	173.0	494.0	P	18.4	1.85	F	NA
	1977(x-2)	38.2	59.0	NA	136.0	106.0	258.0	161.0	419.0	P	P	1.60	F	NA
	1976(x-3)	38.0	56.4	NA	135.0	96.0	247.0	136.0	383.0	P	P	1.82	F	NA
Portland General Electric	1978(x-1)	56.6	82.2	NA	81.4	186.4	984.0	633.0	1617.0	P	F	1.55	F	F
	1977(x-2)	37.0	59.7	NA	61.8	116.8	774.0	568.0	1342.0	P	F	1.3	F	F
	1976(x-3)	52.0	59.2	NA	58.7	126.7	685.0	495.0	1180.0	P	F	1.38	F	F
Potomac Electric Power Co.	1978(x-1)	78.8	137.9	NA	195.0	149.0	1287.0	827.0	2114.0	P	10.7	1.56	F	NA
	1977(x-2)	84.9	141.9	NA	234.0	160.0	1286.0	773.0	2059.0	P	11.0	1.66	F	NA
	1976(x-3)	77.0	131.6	NA	156.0	189.0	1093.0	753.0	1846.0	P	12.0	1.45	F	F
Public Service Co. of Colorado	1978(x-1)	57.7	102.4	NA	194.0	184.0	933.0	720.0	1653.0	P	11.0	1.30	F	NA
	1977(x-2)	51.0	92.5	NA	170.0	148.0	830.0	664.0	1494.0	P	11.1	1.25	F	NA
	1976(x-3)	54.7	94.0	NA	159.0	127.0	786.0	615.0	1401.0	P	12.0	1.28	F	NA
Public Service Co. of Indiana	1978(x-1)	87.7	140.7	NA	223.0	187.0	1219.0	825.0	2044.0	P	11.5	1.48	F	NA
	1977(x-2)	88.5	134.2	NA	162.0	141.0	1026.0	699.0	1725.0	P	13.1	1.47	F	NA
	1976(x-3)	75.0	117.5	NA	-23.0	169.0	841.0	617.0	1458.0	P	14.0	1.36	F	F
Public Service Co. of New Hampshire	1978(x-1)	36.5	51.3	NA	72.0	174.0	500.0	[illegible]2.0	812.0	P	10.3	1.60	F	F
	1977(x-2)	21.7	35.8	NA	61.0	95.0	365.5	275.0	640.0	P	F	1.33	F	F
	1976(x-3)	21.0	34.8	NA	62.0	42.0	310.0	230.0	540.0	P	11.2	1.34	F	NA

TABLE VI-6 (Concluded)

Name of Firm	Year	NI	CF	QA	CA	CL	TL	NW	TA	NFA/TA 1/	CF/TL 2/	TL/NW 3/	CURRAT 4/	QRAT 5/
San Diego Gas and Electric	1978(x-1)	66.8	102.4	NA	199.0	163.0	860.0	694.0	1554.0	P	11.9	1.24	F	NA
	1977(x-2)	60.2	92.8	NA	187.0	213.0	831.0	582.0	1413.0	P	11.2	1.43	F	F
	1976(x-3)	50.5	80.5	NA	146.0	181.0	706.0	481.0	1187.0	P	11.4	1.47	F	F
Savannah Electric Power Co.	1978(x-1)	11.4	17.4	NA	15.8	16.7	169.0	79.0	248.0	P	10.3	F	F	F
	1977(x-2)	8.7	14.3	NA	11.1	11.0	134.0	73.0	207.0	P	10.7	1.84	F	NA
	1976(x-3)	6.4	11.2	NA	10.8	8.7	127.0	63.0	190.0	P	F	F	F	NA

TABLE VI-7

APPLICABILITY OF FINANCIAL TESTS TO UTILITIES

(26 Firm Samples)

Single Ratio Tests			A_{NBU} [1/] (One-Year Eligibility Requirement)	A_{NBU} (Three-Year Eligibility Requirement)
CF/TL	>	.1	77	54
CF/TL	>	.15	4	4
CF/TL	>	.2	0	0
TL/NW	<	2.0	81	77
TL/NW	<	1.5	46	38
TL/NW	<	1.2	12	4
TL/NW	<	1.0	0	0
NI/TA	>	.02	100	100
NI/TA	>	.25	54	46
NWK/TA	>	.25	0	0
CURRAT	>	1.5	12	8
CURRAT	>	2.0	4	4
QRAT	>	1.0	8	4
QRAT	>	1.2	4	4
NFA/TA	>	.25	100	100
NFA/TA	>	.3	100	100

[1/] A_{NBU} = Percent of viable utilities passing a given test.

Given this reduced list of acceptable parameters, only 28 of the 151 multi-ratio tests were classified as applicable to utilities. These tests were then evaluated against the utility sample, with the results summarized in Table VI-8 and VI-9. For many of the higher E_P score values, the tests that can be effectively applied to utilities are also those which are most effective for other industries. If, however, a greater than 90 percent reduction in the overall rate of large firm bankruptcy is sought, the tests which permit an acceptable percentage of utilities to pass also reject a higher percentage of other viable firms. This disparity is illustrated in Figure VI-1, which contrasts one-year tests on the performance curve with utility applicable tests, using only tests applicable to utilities derived in Section V.

C. Hazardous Waste Management Firms

Because the majority of firms currently in the hazardous waste management business are either privately held or single-site entities with assets less than $1 million (Foster D. Snell, 1976), it was not possible to assemble a sample of hazardous waste management firms which could be used to evaluate test applicability.

Table VI-10 shows average ratios for hazardous waste management firms from 1971-1975. These ratios suggest that the average hazardous waste management firm would have little difficulty with possible net fixed assets to total assets requirements. However the average firm in this industry would have had trouble in many of these years with possible current ratio and total liability to net worth requirements. The average profits to total debt ratio suggests an uncertain picture with

TABLE VI- 8

OVERALL EFFECTIVENESS OF UTILITY-APPLICABLE FINANCIAL TESTS
(One-Year Eligibility Requirement)

Test Number	Test Description	E_P	A_{NB}	A_{NBU}
	Pass All:			
11	CF/TL > .1 TL/NW < 1.5	6.1	77	42
12	CF/TL > .1 TL/NW < 2.0	6.8	81	69
15	NI/TA > .04 TL/NW < 1.5	6.3	66	31
16	NI/TA > .04 TL/NW < 2.0	7.3	72	46
19	NI/TA > .02 TL/NW < 1.5	6.5	77	46
20	NI/TA > .02 TL/NW < 2.0	7.4	82	81
	2 out of 3:			
97	CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	9.7	86	42
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	9.3	93	69
99	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	10.1	91	42
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	10.1	96	69
109	CF/TL > .1 TL/NW < 1.5 QRAT > 1.2	8.3	82	42
110	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	8.4	87	69

TABLE VI-8 (Continued)

Test Number	Test Description	E_P	A_{NB}	A_{NBU}
119	CF/TL > .1 TL/NW < 1.5 QRAT > 1.0	9.5	88	42
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	9.1	92	69
	Pass All:			
123	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	3.3	55	42
124	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	3.1	59	69
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	2.9	62	42
126	NFA/TA > .25 CF/TL > .1 TL/NW < 2.0	3.6	66	69
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	3.8	75	69
	2 out of 3:			
130	NFA/TA > .3 CF/TL > .2 TL/NW < 1.5	7.1	73	46
133	NFA/TA > .3 CF/TL > .15 TL/NW < 1.5	6.8	80	46
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	4.6	79	77
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	5.6	83	77

TABLE VI-8 (Concluded)

Test Number	Test Description			E_P	A_{NB}	A_{NBU}
136	NFA/TA	>	.3	7.9	89	81
	CF/TL	>	.1			
	TL/NW	<	1.5			
137	NFA/TA	>	.3	9.1	92	88
	CF/TL	>	.1			
	TL/NW	<	2.0			
146	NFA/TA	>	.2	9.9	95	77
	CF/TL	>	.1			
	CURRAT	>	2.0			
	3 out of 4:					
149	NFA/TA	>	.3	6.0	87	69
	CF/TL	>	.1			
	CURRAT	>	2.0			
	TL/NW	<	1.5			
150	NFA/TA	>	.3	5.5	81	42
	CF/TL	>	.1			
	CURRAT	>	2.0			
	TL/NW	<	2.0			

TABLE VI-9

OVERALL EFFECTIVENESS OF UTILITY-APPLICABLE FINANCIAL TESTS

(Three-Year Eligibility Requirement)

Test Number	Test Description	E_P	A_{NB}	A_{NBU}
	Pass All:			
11	CF/TL > .1 TL/NW < 1.5	3.7	70	35
12	CF/TL > .1 TL/NW < 2.0	5.2	76	58
15	NI/TA > .04 TL/NW < 1.5	4.7	56	<20
16	NI/TA > .04 TL/NW < 2.0	6.1	60	23
19	NI/TA > .02 TL/NW < 1.5	4.9	69	38
20	NI/TA > .02 TL/NW < 2.0	6.6	75	77
	2 out of 3:			
97	CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	7.7	75	35
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	8.6	82	58
99	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	8.2	80	35
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	9.7	84	58
109	CF/TL > .1 TL/NW < 1.5 QRAT > 1.2	6.5	72	35
110	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	7.4	78	58

TABLE VI-9 (Continued)

Test Number	Test Description			E_P	A_{NB}	A_{NBU}
119	CF/TL	>	.1	8.0	78	35
	TL/NW	<	1.5			
	QRAT	>	1.0			
120	CF/TL	>	.1	8.2	83	58
	TL/NW	<	2.0			
	QRAT	>	1.0			
	Pass All:					
123	NFA/TA	>	.3	1.6	49	35
	CF/TL	>	.1			
	TL/NW	<	1.5			
124	NFA/TA	>	.3	1.5	53	58
	CF/TL	>	.1			
	TL/NW	<	2.0			
125	NFA/TA	>	.25	1.4	56	35
	CF/TL	>	.1			
	TL/NW	<	1.5			
126	NFA/TA	>	.25	2.2	59	58
	CF/TL	>	.1			
	TL/NW	<	2.0			
127	NFA/TA	>	.2	1.9	67	58
	CF/TL	>	.1			
	TL/NW	<	2.0			
	2 out of 3:					
130	NFA/TA	>	.3	4.9	64	38
	CF/TL	>	.2			
	TL/NW	<	1.5			
133	NFA/TA	>	.3	4.7	72	42
	CF/TL	>	.15			
	TL/NW	<	1.5			
134	NEA/TA	>	.3	2.9	72	62
	CF/TL	>	.1			
	TL/NW	<	1.0			
135	NFA/TA	>	.3	4.1	77	62
	CF/TL	>	.1			
	TL/NW	<	1.2			

TABLE VI-9 (Concluded)

Test Number	Test Description	E_P	A_{NB}	A_{NBU}
136	NFA/TA > .3	5.4	82	65
	CF/TL > .1			
	TL/NW < 1.5			
137	NFA/TA > .3	7.3	86	81
	CF/TL > .1			
	TL/NW < 2.0			
146	NFA/TA > .2	9.5	83	62
	CF/TL > .1			
	CURRAT > 2.0			
	<u>3 out of 4:</u>			
149	NFA/TA > .3	5.0	74	58
	CF/TL > .1			
	CURRAT > 2.0			
	TL/NW < 1.5			
150	NFA/TA > .3	4.1	71	35
	CF/TL > .1			
	CURRAT > 2.0			
	TL/NW < 2.0			

FIGURE VI-1

PERFORMANCE CURVE FOR TESTS WITH ONE-YEAR ELIGIBILITY REQUIREMENTS
WITH AND WITHOUT UTILITY APPLICABLE TESTS

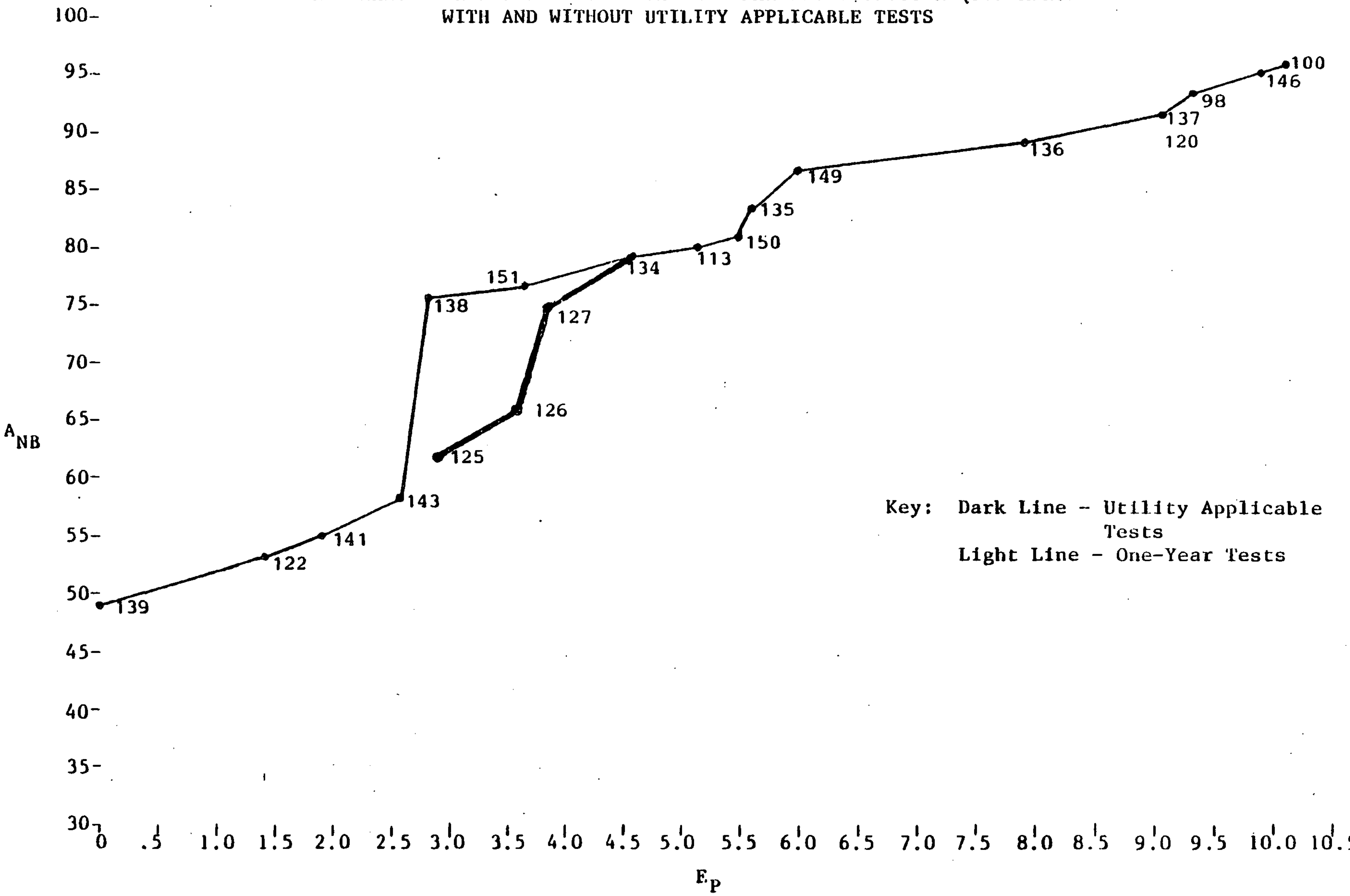

TABLE VI-10

AVERAGE RATIOS OF HAZARDOUS WASTE MANAGEMENT FIRMS, 1971-1975

	1971	1972	1973	1974	1975
Current Ratio					
a. Firms whose main objective is hazardous waste management	1.58	1.77	1.42	1.33	1.28
b. Corporations having divisions or sites engaged in hazardous waste management	1.28	1.61	1.81	2.04	1.83
Total Debt/Equity					
a. Firms whose main objective is hazardous waste management	1.20	1.19	1.18	1.60	1.64
b. Corporations having divisions or sites engaged in hazardous waste management	1.37	1.66	2.43	1.96	NA
Profits/Total Debt					
a. Firms whose main objective is hazardous waste management	NA	.096	.102	.134	.182
b. Corporations having divisions or sites engaged in hazardous waste management	.127	.098	.056	.076	.075
Net Fixed Assets/Total Assets					
a. Firms whose main objective is hazardous waste management	.65	.64	.62	.555	.60
b. Corporations having divisions or sites engaged in hazardous waste management	.62	.57	.63	.60	.62

SOURCE: Foster D. Snell, 1976.

respect to the ability of the average firm in the industry to meet the possible cash flow/total liability requirements. This ability would depend in at least some years on total depreciation, amortization and depletion allowance.

Thus, firms in the hazardous waste management industry could be expected to have difficulty meeting many possible financial tests even without a $10 million in net worth requirement. However, this reflects the financial weakness of this industry during this period rather than some unique financial feature of the industry. The study from which the ratios in Table VI-10 are drawn states:

> Since 1973, long term debt has remained stable for the industry as financial institutions have been reluctant to invest capital in the industry because: hazardous waste management firms in general did not have strong financial positions, and the growth of the industry was deemed risky in future periods. Short debt financing has increased from $3.2 million in 1971 to $7.2 million in 1975. This high cost debt financing additionally points out the current problems of the industry in obtaining lower cost long-term capital. (Foster D. Snell, 1976).

The share of hazardous waste facilities owned by hazardous waste management firms with over $10 million in net worth and independently audited is small. Only 26 facilities are owned by the four largest hazardous waste management firms which are independently audited. The next eight to nine largest firms are all privately held and are unlikely to be independently audited. The majority of off-site facilities are owned by relatively small firms with less than $10 million in net worth (Booz, Allen & Hamilton and Putnam, Hayes & Bartlett, 1980). The 26 facilities which are owned by large, independently audited firms thus represent only about 1 percent of the 2,500 facilities owned by firms eligible for a financial test.

A careful examination of the balance sheets of two of the larger firms in the industry which own 12 of the 26 facilities, Browning Ferris Industries (BFI) and SCA Services, Inc. showed their performance with respect to the relevent ratios as summarized in Table VI-11. BFI would pass 13 of the 16 financial tests on the performance curve for tests with one-year or three-year elibibility requirements. SCA would pass 12 of these 16 tests.

TABLE VI-11

RATIOS FOR BROWNING FERRIS INDUSTRIES (BFI)
AND SCA SERVICES, INC.

Firm Name	Year of Data	CF/TL	TL/NW	NFA/TA	CURRAT	QRAT	NI/TA
BFI	(x-1) 1978	17.5	1.13	P[1/]	1.60	P	P
	(x-2) 1977	15.5	1.10	P	F[2/]	P	P
	(x-3) 1976	15.7	1.12	P	1.64	P	P
SCA	(x-1) 1978	15.4	1.52	P	1.65	P	4.0
	(x-2) 1977	14.9	1.55	P	F	P	3.0

[1/] P = Passes all tests using this variable.

[2/] F = Fails all tests using this variable.

VII. BOND RATINGS

Several commenters on the May 19, 1980 reproposed financial responsibility regulations suggested that corporate bond ratings should be used as an alternative or substitute for the proposed financial test. The Agency therefore analyzed the possibility of using corporate bond ratings as an assurance of financial responsibility.

Bonds are a form of long-term debt. They may be unsecured, or secured by collateral such as equipment, marketable securities, or fixed assets. Certain bonds include specific promises concerning the use of special sinking funds. Repayment of other categories of bonds may be subordinated to repayment of other debt instruments.

Bond ratings provide an appraisal of the ability of firms to repay these long-term debts. They are used extensively by the financial community for the purpose of providing a long-term credit risk evaluation of the relative likelihood of timely payment of interest and repayment of principal of specific bond instruments. Many banks, including large ones, rely almost exclusively on rating service evaluations of bonds and do not have internal groups which independently evaluate the riskiness of their bond portfolios (Kaplan and Urwitz, 1979). Because bond ratings measure the ability of firms to meet a long-term debt, they are better adapted to an analysis of long-term financial responsibility than are ratings of short-term credit and trade credit.

The Agency did not attempt to evaluate the performance of ratings of specific types of bonds. Rather, it considered the ratings performance of all categories of long-term debt that were (1) identified as bonds by either of the two major bond ratings services and (2) rated by either of them.

The two major ratings services are Moody's Investors Services, Inc. (Moody's) and Standard and Poor's Corporation (Standard and Poor's). Each has long experience in rating corporate bonds. Moody's and Standard and Poor's rate almost all corporate bond issues of $5 million and over in principal amount with or without request from the issuer. The bonds of certain issuers (including newly created companies in most cases) are not rated, and ratings of other issuances are carried out only upon request and are not published except upon permission of the issuer.

Both major ratings services provide nine basic ratings of corporate bonds. Figure VII-1 provides a listing of the ratings given by Moody's and the interpretation of each rating as suggested by Moody's. Figure VII-2 provides the ratings and their interpretations used by Standard and Poor's. The ratings classifications are highly qualitative, and neither rating service suggests any specific quantitative equivalent for the ratings assigned.

The top four ratings of both services are assigned to bonds considered to be of investment grade, while the remaining ratings are assigned to bonds that are considered to be speculative. Ratings of each bond issuance are reviewed periodically and may be upgraded or downgraded. Table VII-1 provides a distribution of corporate bond ratings issued by

Aaa

Bonds which are rated Aaa are judged to be of the best quality. They carry the smallest degree of investment risk and are generally referred to as "gilt edge." Interest payments are protected by a large or by an exceptionally stable margin and principal is secure. While the various protective elements are likely to change, such changes as can be visualized are most unlikely to impair the fundamentally strong position of such issues.

Aa

Bonds which are rated Aa are judged to be of high quality by all standards. Together with the Aaa group they comprise what are generally known as high grade bonds. They are rated lower than the best bonds because margins of protection may not be as large as in Aaa securities or fluctuation or protective elements may be of greater amplitude or there may be other elements present which make the long term risks appear somewhat larger than in Aaa securities.

A

Bonds which are rated A possess many favorable investment attributes and are to be considered as upper medium grade obligations. Factors giving security to principal and interest are considered adequate but elements may be present which suggest a susceptibility to impairment sometime in the future.

Baa

Bonds which are rated Baa are considered as medium grade obligations, i.e., they are neither highly protected nor poorly secured. Interest payments and principal security appear adequate for the present but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well.

Ba

Bonds which are rated Ba are judged to have speculative elements; their future cannot be considered as well assured. Often the protection of interest and principal payments may be very moderate and thereby not well safeguarded during both good and bad times over the future. Uncertainty of position characterizes bonds in this class.

B

Bonds which are rated B generally lack characteristics of the desirable investment. Assurance of interest and principal payments or of maintenance of other terms of the contract over any long period of time may be small.

Caa

Bonds which are rated Caa are of poor standing. Such issues may be in default or there may be present elements of danger with respect to principal or interest.

Ca

Bonds which are rated Ca represent obligations which are speculative in a high degree. Such issues are often in default or have other marked shortcomings.

C

Bonds which are rated C are the lowest rated class of bonds and issues so rated can be regarded as having extremely poor prospects of ever attaining any real investment standing.

FIGURE VII-1

KEY TO MOODY'S BOND RATINGS

A Standard & Poor's corporate or municipal bond rating is a current assessment of the creditworthiness of an obligor with respect to a specific debt obligation. This assessment may take into consideration obligors such as guarantors, insurers, or lessees.

The bond rating is not a recommendation to purchase, sell, or hold a security inasmuch as it does not comment as to market price or suitability for a particular investor.

The ratings are based on current information furnished by the issuer or obtained by Standard & Poor's from other sources we consider reliable. We do not perform an audit in connection with any rating and may, on occasion, rely on unaudited financial information. The ratings may be changed, suspended, or withdrawn as a result of changes in, or unavailability of, such information, or for other reasons.

The ratings are based, in varying degrees, on the following considerations:

I. Likelihood of default—capacity and willingness of the obligor as to the timely payment of interest and repayment of principal in accordance with the terms of the obligation

II. Nature of and provisions of the obligation

III. Protection afforded by, and relative position of, the obligation in the event of bankruptcy, reorganization, or other arrangement under the laws of bankruptcy and other laws affecting creditor's rights

AAA Bonds rated AAA have the highest rating assigned by Standard & Poor's to a debt obligation. Capacity to pay interest and repay principal is extremely strong.

AA Bonds rated AA have a very strong capacity to pay interest and repay principal and differ from the highest-rated issues only in a small degree.

A Bonds rated A have a strong capacity to pay interest and repay principal, although they are somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than bonds in higher-rated categories.

BBB Bonds rated BBB are regarded as having an adequate capacity to pay interest and repay principal. Although they normally exhibit adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for bonds in this category than for bonds in higher-rated categories.

BB
B
CCC
CC Bonds rated BB, B, CCC, and CC are regarded, on balance, as predominantly speculative with respect to capacity to pay interest and repay principal in accordance with the terms of the obligation. BB indicates the lowest degree of speculation and CC the highest degree of speculation. While such bonds will likely have some quality and protective characteristics, these are outweighed by large uncertainties or major risk exposures to adverse conditions.

C The rating C is reserved for income bonds on which no interest is being paid.

D Bonds rated D are in default, and payment of interest and/or repayment of principal is in arrears.

Plus (+) or Minus (−): The ratings from AA to BB may be modified by the addition of a plus or minus sign to show relative standing within the major rating categories.

Provisional Ratings: The letter "p" indicates that the rating is provisional. A provisional rating assumes the successful completion of the project financed by the bonds being rated and indicates that payment of debt service requirements is largely or entirely dependent upon the successful and timely completion of the project. This rating, however, while addressing credit quality subsequent to completion of the project, makes no comment on the likelihood of, or the risk of default upon failure of, such completion. The investor should exercise his or her own judgment with respect to such likelihood and risk.

NR Indicates that no rating has been requested, that there is insufficient information on which to base a rating, or that Standard & Poor's does not rate a particular type of obligation as a matter of policy.

Debt obligations of issuers outside the United States and its territories are rated on the same basis as domestic corporate and municipal issues. The ratings measure the creditworthiness of the obligor, but do not take into account currency exchange and other uncertainties.

Bond Investment Quality Standards: Under present commercial bank regulations issued by the Comptroller of the Currency, bonds rated in the top four categories (AAA, AA, A, BBB, commonly known as "investment grade" ratings) are generally regarded as eligible for bank investment. In addition, the legal investment laws of various states impose certain ratings or other standards for obligations eligible for investment by savings banks, trust companies, insurance companies, and fiduciaries generally.

FIGURE VII-2

STANDARD & POOR'S CORPORATE RATING DEFINITIONS

TABLE VII-1

PERCENTAGE DISTRIBUTION OF PUBLICLY OFFERED STRAIGHT CORPORATE BONDS

Amount in billions	1966 7.8	1967 14.8	1968 10.9	1969 9.5	1970 23.1	1971 21.3	1972 12.3	1973 12.3	1974 24.8	1975[1/] 31.1
Aaa & Aa	48%	42%	48%	53%	50%	53%	60%	61%	64%	57%
A	19	19	17	27	38	32	28	29	29	36
Baa & below	27	30	23	20	11	11	8	5	6	7
Not rated	6	9	12	0	1	1	4	5	1	3

[1/] 11 months.

SOURCE: Backer and Gosman (1978).

Moody's for recent years. Table VII-2 shows the number of outstanding bond issues rated by Moody's at a point in time in July 1981. According to this Table, 86 percent of the outstanding bond issues rated by Moody's as of that time would be acceptable for satisfying the bond rating portion of the financial test.

Both ratings services insist that a bond rating is based on the specific bond instrument in question, and does not imply a rating for other instruments of the firm or a rating of the firm as a whole. This is due, in part, to the fact that different bonds are secured by different types and amounts of collateral, and by different types of other so-called "structural credit supports" such as third party guarantees, segregated cash flow, or insurance. However, the rating agencies do carry out an analysis of the situation of both the industry and of the company within the industry and a financial analysis of the company, and these analyses also affect the rating assigned to the specific bond instrument.

According to Standard and Poor's Ratings Guide, ratings are based, to varying degrees, on the following considerations:

I. Likelihood of default--capacity and willingness of the obligor as to the timely payment of interest and repayment of principal in accordance with the terms of the obligation

II. Nature of and provisions of the obligation

III. Protection afforded by, and relative position of, the obligation in the event of bankruptcy, reorganization, or other arrangement under the laws of bankruptcy and other laws affecting creditor's rights

(Standard and Poor's Ratings Guide, 1979)

TABLE VII-2

OUTSTANDING BOND ISSUES*
JULY 1981

Moody's Ratings	Number of Issues	Percentage of Issues
Investment Grade		
Aaa	750	13
Aa	1140	20
A	2029	35
Baa	1012	18
Total Investment Grade	4931	86
Below Investment Grade		
Ba	339	6
B	320	6
Caa	95	2
Ca	38	1
C	10	0
Total Below Investment Grade	802	15

*Includes: Industrials, Utilities, Transportation, Banks and Finance Companies.

Note: Totals may exceed 100% due to rounding error.

SOURCE: Ron Lewis of Moody's Corporate Bond Department.

The wide scope of bond rating agency analysis can be better appreciated from the description given by Brenton W. Harris, a former President of Standard and Poor's, when listing the factors used as a basis for assigning bond ratings:

1. Issuing documents: ... In determining a rating, the indenture is far less important than the company's earning power, financial resources, and property protection. This is not to say, however, that the indenture does not have a great bearing on a bond rating...

2. Earnings: the past record and foreseeable potential are, in most cases, the single most important factor in credit rating. High levels of earnings frequently preclude liquidity problems because access to short-term cash needs can be readily accommodated. Remembering that bond ratings turn on timely repayment of principal and interest, strong cash flows generated by high and continued earnings, combined with an adequate depreciation, depletion, and amortization policy where applicable, contribute a healthy plus factor to the determination of a bond rating...

3. Asset protection: Asset protection generally is more important as a long-term consideration than as one influencing immediate liquidity. The analysis here is primarily statistical and, hence, highly objective. Of primary interest are the ratio of its working capital to its debt; the ratio of its debt to its equity; and the ratio of its total net tangible assets to its debt. The relative importance of these major ratios depends on the type of industry the company is in...

4. Management: Evaluating management is one of the most difficullt chores a rating agency faces. But management is one of the most important facets of a successful operation. It is my opinion that the single most important reason for the failure of the Penn Central was the inability of its management to deal with its problems...

5. Financial resources are, of course, the largest single area in which liquidity has a direct impact on long-term debt rating. In looking at the financial resources of a company, we are concerned not only with a company's cash position but also with its ability to obtain cash. This area of financial resources, which constitutes one of the five fundamental areas of investigation to determine

> long-term debt rating, is the test of liquidity ... Briefly stated, the financial resources we consider are those alternative sources of borrowing that a firm may use to raise cash for either long- or short-term debt repayment. They include the amount of cash reserves on hand including salable receivables; the short-term borrowing potential, particularly bank lines; the ability of the company to tap the long-term debt market, particularly at the time of its choosing; the ease with which the company could sell stock; and the potential sale of assets--obviously the weakest alternative.
>
> (Quoted in Backer and Gosman, 1978)

The Agency is satisfied that the actual establishment of a rating is the result of the informed judgment of trained analysts based on a detailed study of all of the above factors, and does not involve the mechanical application of formulae. Bond ratings are therefore a different type of analysis of financial liability than a financial test. Spokesmen for the ratings services emphasize the point that bond ratings are based on expert judgment (Backer and Gosman, 1978). Although some investigators have questioned this assertion (Ross 1976, Sherwood 1976), arguing that bond ratings services rely on explicit cutoff points of particular financial ratios, a thorough recent study of bond and other financial ratings procedures prepared for the National Association of Accountants reported, with respect to the importance of financial ratios in credit rating evaluations, that:

> All interviewees stated the belief that financial ratios were of moderate to strong importance in their credit rating evaluations. However, almost all those interviewed cautioned that such financial measures were not the only thing of importance; additional considerations frequently mentioned included quality of management, future for product, and general economic conditions. (Backer and Gosman, 1978).

The same study conducted a statistical analysis to determine which ratios seemed to be most important by comparing a group of bonds that had not been downgraded and group of bonds that had been downgraded. The most statistically significant ratio was found to be cash flow to long-term debt. However, the statistical results also indicated that a number of other ratios could also be of some importance: return on sales, return on total assets, return on tangible net worth, long-term debt to capitalization, net tangible assets to long-term debt, long-term debt to property and equipment, and cash flow to total debt. This statistical examination of downgraded bonds compared to bonds that were not downgraded would probably have revealed a specific formula had one existed. No such specific formula was found.

The Agency, in order to assess the actual performance of bond ratings in predicting default, first conducted a literature search for previous studies of performance. A variety of sources suggest that bond ratings can be used as a reasonably good indicator of the quality of corporate debt. (See Lev, 1974; Fraine and Mills, 1961; and Fiedler, 1971.) The only sources for detailed statistical data supporting this conclusion, however, are two studies by W.B. Hickman, Corporate Bond Quality and Investor Experience (1958), and Statistical Measures of Corporate Bond Financing Since 1900 (1960).

Although Hickman's work is somewhat dated, covering the period 1900-1943, it does examine a period of economic volatility which provides a good test of the results of ratings services. The ratings used are those assigned at the time of issue. Thus, if the bond was downgraded prior to default but after issue, this would not be reflected in these ratings. Given the volatility of the economy for the period in question, and the fact that changes in ratings are not accounted for use of these data results in a strict judgment of bond ratings. In addition, statistical analysis of the performance of bond ratings is difficult for recent periods because so few firms with rated bonds have gone bankrupt that creation of a useful sample is almost impossible. The Agency noted, for example, that none of the firms in its sample of bankrupt firms between 1966 and 1979 had an investment grade rated bond issuance.

In a study incorporating Hickman's findings, T.B. Atkinson compared prewar and postwar (through 1965) corporate bond quality. He concluded that:

> U.S. corporate bonds defaulting in the postwar period (from 1945 through 1965) averaged less than 0.1 percent of the volume of outstanding, or about one-half billion dollars in all. This compares with 1.7 percent of the outstanding bonds which defaulted during 1900-43. The postwar defaults were concentrated in bonds of the railroad industry, many of which had been outstanding before 1920 or had been refundings of the original bonds issued prior to that year. (Atkinson, 1967)

It should be noted that these percentages of outstanding bonds which defaulted include bonds of investment and speculative quality.

In order to analyze the effectiveness of agency ratings in predicting defaults, the Agency applied a general procedure similar to that used to calculate the effectiveness (E) of various financial tests. Hickman reported in his study the percentage of the total value of outstanding bonds of a particular rating defaulted upon by firms with these bonds and the percentage of the total value not defaulted. Although there is no direct evidence correlation between the default rates of bonds and firms, it was assumed that as a rough approximation the accuracy of predicting defaults on bonds is equivalent to the accuracy in identifying defaulting firms. Therefore, the percentages reported by Hickman were used in columns 1 and 2 of Table VII-3 as the equivalents of the M_P and A_{NB} measures obtained when a particular financial test is applied to the bankrupt and to the non-bankrupt firm samples developed by the Agency. Using two alternative estimates of the baseline failure rate, effectiveness measures (E) were calculated for each grade of bond ratings in the top four categories. The results of this analysis are given in Table VII-3. The first assumption is the baseline of 22 per 10,000 used earlier in this report. The second reflects the possibility that the baseline failure rate for the kinds of firms which would have rated bonds might be as low as 11 per 10,000. Public bond ratings are generally given to bond issuances from substantial firms. A significant number of large public bond issues are not rated at all. This category of unrated public debt issues has a much higher failure rate than the failure rate of those which are rated. The unrated issues are excluded from the entire rating system, and from the percentages shown in the Table.

As can be noted from the Table, the results are quite different depending upon whether one considers the ratings for public utilities, industrials, and transportation companies combined, or only the ratings for industrials (and public utilities, though they are not shown). One important reason why bond ratings, taken as a whole, did not perform

TABLE VII-3

PERFORMANCE OF AGENCY RATINGS (1900-1943)

Agency Rating	Percentage of Defaulting Firms With Rating (M_P) 1/	Percentage of Nondefaulting Firms With Rating (A_{NB}) 1/	Effectiveness in Predicting Defaults Per 10,000 Firms (E) Assuming	
			Baseline Failure Rate (F) = 22/10,000 2/	Baseline Failure Rate = 11/10,000 3/
A. All Corporate Bonds Rated (Industrials, public utilities, railroads)				
I	6.6	19	7.6	3.8
II or above	17.1	46	8.5	4.3
III or above	44.3	74	13.0	6.5
IV or above 4/	72.5	94	16.8	8.3
B. Industrials Only				
I	0	13	0	0
II or above	5	33	3.3	1.7
III or above	28	66	9.5	4.7
IV or above 3/	73	93	17.3	8.6

1/ For this Table, it is assumed that the accuracy of predicting defaults on bonds is equivalent to the accuracy in identifying defaulting firms.

2/ Calculated as: $\frac{F(1-(1/100 \times \text{Column } 1))}{1/100 \times \text{Column } 2}$ = Effectiveness for Bond Rating

3/ Calculated as 1/2 of Column 3 .

4/ Agency ratings of IV or above represent investment grade bonds.

better during this period is that transportation company bonds, specifically those of railroads, were overrated and suffered very high failure rates, even for firms in the highest rating categories.

The column of Table VII-3 labeled "Percentage of Non-Defaulting Bonds With Rating" shows the proportion of non-defaulting bonds by dollar value included in each set of rating categories. The investment grade ratings I-IV include the vast majority of all rated bonds. They include 94 percent of all rated corporate bonds and 93 percent of all rated industrial bonds. Thus, about 6 percent of corporate bonds and 7 percent of industrial bonds are eliminated by insisting on a rating of investment grade or better. This means that over 94 percent of the dollar value of all corporate bonds rated were rated as investment grade or above.

The top two classes of investment grade ratings are much more restrictive. For all bonds, only 46 percent had one of the top two ratings, and only 19 percent had the top rating. The Agency therefore concluded that the top two bond ratings are roughly equivalent to the effectiveness of a relatively stringent financial test, assuming that the baseline failure rate is approximately 11 per 10,000 for the firms likely to use the test rather than 22 per 10,000. A rating of IV or above, in contrast, is about equivalent to the effectiveness of a less stringent test.

The Agency also performed a special study to determine the effectiveness of bond ratings as a means of financial responsibility for utilities in particular. A sample of 113 utilities was drawn from

Moody's Public Utilities Manual. All were large (greater than $10 million in net worth), and were either electric or gas utilities. The mix of bond ratings for these firms was as follows:

TABLE VII-4

UTILITY BOND RATINGS

RATING	NUMBER OF UTILITIES	PERCENTAGE OF TOTAL	PERCENTAGE OF RATED UTILITIES
Aaa	4	3.5	3.9
Aa	22	19.4	21.7
A	50	44.2	49.6
Baa	25	22.1	24.8
Unrated	12	10.7	--
	113	100.0	100.0

As can be seen, requiring that firms have Aaa or Aa ratings to pass the test would allow only 23-26 percent of utilities to pass this test. If utilities with A ratings are included, 67-75 percent of utilities would be able to pass, and a requirement that a firm have an investment grade bond rating would allow about 89 percent or more to pass the test. However, because the sample obtained did not contain any utilities with a rating lower than investment grade, the Agency could not determine the precise effect of requiring an investment grade rating.

VIII. RESULTS FOR ALL RATIO TESTS

This Section presents the Tables showing the performance of all of the ratio tests with respect to the evaluation criteria described in Section IV.A for the primary sample. Tables VIII-1 through VIII-4 give results for tests with a one-year eligibility requirement and Tables VIII-5 through VIII-8 give results for tests with a three-year eligibility requirement.

TABLE VIII-1

PERFORMANCE OF TWO-RATIO TESTS

(One-Year Eligibility Requirement)
(Tests 1-56)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
1	CF/TL > .2 TL/NW < 1.0	4.7	11.9	38	91.7*	26.1	4.8*
2	CF/TL > .2 TL/NW < 1.2	4.7	14.2	41	90.5*	26.8	5.1*
3	CF/TL > .2 TL/NW < 1.5	9.5	16.6	41	87.0	24.4	7.0
4	CF/TL > .2 TL/NW < 2.0	9.5	16.6	41	87.0	24.4	7.0
5	CF/TL > .15 TL/NW < 1.0	4.7	14.2	52	90.5*	37.8	4.0*
6	CF/TL > .15 TL/NW < 1.2	4.7	16.6	59	89.3	42.4	4.0*
7	CF/TL > .15 TL/NW < 1.5	9.5	19.0	62	85.8	43.0	5.1*
8	CF/TL > .15 TL/NW < 2.0	7.1	21.4	63	85.7	41.6	5.0*
9	CF/TL > .1 TL/NW < 1.0	4.7	16.6	58	89.3	41.4	4.1*
10	CF/TL > .1 TL/NW < 1.2	4.7	21.4	71	87.0	49.6*	4.1*
11	CF/TL > .1 TL/NW < 1.5	11.9	30.9	77	78.6	46.1	6.1
12	CF/TL > .1 TL/NW < 2.0	11.9	38.0	81	75.0	43.0	6.8
13	NI/TA > .04 TL/NW < 1.0	4.7	14.2	54	90.5*	39.8	3.9*
14	NI/TA > .04 TL/NW < 1.2	4.7	19.0	64	88.1	45.0	4.1*
15	NI/TA > .04 TL/NW < 1.5	11.9	26.1	66	81.0	39.9	6.3

TABLE VIII-1 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
16	NI/TA > .04 TL/NW < 2.0	11.9	35.7	72	76.2	36.3	7.3
17	NI/TA > .02 TL/NW < 1.0	4.7	16.6	58	89.3	41.4	4.1*
18	NI/TA > .02 TL/NW < 1.2	4.7	21.4	71	87.0	49.6*	4.1*
19	NI/TA > .02 TL/NW < 1.5	11.9	33.3	77	77.4	43.7	6.5
20	NI/TA > .02 TL/NW < 2.0	11.9	42.8	82	72.6	39.2	7.4
21	CF/TL > .2 CURRAT > 2.0	4.7	9.5	35	92.9*	25.5	4.5*
22	CF/TL > .15 CURRAT > 2.0	4.7	14.2	54	90.5*	39.8	3.9*
23	CF/TL > .1 CURRAT > 2.0	4.7	19.0	63	88.1	44.0	4.2*
24	CF/TL > .2 CURRAT > 1.5	4.7	9.5	41	92.9*	31.5	3.8*
25	CF/TL > .15 CURRAT > 1.5	7.1	19.0	62	87.0	43.0	4.6*
26	CF/TL > .1 CURRAT > 1.5	11.9	33.3	81	77.4	47.7*	6.1
27	CF/TL > .2 QRAT > 1.2	4.7	9.5	28	92.9*	18.5	5.6*
28	CF/TL > .15 QRAT > 1.2	4.7	11.9	42	91.7*	30.1	4.3*
29	CF/TL > .1 QRAT > 1.2	4.7	16.6	50	89.4	33.4	4.7*
30	CF/TL > .2 QRAT > 1.0	4.7	9.5	44	92.9*	34.5	3.6*
31	CF/TL > .15 QRAT > 1.0	4.7	14.2	55	90.5*	40.8	3.8*

TABLE VIII-1 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
32	CF/TL > .1 QRAT > 1.0	7.1	26.1	66	83.4	39.9	5.6*
33	TL/NW < 1.0 CURRAT > 2.0	7.1	16.6	54	88.1	37.4	4.8*
34	TL/NW < 1.2 CURRAT > 2.0	11.9	23.8	65	82.2	41.2	6.0
35	TL/NW < 1.5 CURRAT > 2.0	16.6	30.9	69	76.2	38.1	7.6
36	TL/NW < 2.0 CURRAT > 2.0	16.6	35.7	72	73.9	36.3	8.0
37	TL/NW < 1.0 CURRAT > 1.5	4.7	21.4	62	87.0	40.6	4.6*
38	TL/NW < 1.2 CURRAT > 1.5	9.5	28.5	76	81.0	47.5*	5.5*
39	TL/NW < 1.5 CURRAT > 1.5	19.0	45.2	84	67.9	38.8	8.4
40	TL/NW < 2.0 CURRAT > 1.5	23.8	57.1	91	59.6	33.9	9.8
41	TL/NW < 1.0 QRAT > 1.2	7.1	11.9	42	90.5*	30.1	5.0*
42	TL/NW < 1.2 QRAT > 1.2	7.1	19.0	49	86.9	30.0	5.9
43	TL/NW < 1.5 QRAT > 1.2	9.5	23.8	51	83.4	27.2	7.2
44	TL/NW < 2.0 QRAT > 1.2	9.5	26.1	54	82.2	27.9	7.3
45	TL/NW < 1.0 QRAT > 1.0	7.1	11.9	52	90.5*	40.1	4.0*
46	TL/NW < 1.2 QRAT > 1.0	9.5	19.0	63	85.8	44.0	5.0*
47	TL/NW < 1.5 QRAT > 1.0	14.2	26.1	68	79.8	41.9	6.5

TABLE VIII-1 (Concluded)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
48	TL/NW < 2.0 QRAT > 1.0	14.2	33.3	74	76.2	40.7	7.1
49	NI/TA > .04 CURRAT > 2.0	4.7	19.0	57	88.1	38.0	4.6*
50	NI/TA > .04 CURRAT > 1.5	9.5	30.9	73	79.8	42.1	6.1
51	NI/TA > .02 CURRAT > 2.0	4.7	26.1	64	84.6	37.9	5.3*
52	NI/TA > .02 CURRAT > 1.5	9.5	45.2	83	72.7	37.8	7.2
53	NI/TA > .04 QRAT > 1.2	4.7	14.2	46	90.5*	31.8	4.5*
54	NI/TA > .02 QRAT > 1.2	7.1	23.8	49	84.6	25.2	6.9
55	NI/TA > .04 QRAT > 1.0	4.7	19.0	62	88.1	43.0	4.2*
56	NI/TA > .02 QRAT > 1.0	7.1	30.9	67	81.0	36.1	6.2

*Exceeds performance of best single ratio tests.

TABLE VIII-2

PERFORMANCE OF THREE-RATIO TESTS: PASS ALL TO PASS

(One-Year Eligibility Requirement)
(Tests 57-88)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
57	CF/TL > .2 TL/NW < 1.0 CURRAT > 2.0	4.7	7.1	33	94.1*	25.9	3.9*
58	CF/TL > .15 TL/NW < 1.0 CURRAT > 2.0	4.7	9.5	46	92.9*	36.5	3.4*
59	CF/TL > .1 TL/NW < 1.0 CURRAT > 2.0	4.7	9.5	50	92.9*	40.5	3.1*
60	CF/TL > .2 TL/NW < 1.2 CURRAT > 2.0	4.7	9.5	34	92.9*	24.5	4.6*
61	CF/TL > .2 TL/NW < 1.5 CURRAT > 2.0	4.7	9.5	34	92.9*	24.5	4.6*
62	CF/TL > .15 TL/NW < 1.2 CURRAT > 2.0	4.7	11.9	51	91.7*	39.1	3.6*
63	CF/TL > .15 TL/NW < 1.5 CURRAT > 2.0	4.7	14.2	52	90.5*	37.8	4.0*
64	CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	4.7	11.9	59	91.7*	47.1*	3.1*
65	CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	4.7	14.2	62	90.5*	47.8*	3.4*
66	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	4.7	19.0	62	88.1	43.0	4.2*
67	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	7.1	23.8	76	84.6	52.2	4.5*

TABLE VIII-2 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
68	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	7.1	33.3	80	79.8	46.7*	5.6*
69	CF/TL > .2 TL/NW < 1.0 QRAT > 1.2	4.7	7.1	27	94.1*	19.9	4.8*
70	CF/TL > .15 TL/NW < 1.0 QRAT > 1.2	4.7	9.5	36	92.9*	26.5	4.3*
71	CF/TL > .1 TL/NW < 1.0 QRAT > 1.2	4.7	9.5	38	92.9*	28.5	4.1*
72	CF/TL > .2 TL/NW < 1.2 QRAT > 1.2	4.7	9.5	28	92.9*	18.5	5.6*
73	CF/TL > .2 TL/NW < 1.5 QRAT > 1.2	4.7	9.5	28	92.9*	18.5	5.6*
74	CF/TL > .15 TL/NW < 1.2 QRAT > 1.2	4.7	11.9	41	91.7*	29.1	4.5*
75	CF/TL > .15 TL/NW < 1.5 QRAT > 1.2	4.7	11.9	41	91.7*	29.1	4.5*
76	CF/TL > .1 TL/NW < 1.2 QRAT > 1.2	4.7	14.2	45	90.5*	30.8	4.6*
77	CF/TL > .1 TL/NW < 1.5 QRAT > 1.2	4.7	14.2	46	90.5*	31.8	4.5*
78	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	4.7	16.6	47	89.3	30.4	5.0*
79	CF/TL > .2 TL/NW < 1.0 QRAT > 1.0	4.7	7.1	34	94.1*	26.9	3.8*

TABLE VIII-2 (Concluded)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
80	CF/TL > .15 TL/NW < 1.0 QRAT > 1.0	4.7	9.5	46	92.9*	36.5	3.4*
81	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	4.7	9.5	49	92.9*	39.5	3.2*
82	CF/TL > .2 TL/NW < 1.2 QRAT > 1.0	4.7	9.5	36	92.9*	26.5	4.3*
83	CF/TL > .2 TL/NW < 1.5 QRAT > 1.0	4.7	9.5	36	92.9*	26.5	4.3*
84	CF/TL > .15 TL/NW < 1.2 QRAT > 1.0	4.7	11.9	52	91.7*	40.1	3.5*
85	CF/TL > .15 TL/NW < 1.5 QRAT > 1.0	4.7	11.9	54	91.7*	42.1	3.4*
86	CF/TL > .1 TL/NW < 1.2 QRAT > 1.0	4.7	14.2	59	90.5*	44.8	5.3*
87	CF/TL > .1 TL/NW < 1.5 QRAT > 1.0	4.7	16.6	62	89.3	45.4	3.8*
88	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	4.7	23.8	64	85.8	40.2	4.9*

*Exceeds performance of best single ratio tests.

TABLE VIII-3

PERFORMANCE OF THREE-RATIO TESTS: PASS 2 OF 3 TO PASS

(One-Year Eligibility Requirement)
(Tests 89-120)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
89	CF/TL > .2 TL/NW < 1.0 CURRAT > 2.0	7.1	21.4	62	85.8	40.6	5.0*
90	CF/TL > .15 TL/NW < 1.0 CURRAT > 2.0	7.1	26.2	70	83.3	43.8	5.2*
91	CF/TL > .1 TL/NW < 1.0 CURRAT > 2.0	7.1	33.3	76	79.8	42.7	5.8*
92	CF/TL > .2 TL/NW < 1.2 CURRAT > 2.0	11.9	26.2	72	81.0	45.8	5.8*
93	CF/TL > .2 TL/NW < 1.5 CURRAT > 2.0	23.8	35.7	77	70.3	41.3	8.5
94	CF/TL > .15 TL/NW < 1.2 CURRAT > 2.0	11.9	30.9	74	78.6	43.1	6.4
95	CF/TL > .15 TL/NW < 1.5 CURRAT > 2.0	11.9	35.7	78	76.2	42.3	6.7
96	CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	23.8	38.0	80	69.1	42.0	8.5
97	CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	26.1	50.0	86	62.0	36.0	9.7
98	CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	26.1	52.3	93	60.8	40.7	9.3
99	CF/TL > .1 TL/NW < 1.5 CURRAT > 1.5	23.8	59.5	91	58.4	31.5	10.1

TABLE VIII-3 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
100	CF/TL > .1 TL/NW < 2.0 CURRAT > 1.5	28.5	59.5	96	56.0	36.5	10.1
101	CF/TL > .2 TL/NW < 1.0 QRAT > 1.2	7.1	16.6	54	88.1	37.4	4.8*
102	CF/TL > .15 TL/NW < 1.0 QRAT > 1.2	7.1	19.0	59	87.0	40.0	4.8*
103	CF/TL > .1 TL/NW < 1.0 QRAT > 1.2	7.1	26.1	62	83.4	35.9	5.9
104	CF/TL > .2 TL/NW < 1.2 QRAT > 1.2	7.1	21.4	64	85.8	42.6	4.9*
105	CF/TL > .2 TL/NW < 1.5 QRAT > 1.2	14.2	28.5	70	78.6	41.5	6.7
106	CF/TL > .15 TL/NW < 1.2 QRAT > 1.2	7.1	23.8	69	84.6	45.2	4.9*
107	CF/TL > .15 TL/NW < 1.5 QRAT > 1.2	14.2	30.9	72	77.4	41.1	6.9
108	CF/TL > .1 TL/NW < 1.2 QRAT > 1.2	7.1	28.5	77	82.2	48.5*	5.1*
109	CF/TL > .1 TL/NW < 1.5 QRAT > 1.2	19.0	42.8	82	69.1	39.2	8.3
110	CF/TL > .1 TL/NW < 2.0 QRAT > 1.2	19.0	47.6	87	66.7	39.4	8.4
111	CF/TL > .2 TL/NW < 1.0 QRAT > 1.0	7.1	16.6	59	88.1	42.4	4.4

TABLE VIII-3 (Concluded)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
112	CF/TL > .15 TL/NW < 1.0 QRAT > 1.0	7.1	21.4	67	85.8	45.6	4.7*
113	CF/TL > .1 TL/NW < 1.0 QRAT > 1.0	7.1	30.9	80	81.0	49.1	5.2*
114	CF/TL > .2 TL/NW < 1.2 QRAT > 1.0	9.5	21.4	68	84.6	46.6*	4.9*
115	CF/TL > .2 TL/NW < 1.5 QRAT > 1.0	19.0	30.9	74	75.0	43.1	7.4
116	CF/TL > .15 TL/NW < 1.2 QRAT > 1.0	9.5	26.1	75	82.2	48.9*	5.2*
117	CF/TL > .15 TL/NW < 1.5 QRAT > 1.0	19.0	35.7	79	72.7	43.3	7.6
118	CF/TL > .1 TL/NW < 1.2 QRAT > 1.0	11.9	38.0	83	75.0	45.0	6.6
119	CF/TL > .1 TL/NW < 1.5 QRAT > 1.0	26.1	50.0	88	62.0	38.0	9.5
120	CF/TL > .1 TL/NW < 2.0 QRAT > 1.0	26.1	50.0	92	62.0	42.0	9.1

*Exceeds performance of best single ratio tests.

TEST VIII-4

PERFORMANCE OF MULTI-RATIO FINANCIAL TESTS
INCLUDING NET FIXED ASSETS/TOTAL ASSETS

(One-Year Eligibility Requirement)
(Tests 121-151)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
	Pass All:						
121	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	2.3	4.7	43	96.5*	38.3	1.7*
122	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	2.3	4.7	53	96.5*	48.3*	1.4*
123	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	4.7	11.9	55	91.7*	43.1	3.3*
124	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	4.7	11.9	59	91.7*	47.1*	3.1*
125	NFA/TA > .25 CF/TL > .1 TL/NW < 1.5	4.7	11.9	62	91.7*	50.1*	2.9*
126	NFA/TA > .25 CF/TL > .1 TL/NW < 2.0	7.1	14.2	66	89.3	51.8*	3.6*
127	NFA/TA > .2 CF/TL > .1 TL/NW < 2.0	9.5	16.6	75	87.0	58.4*	3.8*
	Pass 2 of 3:						
128	NFA/TA > .3 CF/TL > .2 TL/NW < 1.0	7.1	11.9	62	90.5*	50.1*	3.3*
129	NFA/TA > .3 CF/TL > .2 TL/NW < 1.2	9.5	16.6	70	87.0	53.4*	4.0*
130	NFA/TA > .3 CF/TL > .2 TL/NW < 1.5	19.0	28.6	73	76.2	44.4	7.1

TABLE VIII-4 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
131	NFA/TA > .3 CF/TL > .15 TL/NW < 1.0	7.1	14.2	71	89.3	56.8*	3.3*
132	NFA/TA > .3 CF/TL > .15 TL/NW < 1.2	9.5	19.0	76	85.8	57.0*	4.1*
133	NFA/TA > .3 CF/TL > .15 TL/NW < 1.5	19.0	30.9	80	75.0	49.1*	6.8
134	NFA/TA > .3 CF/TL > .1 TL/NW < 1.0	9.5	23.8	79	83.4	55.2*	4.6*
135	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2	11.9	30.9	83	78.6	52.1*	5.6*
136	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5	19.0	45.2	89	67.9	43.8	7.9
137	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0	21.4	54.7	92	62.0	37.3	9.1
	Pass All:						
138	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	4.7	14.2	76	90.5*	61.8*	2.8*
139	NFA/TA > .3 CF/TL > .1 CURRAT > 2.0	0	0	49	100.0*	49.0*	0*
140	NFA/TA > .3 CF/TL > .2 CURRAT > 1.5	2.3	2.3	31	97.7*	28.7	1.6*
141	NFA/TA > .2 CF/TL > .1 CURRAT > 2.0	2.3	7.1	55	95.3*	47.9*	1.9*

TABLE VIII-4 (Concluded)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
142	NFA/TA > .2 CF/TL > .2 CURRAT > 2.0	2.3	4.7	32	96.5*	27.3	2.4*
143	NFA/TA > .2 TL/NW < 1.2 QRAT > 1.0	4.7	9.5	58	92.9*	48.5*	2.6*
144	NFA/TA > .3 TL/NW < 1.0 CURRAT > 1.5	2.3	4.7	49	96.5*	44.3	1.5*
145	NFA/TA > .3 TL/NW < 1.5 CURRAT > 2.0	4.7	7.1	49	94.1*	41.9	2.6*
	Pass 2 of 3:						
146	NFA/TA > .2 CF/TL > .1 CURRAT > 1.5	21.4	64.2	95	57.2	30.8	9.9
147	NFA/TA > .3 CF/TL > .2 CURRAT > 2.0	16.6	23.8	70	79.8	46.2	6.3
148	NFA/TA > .3 CF/TL > .2 CURRAT > 1.5	21.4	30.9	80	73.9	49.1*	7.1
	Pass 3 of 4:						
149	NFA/TA > .3 CF/TL > .1 TL/NW < 2.0 CURRAT > 2.0	14.2	33.3	87	76.2	53.7*	6.0
150	NFA/TA > .3 CF/TL > .1 TL/NW < 1.5 CURRAT > 2.0	11.9	28.5	81	79.8	52.5*	5.5*
151	NFA/TA > .3 CF/TL > .1 TL/NW < 1.2 CURRAT > 2.0	7.1	19.0	77	87.0	58.0*	3.7*

*Exceeds performance of best single ratio tests.

TABLE VIII-5

PERFORMANCE OF TWO-RATIO TESTS
(Three-Year Eligibility Requirement)
(Tests 1-56)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
1	CF/TL > .2 TL/NW < 1.0	2.3	9.5	31	94.1	40.5	4.2
2	CF/TL > .2 TL/NW < 1.2	2.3	11.9	34	92.9	22.1	4.6
3	CF/TL > .2 TL/NW < 1.5	4.7	11.9	35	91.7	23.1	5.2
4	CF/TL > .2 TL/NW < 2.0	4.7	11.9	36	91.7	24.1	5.1
5	CF/TL > .15 TL/NW < 1.0	2.3	11.9	43	92.9	31.1	3.6
6	CF/TL > .15 TL/NW < 1.2	2.3	14.2	50	91.7	35.8	3.7
7	CF/TL > .15 TL/NW < 1.5	4,7	14.2	52	90.5	37.8	4.0
8	CF/TL > .15 TL/NW < 2.0	4.7	19.0	54	88.1	35.0	4.8
9	CF/TL > .1 TL/NW < 1.0	2.3	14.2	49	91.7	34.8	3.7
10	CF/TL > .1 TL/NW < 1.2	2.3	19.0	62	89.4	43.0	3.8
11	CF/TL > .1 TL/NW < 1.5	2.3	21.4	70	88.1	48.6	3.7
12	CF/TL > .1 TL/NW < 2.0	4.7	30.9	76	82.2	45.1	5.2
13	NI/TA > .04 TL/NW < 1.0	2.3	11.9	41	92.9	29.1	3.8
14	NI/TA > .04 TL/NW < 1.2	2.3	16.6	51	90.5	34.4	4.1
15	NI/TA > .04 TL/NW < 1.5	4.7	19.0	56	88.1	37.0	4.7

TABLE VIII-5 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
16	NI/TA > .04 TL/NW < 2.0	4.7	28.5	60	83.4	31.5	6.1
17	NI/TA > .02 TL/NW < 1.0	2.3	14.2	49	91.7	34.8	3.7
18	NI/TA > .02 TL/NW < 1.2	2.3	19.0	60	89.4	41.0	3.9
19	NI/TA > .02 TL/NW < 1.5	4.7	26.1	69	84.6	42.9	4.9
20	NI/TA > .02 TL/NW < 2.0	7.1	38.0	75	77.4	37.0	6.6
21	CF/TL > .2 CURRAT > 2.0	0	4.7	25	97.7*	20.3	2.0*
22	CF/TL > .15 CURRAT > 2.0	0	9.5	37	95.3	27.5	2.8*
23	CF/TL > .1 CURRAT > 2.0	0	14.2	49	92.9	34.8	3.2*
24	CF/TL > .2 CURRAT > 1.5	2.3	7.1	34	95.3	26.9	3.0*
25	CF/TL > .15 CURRAT > 1.5	2.3	14.2	46	91.7	31.8	4.0
26	CF/TL > .1 CURRAT > 1.5	4.7	26.1	64	84.6	37.9	5.3
27	CF/TL > .2 QRAT > 1.2	0	4.7	20	97.7*	10.5	2.5*
28	CF/TL > .15 QRAT > 1.2	0	7.1	27	96.5*	15.1	2.9*
29	CF/TL > .1 QRAT > 1.2	0	11.9	30	94.1	18.1	4.3
30	CF/TL > .2 QRAT > 1.0	2.3	7.1	32	95.3	24.9	3.2*
31	CF/TL > .15 QRAT > 1.0	2.3	11.9	43	92.9	31.1	3.6

TABLE VIII-5 (Continued)

Test Number	Test Variables	M_B	M_W	A_{NB}	C	D	E_P
32	CF/TL > .1 QRAT > 1.0	4.7	23.8	52	85.8	28.2	6.1
33	TL/NW < 1.0 CURRAT > 2.0	2.3	11.9	42	92.9	30.1	3.7
34	TL/NW < 1.2 CURRAT > 2.0	7.1	19.0	50	87.0	31.0	5.8
35	TL/NW < 1.5 CURRAT > 2.0	9.5	23.8	55	83.4	31.2	6.7
36	TL/NW < 2.0 CURRAT > 2.0	11.9	30.9	56	78.6	25.1	8.4
37	TL/NW < 1.0 CURRAT > 1.5	2.3	19.0	53	89.4	34.0	4.4
38	TL/NW < 1.2 CURRAT > 1.5	7.1	26.1	66	83.4	39.9	5.5
39	TL/NW < 1.5 CURRAT > 1.5	9.5	35.7	76	77.4	40.3	6.6
40	TL/NW < 2.0 CURRAT > 1.5	16.6	50.0	80	66.7	30.0	9.2
41	TL/NW < 1.0 QRAT > 1.2	2.3	7.1	26	95.3	18.9	4.0
42	TL/NW < 1.2 QRAT > 1.2	2.3	14.2	30	91.7	15.8	6.1
43	TL/NW < 1.5 QRAT > 1.2	4.7	19.0	33	88.1	14.0	7.9
44	TL/NW < 2.0 QRAT > 1.2	4.7	21.4	33	86.9	11.6	8.7
45	TL/NW < 1.0 QRAT > 1.0	4.7	9.5	46	92.9	36.5	3.4
46	TL/NW < 1.2 QRAT > 1.0	7.1	16.6	50	88.1	33.4	5.2
47	TL/NW < 1.5 QRAT > 1.0	11.9	23.8	54	82.2	30.2	7.3