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Inspections, Violations, and Penalties U.S. Commercial Nuclear Power Plants

By:

Susan B. Long, Suzanne Maurer, and David Burnham

Executive Editor: Miranda Maroney

February 1992

Introductory Volume

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PREFACE

This *Introductory Volume* is part of a sequence of publications and associated data sets on the enforcement activities of the Nuclear Regulatory Commission. The series, on NRC's regulation of commercial nuclear power plants, has three parts: (a) an *Introductory Volume*, (b) four *Research Volumes*, and (c) a *User's Guide* with accompanying computerized data bases developed by *TRAC*. Specific support provided for this project by the Deer Creek Foundation and the Alida Rockefeller Charitable Lead Trust No. 2 is gratefully acknowledged. Additional general support for *TRAC* activities has been received from the Rockefeller Family Fund, the Millstream Fund, the National Press Foundation, the New York Times Company Foundation, the Matz Foundation, the J. Roderick MacArthur Foundation, the Bauman Family Foundation, the Philip M. Stern Family Fund, and the Fund for Constitutional Government.

The *Introductory Volume* describes the information that has been obtained by *TRAC*, presents highlights drawn from the *TRAC* data bases on the Nuclear Regulatory Commission's enforcement activities, and discusses why nuclear power reactors and their regulation are important to the American people. The *Introductory Volume* is illuminated by 28 graphs which summarize key features and trends in NRC formal enforcement activities -- inspecting the reactors, citing the utilities operating the reactors for violations, and imposing penalties. Tables, listing each of the 130 commercial nuclear power plants, provide information on the dates of construction, operation, and (where applicable) shutdown, state location, operating utility, generating capacity, and reactor type. Maps of the five NRC regions, identifying the location of each of these nuclear reactors are also included.

Four accompanying *Research Volumes* present detailed information in tabular form on NRC enforcement activities since the agency's inception in 1975. Separate series are included allowing a user to examine these activities across time, among NRC regions, by individual nuclear power plant or by its operating utility, by state, and according to phase in a reactor's lifespan (pre-construction, construction, operation, shutdown). Additional table series rank selected information about both the NRC and the nuclear power industry by activity, performance, and outcome.

The *User's Guide to NRC's Inspection Data Base* describes data sets developed by *TRAC* to facilitate public analysis of the regulation of commercial reactors. These *TRAC* data bases are available in a number of different forms, including a variety of easy-to-use formats suitable for use with personal computers. Included in this series is a separate data set containing NRC inspection information for each of the 130 commercial nuclear power plants.

The data bases created by *TRAC* provide a massive and unified source of information about nuclear power plants and the NRC's effort to regulate them. These files along with the accompanying printed volumes permit a whole new range of analyses, allowing the user to correlate the various characteristics of reactors -- such as their age, capacity, manufacturer, type operating utility, etc. -- with their inspection, violation, and penalty records.

TABLE OF CONTENTS
Introductory Volume

List of Figures

List of Figures (con't)

OVERVIEW

Commercial nuclear reactors today generate about one fifth of the electricity that lights America's homes and powers America's factories. In some states nuclear power currently supplies more than half of the electrical needs.[1] While the size of this contribution makes nuclear power an important element in the nation's life today, economic, environmental, and other forces are at work that are likely to make nuclear power and its regulation even more crucial in the coming decades.

First, the increasing age of the current stock of commercial power reactors, and the absence of proposals to build new ones, mean that a sharply rising number of licensed nuclear reactors will reach the end of their planned lives as the nation passes into the 21st century. The inevitable outcome will be increased pressure to replace the old reactors with new ones, or to extend the operating lives of current ones.

Second, growing concern over the environmental consequences of fossil fuels, combined with previously unrecognized questions about the deleterious effects of hydroelectric power, are likely to force renewed consideration of alternative energy sources. At present, nuclear power is a leading alternative.

Third, issues surrounding the storage and disposal of nuclear material and waste products have not been fully resolved. These issues are likely to grow as the United States contends with the added burden of dismantling nuclear plants that have completed their productive lives, and then must dispose of waste products inherent in the permanent shutdown and decommissioning process.

The proper management of nuclear power for the production of electricity -- the ability of the industry and government to build, operate and retire these massive plants in a safe and efficient manner -- is already an important issue in American life. But assuming that the United States chooses to increase its reliance on this particular source of energy in the years ahead, achieving the required high standards will become an even more difficult challenge.

From the beginning of the nuclear age, Congress has insisted that nuclear power be regulated by the federal government. This policy has been followed in part because the program to harness nuclear energy for commercial purposes grew out of the highly secretive World War II program to build nuclear weapons and, in part, because -- even in civilian form -- the technology must be handled with great care. Since 1975, this task has been the responsibility of the United States Nuclear Regulatory Commission.

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[1] Six states currently generate more than 50 percent of their electricity from nuclear sources: Vermont (76%), South Carolina (61%), Maine (60%), Illinois (59%), Connecticut (57%) and New Jersey (56%). Nuclear Regulatory Commission, Information Digest (NUREG-1350, 1991).

What follows is a report that describes the sources for, and a few highlights from, a comprehensive and highly detailed group of data bases that document all of the Nuclear Regulatory Commission's formal efforts to regulate commercial power reactors during the agency's entire life span. For the first time, these data bases provide the American people an objective and unique way to consider the basic effectiveness of the federal effort to regulate a vital segment of the American economy. It should be stressed that *TRAC*'s report has been prepared as an introduction and guide to the computerized data and the printed tables drawn from the data, and not as an analysis of what the data reveal.

The NRC's formal enforcement activities involve three major functions: (1) inspecting the reactors, (2) citing the utilities operating the reactors for violations or other departures from federal regulations, and (3) imposing penalties. These enforcement functions occur throughout the life cycle of a nuclear power plant -- beginning with the initial request for a construction permit, through construction, during commercial operation, and even after the plant is finally shut down.

Each of these aspects of the NRC's regulatory role is examined in this introductory report and the four accompanying research volumes.[2] The report and the related tables printed in the research volumes are designed as an adjunct to the far more detailed computer data bases developed by *TRAC* that encompass the broad scope of the NRC's enforcement activities involving commercial nuclear power plants in the United States. The purpose of the extensive data bases is to facilitate public analysis of the regulation of commercial reactors. These *TRAC* data bases are available in a number of different forms, including a variety of easy-to-use formats suitable for use with personal computers.[3]

INFORMATION SOURCES AND WHAT THE REPORT COVERS AND DOES NOT COVER

Information Sources

The data that form the building blocks of this report come from a number of different computerized and non-computerized sources. The primary source was the NRC's own "766 file," a data base that records many of the enforcement activities of the agency from 1975 to August of 1989. The files within this data base record detailed information concerning each inspection, area (module) inspected, and

[2] The organization and content of these volumes is described more fully in Appendix B of this report.

[3] These data sets are described more fully in *TRAC*'s accompanying "User's Guide to NRC's Inspection Data Base."

violation found, including both quantitative and qualitative (textual) information.

Because the "766" files do not contain any information on penalties imposed for violations detected by NRC inspections, two further primary sources were used by *TRAC* in the creation of a penalty master file. One of these was the NRC's Enforcement Action Tracking System (or EATS). This computerized system records the civil penalties that were logged against the owners of power and non-power reactors, fuel facilities and nuclear material licensees between 1971 and 1991.[4]

Another internal NRC data compilation provided additional penalty details not covered by EATS. This was only available from NRC on paper. It thus had to be computerized by *TRAC's* staff and then painstakingly merged with the EATS penalty file. These data not only supplemented the EATS information, but provided a further cross-check on key data items.

Finally, a master file bringing together all kinds of detailed information about the age, manufacturer, operating utility, location, etc., of the 130 commercial nuclear reactors was assembled by *TRAC* from printed NRC reports, earlier reports of the Atomic Energy Commission (the precursor of the NRC), and data gathered during interviews of NRC staff members and others from the nuclear industry. These items were compiled into an additional computer data base by *TRAC* personnel, and then associated with the inspection and penalty files for this analysis.[5]

The data bases created by *TRAC* will provide a massive and unified source of information about nuclear power plants and the NRC's effort to regulate them. These files will permit a whole new range of analyses since it will allow the user to correlate the various characteristics of reactors -- such as their age, capacity, manufacturer, type, operating utility, etc. -- with their inspection, violation, and penalty records.

There are two explanations why the *TRAC* data bases are such an important new research tool. First, the anomalies and trends that have emerged from the initial organization of the data have raised a host of questions which were previously invisible, simply because they were obscured in a confusing clutter of unorganized information. Second, once the new research questions have emerged from the now organized information, the *TRAC* data bases provide the American

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[4] In order to match the time frame covered by NRC inspection files, the penalties considered in this report are only those arising from violations detected during NRC inspections from 1975 to (August) 1989.

[5] A further source obtained by *TRAC* has been the NRC's "Minimaster" and related files, which include various kinds of administrative information about public and private institutions that currently are, or at one time were, licensed to possess and use nuclear material. Detailed computerized files on NRC personnel have also been obtained. These data sources are outside the scope of the current report.

people a systematic technique for attempting to answer them.

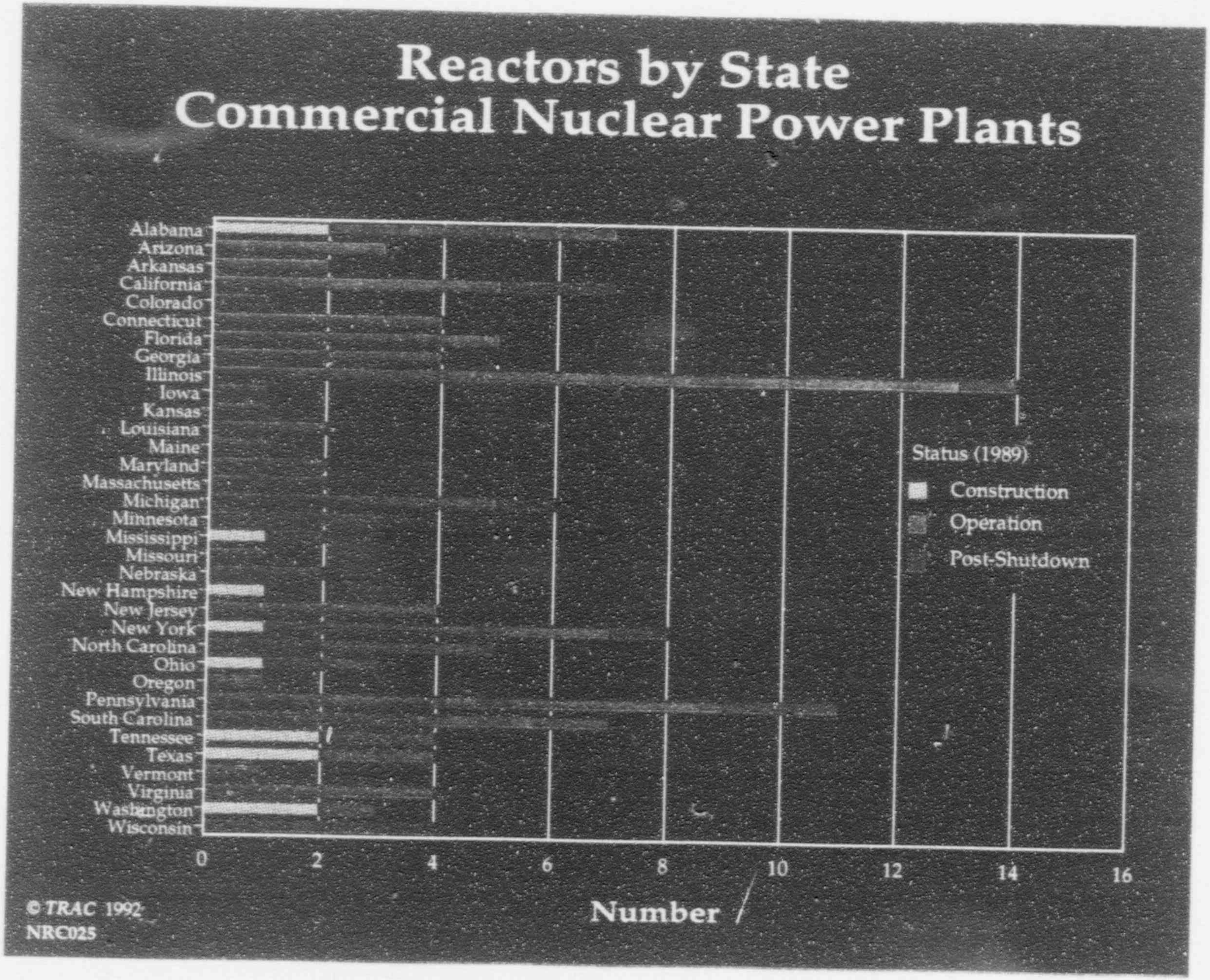
Here are a few examples. (1) Since the mid-1980's, the NRC has operated a program called the Systematic Assessment of Licensee Performance. The so-called SALP program attempts to assess the performance of each licensee constructing or operating a nuclear power plant. A systematic comparison of the SALP assessments with the total violation and penalty rates that emerge from the *TRAC* data, would provide an objective measure of the overall standards of the SALP program. (2) The NRC operates a second program in which problem reactors are placed under an intensive Watch Program. Have the reactors placed under special watch had the worst violation and penalty rates? (3) Does the *TRAC* record of NRC inspections show that the agency has consistently provided systematic follow-up to reactors with problematic records? (4) What enforcement strategies seem most effective? Has the imposition of penalties proven an effective deterrent, reducing the frequency of subsequent misconduct by operating utilities? (5) How do the patterns of enforcement by individual inspectors differ and do these differences matter? (6) Does the nature or frequency of specific types of violations point to broader inadequacies in federal law, NRC policies or regulations, or in the training and supervision of staff?

Time Period and Facilities Covered

This report and the related research volumes focus on NRC monitoring and formal enforcement actions with respect to each of the 130 commercial nuclear power plants in the United States which the NRC regulated from 1975 to August of 1989.[6] These plants are identified in Table 1 in Appendix A, along with the relevant dates for their construction, operation, and (where applicable) shut down. These plants are distributed across 34 states (see Figure 1). Nine states have 5 or more separate power reactors: Illinois (14), Pennsylvania (11), New York (8), Alabama, California, and South Carolina (each 7), Michigan (6), Florida and North Carolina (each 5). Maps showing the geographic location of each plant are also found in Appendix A.

Many of these nuclear power plants already were under construction or operating in 1975, the year the NRC assumed regulatory responsibility for them (see Figures 2 and 3). But over half of these reactors have been commissioned for commercial operation since then by the NRC itself (see Figure 4). Even today, not

[6] Here the terms "plant," "facility," and "reactor" are used interchangeably when referring to each of these 130 commercial nuclear power plants.



Reactors by State
Commercial Nuclear Power Plants
Alabama
Arizona
Arkansas
California
Colorado
Connecticut
Florida
Georgia
Illinois
Iowa
Kansas
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Nebraska
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oregon
Pennsylvania
South Carolina
Tennessee
Texas
Vermont
Virginia
Washington
Wisconsin
0
2
4
6
8
10
12
14
16
Number
Status (1989)
Construction
Operation
Post-Shutdown
© TRAC 1992
NRC025

Figure 1

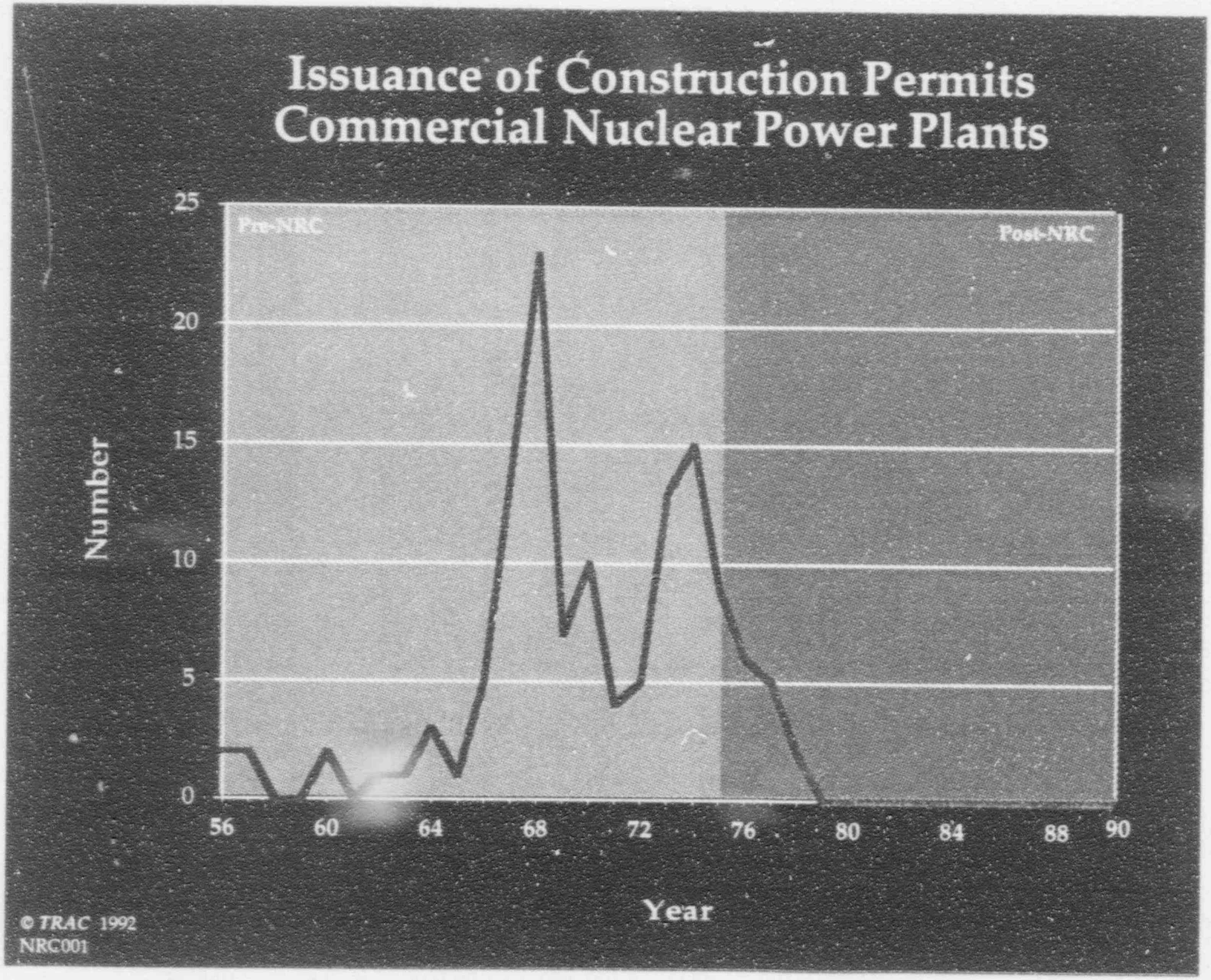

Issuance of Construction Permits
Commercial Nuclear Power Plants
Pre-NRC
Post-NRC
Number
25
20
15
10
5
0
56
60
64
68
72
76
80
84
88
90
Year
© TRAC 1992
NRC001

Figure 2

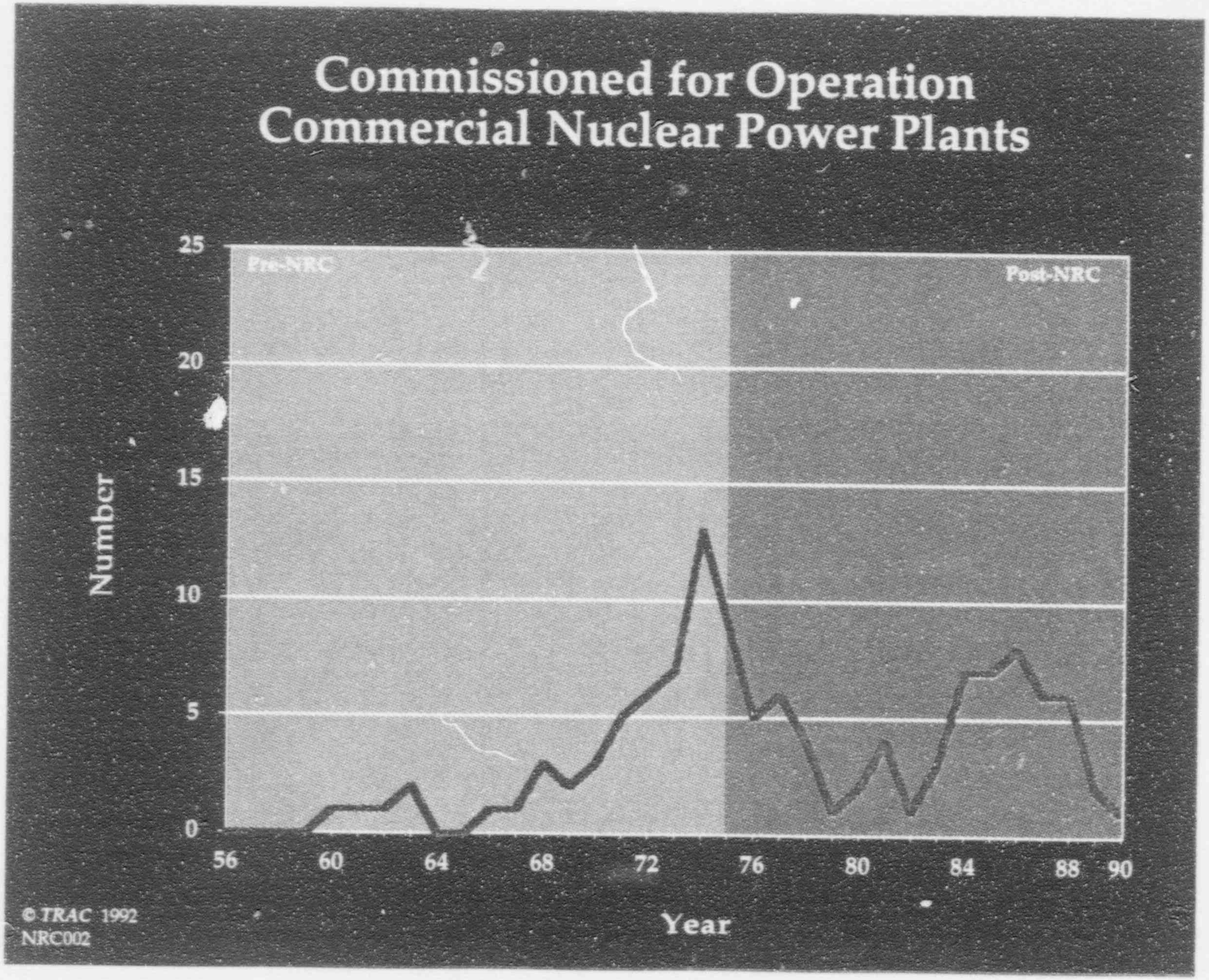

Commissioned for Operation
Commercial Nuclear Power Plants
Number
25
20
15
10
5
0
Pre-NRC
Post-NRC
56
60
64
68
72
76
80
84
88
90
Year
© TRAC 1992
NRC002

Figure 3

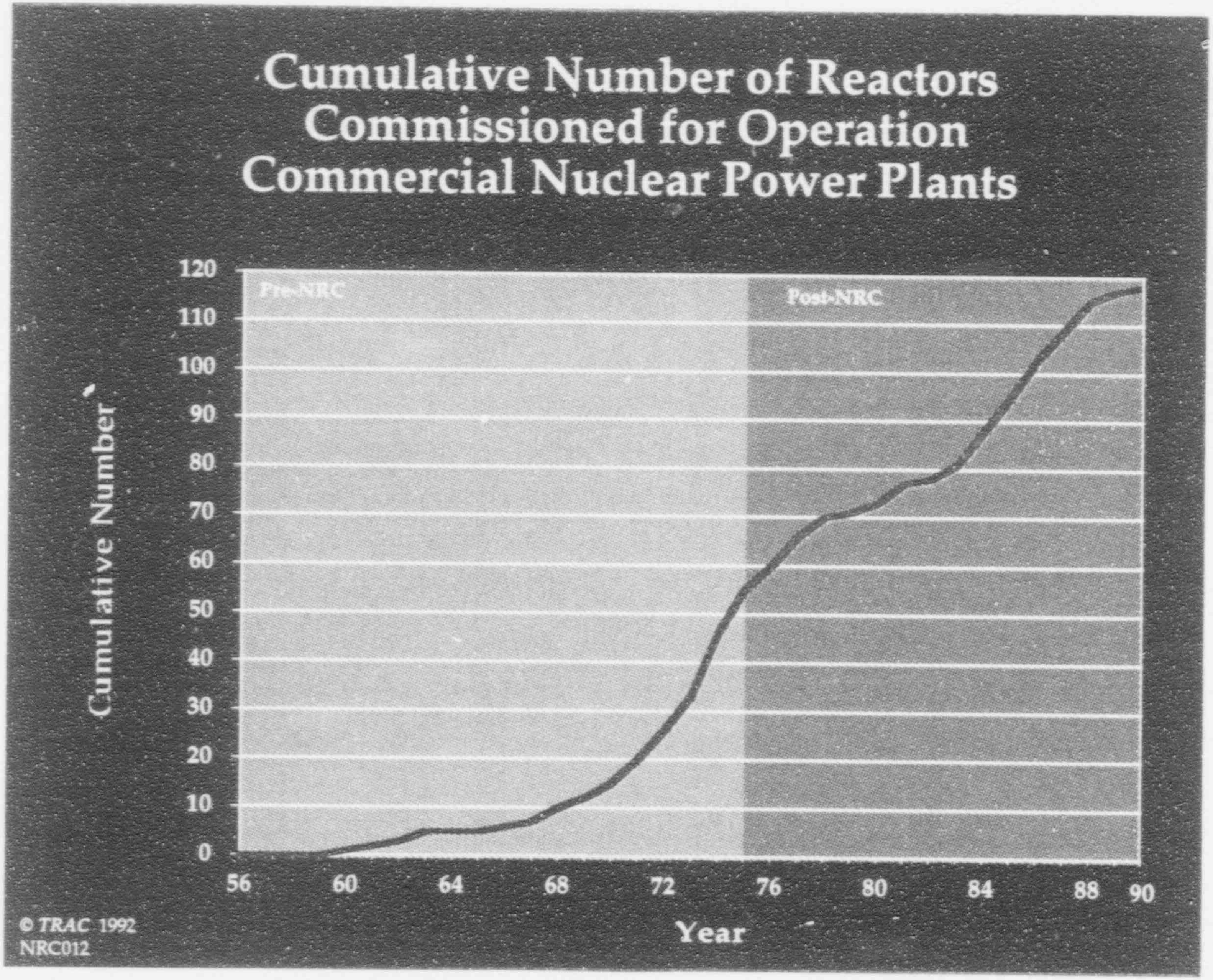

Cumulative Number of Reactors
Commissioned for Operation
Commercial Nuclear Power Plants
Cumulative Number
120
110
100
90
80
70
60
50
40
30
20
10
0
Pre-NRC
Post-NRC
56
60
64
68
72
76
80
84
88
90
Year
© TRAC 1992
NRC012

Figure 4

all of these 130 plants have been completed.[7] A few (9 as of 1989) have been permanently shut down.[8] This number is expected to expand quite rapidly after the year 2000 when the licenses of many reactors operating at the current time are scheduled to expire (see Figure 5 and Table 1).[9]

A total of 56 utilities have primary responsibility for day-to-day management of these nuclear power plants. Most of these utilities are responsible for only one, or at most two, plants (see Figure 6). Only three utility companies have more than five plants each: Commonwealth Edison with 13, the Tennessee Valley Authority with 9, and Duke Power Company with 7. (See Table 2 in Appendix A for a complete listing of operating utilities and the respective nuclear power plants they manage.)

Four different basic types of nuclear power reactors are represented. However, pressurized water reactors are the dominant design (see Figure 7 and Table 2). Electrical generating capacities range from less than 1 to over 1,200 megawatts of power (Figure 8 and Table 2). A 1,000 megawatt nuclear reactor generates enough electricity to power 10 million 100-watt light bulbs, or approximately one-quarter of a million homes.

Areas Not Covered

Several important segments of nuclear energy are not covered at all by this report and the accompanying research volumes. The NRC is responsible for regulating a large number of research and test reactors -- most located in universities, although some are found in corporations which are actively involved in the nuclear energy field (such as General Electric and Westinghouse). These are

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[7] Plants where construction has stopped, but plans for eventual completion have not been abandoned, are included since the NRC continues to be responsible for regularly inspecting each site. However, those plants for which construction permits were obtained but where these plants were later abandoned, either before or after construction began, are excluded from consideration here.

[8] There are a number of other older commercial power facilities that have long been shut down (with construction dating back to the fifties). These are not covered here since the NRC was not actively involved in their supervision. Fermi 1, located in Newport, Michigan, was shut down roughly a decade before the NRC came into existence. The NRC did assume regulatory responsibility for the plant so it is included here.

[9] The expiration of a plant's commercial operating license has not always automatically resulted in it being shut down. The NRC and earlier, the AEC, have allowed some plants to use Section 2.109 of Title 10 to continue to operate for decades after their license had technically expired. Section 2.109 provides: "If, at least thirty (30) days prior to the expiration of an existing license . . ., a licensee files an application for a renewal or for a new license . . . . , the existing license will not be deemed to have expired until the application has been finally determined." As of 1989, Dresden 2, Oyster Creek, Palisades, and San Onofre continued to operate under this provision. Since 1989, the NRC has formally extended their operating licenses into the 21st century. See also Table 1 notes. Other plants approaching the end of their originally designated lifespans have also received, or have requested, extensions to their operating licenses.

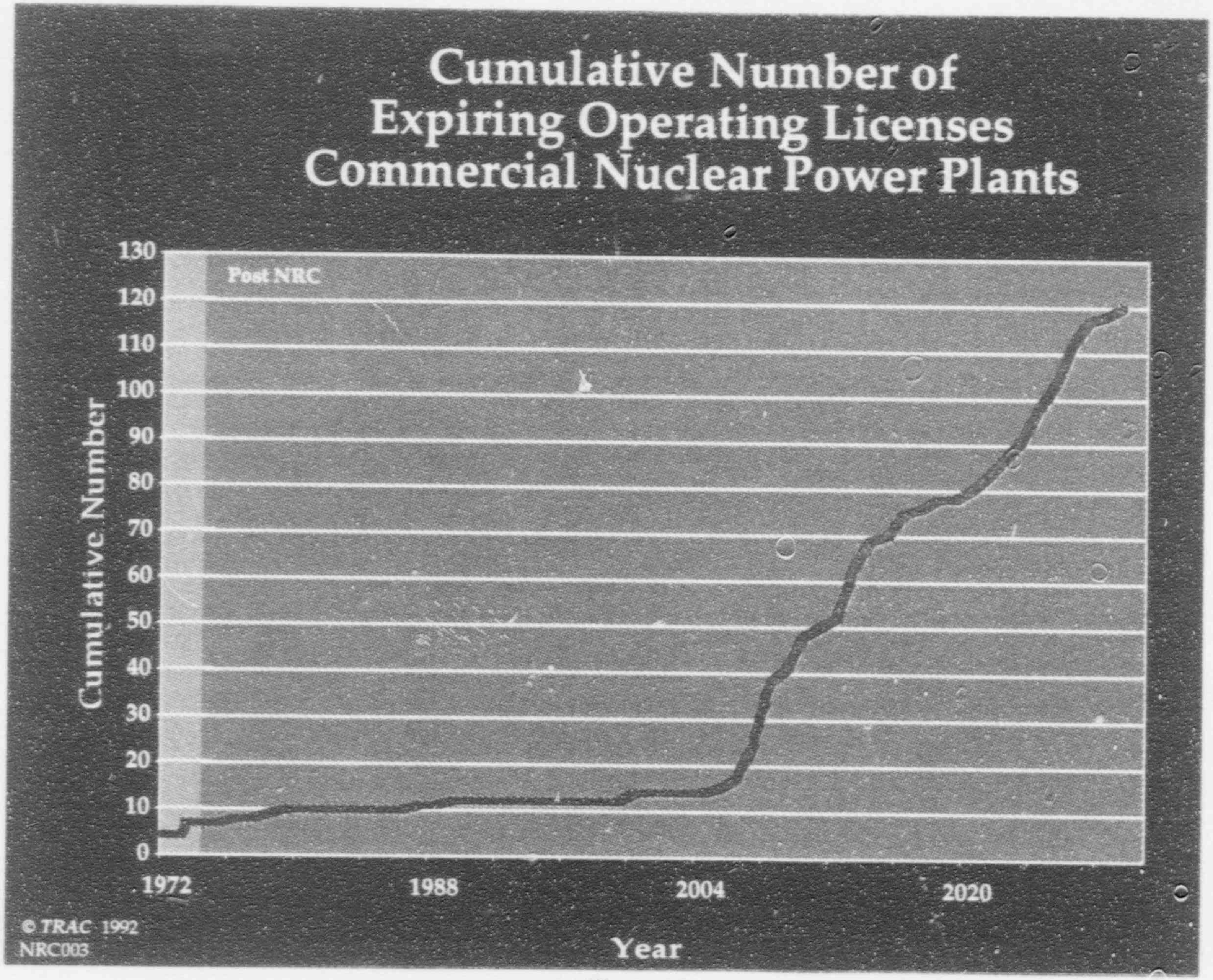

Cumulative Number of
Expiring Operating Licenses
Commercial Nuclear Power Plants
Post NRC
Cumulative Number
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1972
1988
2004
2020
Year
© TRAC 1992
NRC003

Figure 5

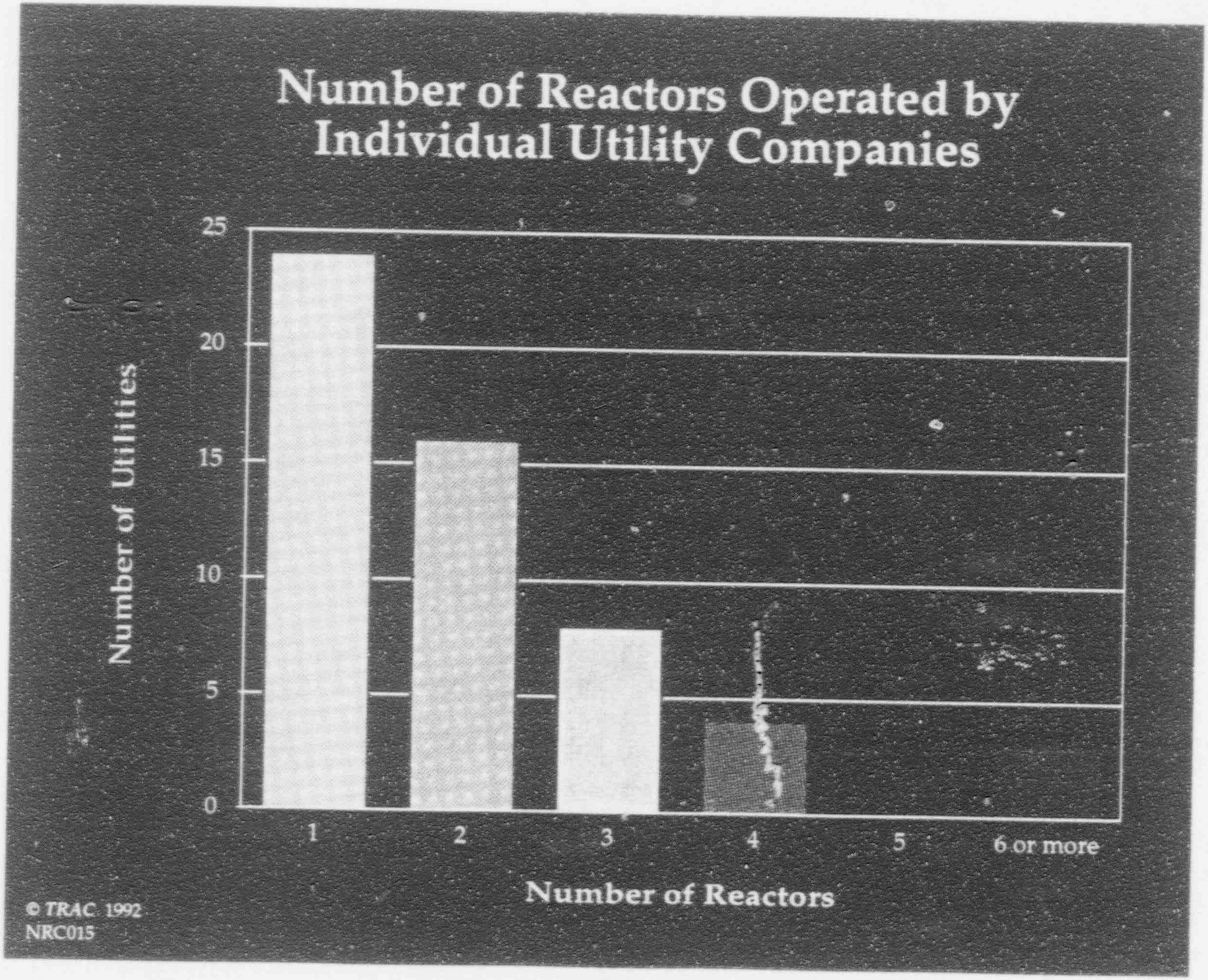

Number of Reactors Operated by
Individual Utility Companies
Number of Utilities
25
20
15
10
5
0
1
2
3
4
5
6 or more
Number of Reactors
© TRAC 1992
NRC015

Figure 6

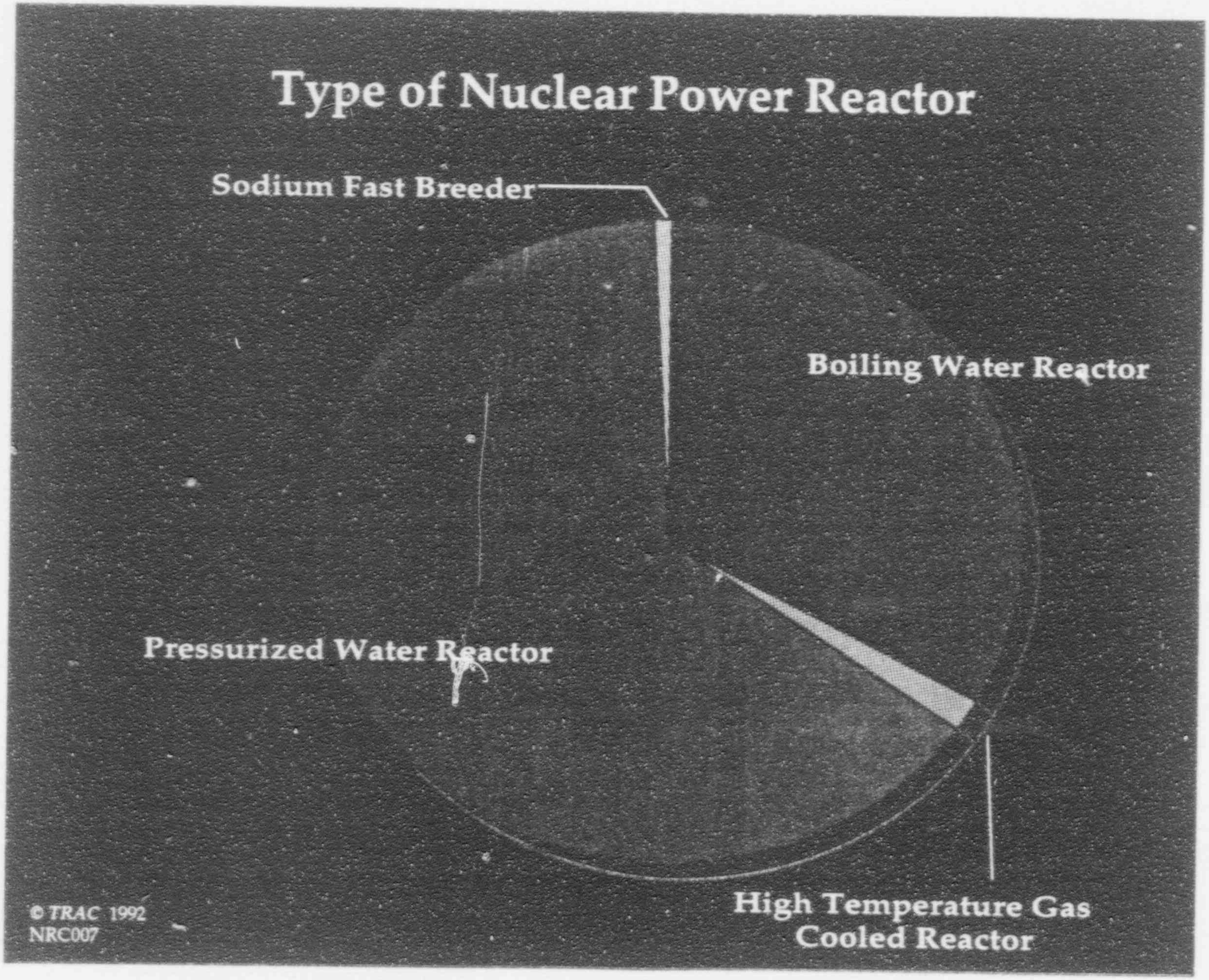
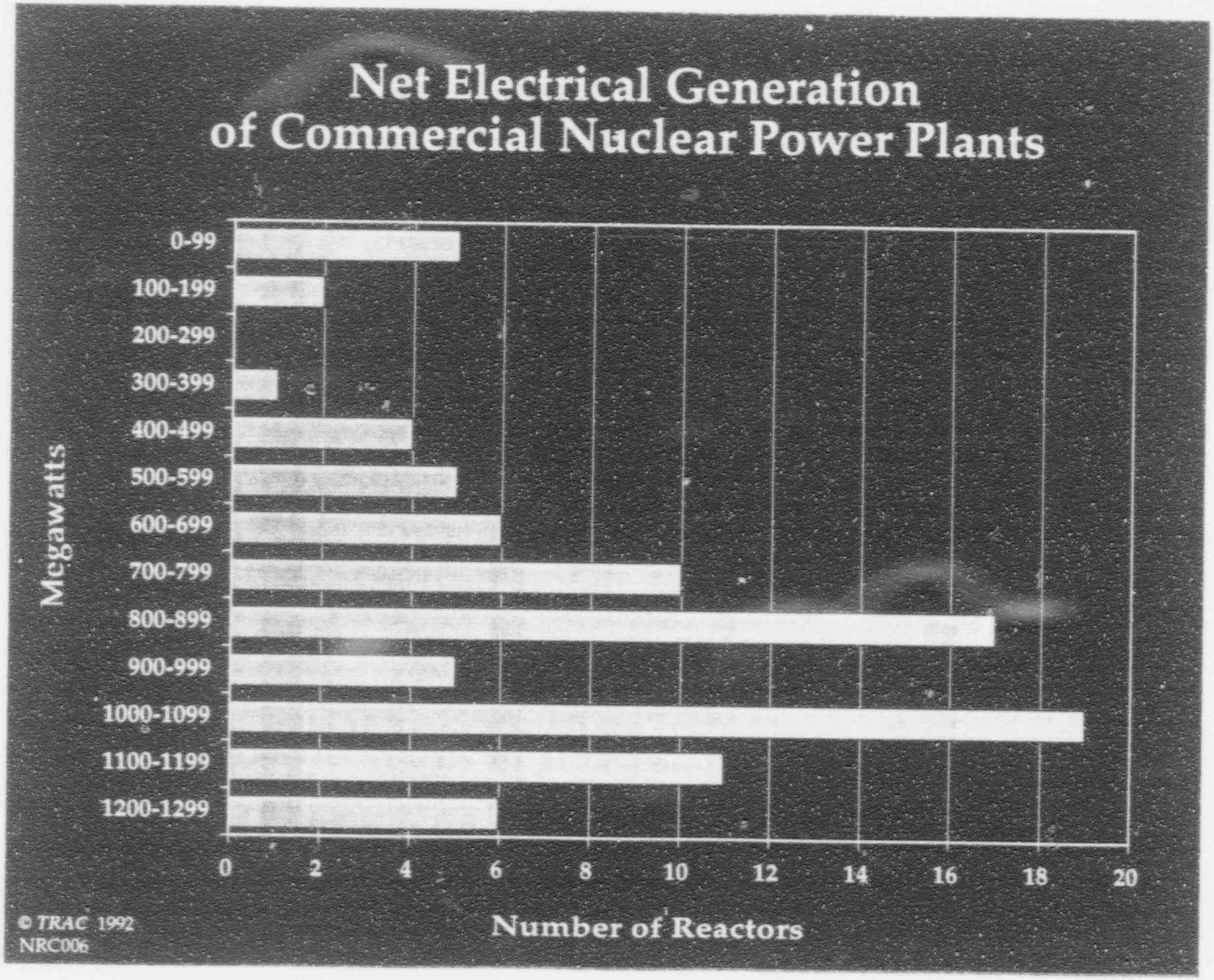

Type of Nuclear Power Reactor
Sodium Fast Breeder
Boiling Water Reactor
Pressurized Water Reactor
High Temperature Gas
Cooled Reactor
© TRAC 1992
NRC007

Figure 7


Net Electrical Generation
of Commercial Nuclear Power Plants
Megawatts
0-99
100-199
200-299
300-399
400-499
500-599
600-699
700-799
800-899
900-999
1000-1099
1100-1199
1200-1299
0
2
4
6
8
10
12
14
16
18
20
Number of Reactors
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NRC006

Figure 8

outside the scope of this report, although data on NRC inspections and enforcement actions for these plants are covered by the data bases *TRAC* has assembled. The NRC also has responsibility in many states for inspecting organizations which handle nuclear materials used in many medical and industrial applications. Neither of these areas are included here because they are not related to commercial power production. Finally, military uses of nuclear energy are not covered in this report. There are a significant number of nuclear facilities and storage sites operated by the federal government in connection with the production and maintenance of nuclear weapons. The task of monitoring these facilities is primarily the responsibility of the Department of Energy -- not the NRC -- and they are thus excluded from consideration here.

HIGHLIGHTS

Because the laws of Congress must be worded in a general way, because the operation of a reactor often involves complex and subtle technical judgments, because questions of safety are inevitably balanced against operating costs, and for a variety of other reasons, the NRC by necessity has been granted enormous discretion in how it goes about enforcing the laws and regulations of the United States relating to nuclear power.

But acknowledging that the NRC must be granted considerable day-to-day discretion no longer means that the public must remain ignorant of both the details and general trends of the Commission's performance. Despite a wealth of NRC publications, extensive files made available through the agency's public document rooms, and other information sources, the very volume of the NRC's actions has made it difficult for members of the public to examine and judge the agency's effectiveness. The gathering of the agency records into comprehensive and computerized data bases now makes such analyses possible.

The purpose of this report and the accompanying research volumes is twofold: first, to provide a comparative context, or matrix, for more detailed and focused analyses utilizing *TRAC*'s data bases on the NRC, and second, to highlight a number of important aspects and trends since 1975 in the NRC's regulation of commercial nuclear power plants. This introductory report and accompanying research volumes seek to present in a systematic and understandable way key elements in both the enforcement record of the government and the compliance record of the industry.

While computerized information collected by the government for its own administrative purposes can provide data that can be extremely useful in assessing how the government is functioning, all such data have certain limitations. In considering the NRC, for example, several specific problems have emerged. First, while the underlying NRC files are supposed to log all agency inspections, it appears that the coverage is not absolutely complete, particularly for the first year and last year included in this report.[10] In addition, because of the date when *TRAC* obtained the central data base used in this report, information about NRC operations in 1989 only covers the first seven months of that year. As a result, when reviewing long term trends, it is often prudent to place less reliance on figures for 1975 and 1989 than those for the intervening years.

Over the years, the NRC has made some changes in the information it collects and records, affecting comparability across time. One concrete example of this problem concerns how the agency classified the seriousness of violations. Because of changes in the classification system, it is not meaningful to compare violation seriousness categories from 1975 to 1980 with the different categories used from 1981 to 1989. It is for this reason that the tables presenting information about serious violations only go back to 1981.

Finally, not all violations are likely to be detected by the NRC, and the question of what is a violation or deviation -- as well as the classification of its seriousness -- involves difficult judgments by NRC personnel. Thus, violation rates reflect the behavior of NRC inspectors, not simply the behavior of the operating utilities. Indeed, these data suggest not only that there are differences in judgment among inspectors, but in the regulatory culture of different NRC regions.

Overall Features of the Regulatory Landscape

• The NRC conducted close to 50,000 separate inspections of the 130 plants during this 15 year period (Table I.1).[11] This averages out to 26 inspections annually per plant -- a little over 2 per month (Table I.4). Each inspection took 69 hours (less than two 40-hour weeks) (Table I.3).

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[10] Delays in posting information to the NRC's master inspection file make coverage less complete, particularly in the final seven months of coverage during 1989. Posting delays appear to be accentuated on those inspections where the NRC finds violations. Figures for 1975 are unusually low, as if there were delays in the initiation of this information system at the time the NRC was organized, or some initial start-up problems in implementing the inspection reporting system. These are apparent problems for the inspection, but not the penalty, files from the NRC. As a result, this affects inspection and violation -- but not penalty -- counts.

[11] Unless otherwise noted, references are to specific tables in the accompanying Research Volumes. These are referred to by Roman numeral for table series, and by number within each series. The table series are: yearly (I), regional (II), facilities (III), utilities (IV), state (V), ranking of facilities (VI), ranking of utilities (VII), and ranking by state (VIII). Thus, a reference to "Table I.1" refers to table number "1" in "Yearly Series I". A list of the tables included in the four accompanying Research Volumes is found at Appendix B to this report.

• When NRC inspectors find problems at a nuclear power plant, they are authorized to cite the operator for violating the regulations. Agency records show that the inspectors during this same period noted about 27,000 violations (Table I.6).[12] On average this amounts to more than one violation at a plant per month -- 14 violations per plant a year (Table I.9). What NRC categorized as serious violations were much rarer -- averaging about 1 per year at each plant (Table I.10).

• Penalties were even rarer. For the entire period, the NRC only proposed 629 penalties or, on average, only one every three years for the typical plant (Tables I.13 and I.18).[13] When proposed, penalties averaged a little over $50,000 each (Table I.16). While the NRC can also recommend that the Justice Department bring criminal charges in the most egregious situations, this sanction has been so rarely used that it is not considered in this report.

Variation in Enforcement by Plant Phase:
Pre-Construction, Construction, Operation and Shutdown

Inspection, violation and penalty rates varied according to the phase in a reactor's life: pre-construction, construction, operation, and shutdown.

• Both the frequency and length of NRC inspections (see Figure 9, Tables I.4 and I.5), for example, are lower during the construction phase than after the plants are licensed for commercial operation. The NRC also cites plants more frequently for violations once commercial operation has begun than during other phases of their lives.[14] This is particularly the case for violations the NRC classified as serious

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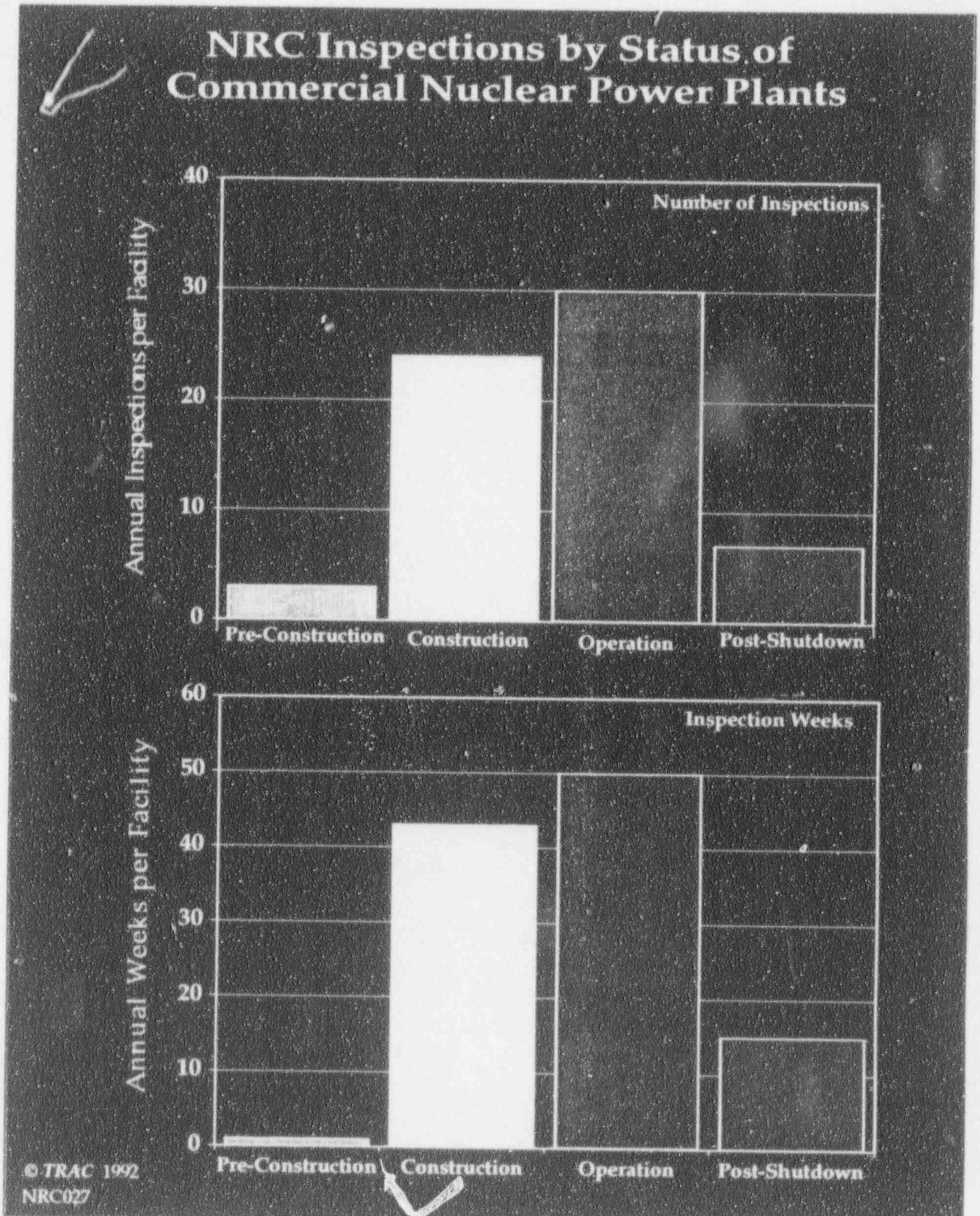
[12] NRC inspectors are authorized to cite the operating utility for deviations as well as violations, but do so only infrequently. The main difference between a deviation and a violation is that a deviation refers to a failure to "satisfy" guidelines whereas a violation refers to a failure to comply with actual requirements. NRC inspectors may also issue a non-citation in those instances when the utility identifies and voluntarily corrects a problem.

[13] For these analyses, a penalty asserted against a series of reactors operated by one utility is separately counted for each reactor affected. During this period, NRC also imposed penalties against seventeen shift supervisors and sixteen reactor operators at Philadelphia Electric's Peach Bottom facilities in southeastern Pennsylvania. The shift supervisors were fined between $500 and $1000 apiece, while the reactor operators were fined $500 each. This represented a departure from the usual practice of only penalizing the operating utility. For example, the cases of prior operator negligence at Davis Besse near Toledo, Ohio, and the Quad Cities plants did not lead to citations of the individuals. These isolated penalties at Peach Bottom against individual employees were not included in the penalty totals that are reported here. [The utility itself was also fined $1,250,000 (at Peach Bottom 2 and 3), and this fine was included in this report's figures.]

[14] Information about inactive power-producing reactors poses additional complexities in terms of record-keeping. At the present time the NRC is still developing procedures to be used in planning and implementing decommissioning of plants. A number of inactive reactors, including some that have not operated for two decades or more, have not been formally "decommissioned." The NRC's Office of Nuclear Material Safety and Safeguards (NMSS), which is responsible for the oversight of radioactive waste and uranium recovery facilities, has been given the task of regulating inactive power reactors once a decommissioning plan has been approved and the operating utility has been given a "possession-only" license. A possession-only license means that the utility may possess or


NRC Inspections by Status of
Commercial Nuclear Power Plants
Number of Inspections
Annual Inspections per Facility
40
30
20
10
0
Pre-Construction
Construction
Operation
Post-Shutdown
Inspection Weeks
Annual Weeks per Facility
60
50
40
30
20
10
0
Pre-Construction
Construction
Operation
Post-Shutdown
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NRC027

Figure 9

(See Figure 10 and Tables I.9 and I.10).

• Penalties, although extremely rare, are more likely to be proposed during the operating phase than other phases, although the average amount of the penalty appears to remain much the same regardless of when it is proposed. On average, civil penalties were proposed by the NRC each year on only one out of every 10 plants under construction -- or about two percent of their violations. In contrast, the NRC proposed penalties on one out of every two operating plants on average per year -- or roughly five percent of their violations (Tables I.16 - I.18, I.22). Note: Some caution should be used interpreting figures on the percentage of violations subject to penalties in this report. Due to limitations in the underlying NRC files, these percentages are only an approximation. Their chief value is for comparison purposes -- e.g., to examine how the percentages differ across different plant statuses, across regions, or over time.[15]

Because, under most circumstances, an accident at an operating reactor presumably would present a graver threat to a larger number of people than an accident at a reactor that was under construction or closed down, it might be argued that the NRC enforcement emphasis is appropriate. Looked at from a different perspective, however, intense inspection during the construction phase could well catch serious technical shortcomings which subsequently might result in a major accident. Either way, being able to determine whether an inspection occurred during the construction, operation or post operation phase of a reactor's life is important to analyzing the actual impact of the inspection process.

• The number of plants under construction in the United States compared to the number that are operating has declined steadily over time, largely because utilities have not initiated any new construction for many years (see Figure 11, top). While the allocation of NRC inspection time between power plants under

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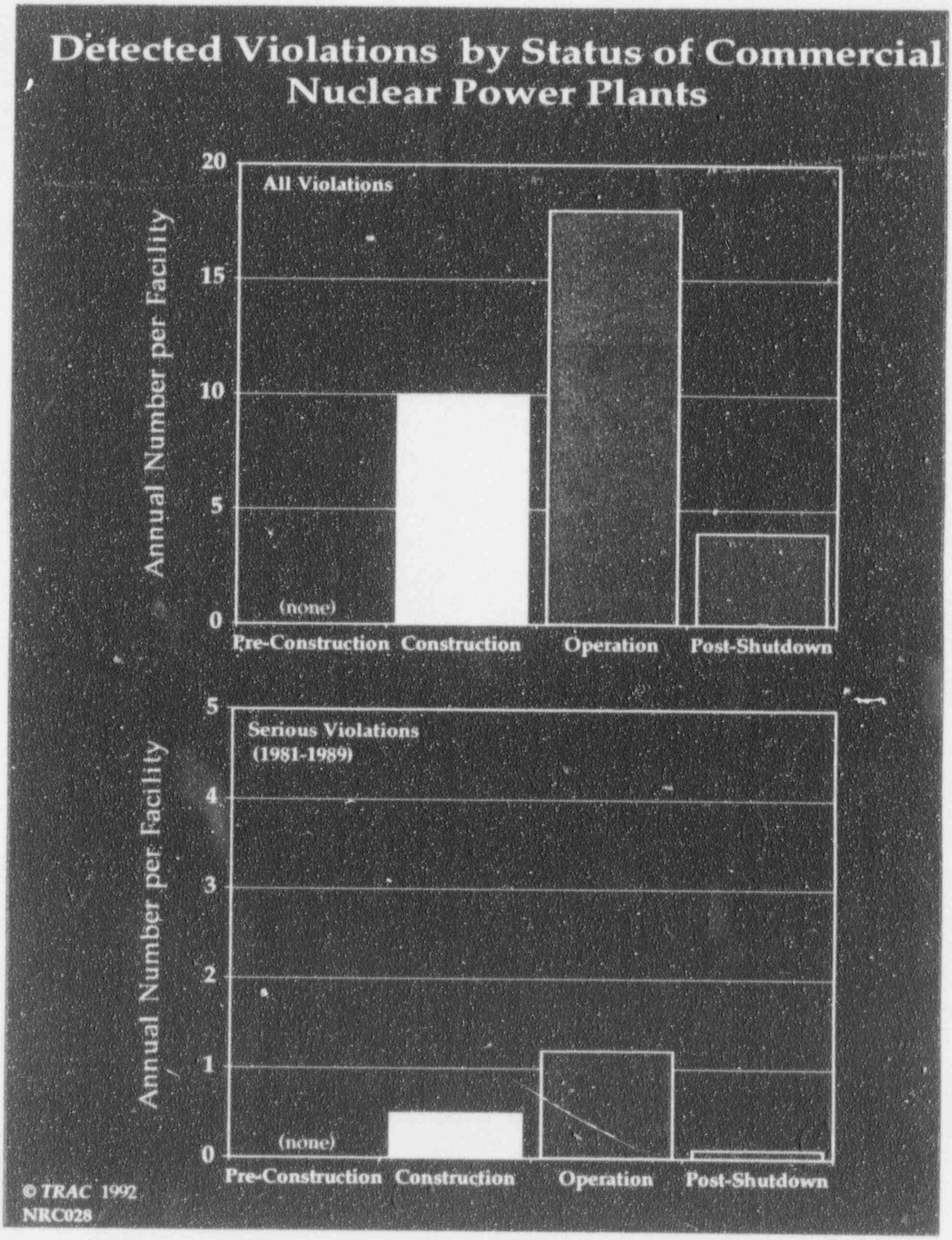
hold radioactive materials but is no longer authorized to generate power.

[15] There are a number of data limitations which make the figures given for the percentage of violations resulting in a penalty only approximate. Not all violations are legally subject to penalties, and these demarcations are not recorded in these data. Further, if more than one violation is found during an inspection, NRC EATS penalty records do not distinguish which of these violation(s) are covered by the resulting penalty. A single penalty, however, can be proposed for more than one violation. Occasionally, a single penalty covers violations found during more than one inspection. NRC EATS records appeared to treat these instances inconsistently. Occasionally, the penalty was entered twice in the file, once for each inspection, despite the fact that only a single penalty was involved. Through a comparison of the EATS files with other noncomputerized NRC records, *TRAC* attempted to eliminate this double counting of penalties (and penalty amounts). This index is derived by comparing the total number of penalties (where a single penalty covering more than one reactor is counted once for each reactor), against the total number of violations. Thus, this index underestimates the percentage of individual violations penalized since the fact that a penalty may cover multiple violations is not reflected in the percentage calculation. The chief value of these percentages is for comparison -- e.g., when comparing different periods or plant statuses, years, or regions -- to examine differential rates. Differences among rates, rather than their absolute levels, should be less affected by the above data limitations in NRC recording systems.


Detected Violations by Status of Commercial Nuclear Power Plants
All Violations
Annual Number per Facility
20
15
10
5
0
(none)
Pre-Construction
Construction
Operation
Post-Shutdown
Serious Violations (1981-1989)
Annual Number per Facility
5
4
3
2
1
0
(none)
Pre-Construction
Construction
Operation
Post-Shutdown
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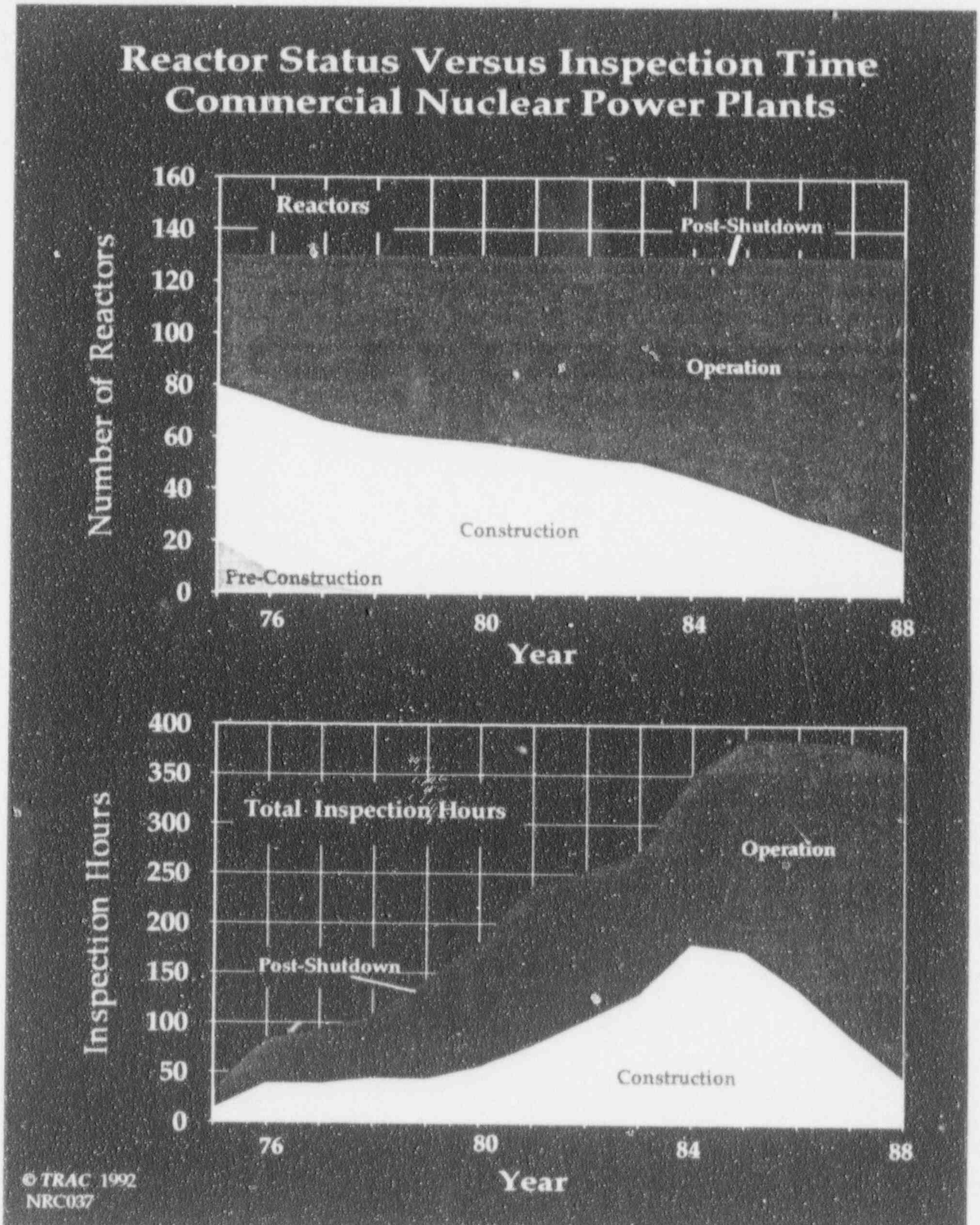
NRC028

Figure 10


Reactor Status Versus Inspection Time
Commercial Nuclear Power Plants
Number of Reactors
Reactors
Post-Shutdown
Operation
Construction
Pre-Construction
Year
Inspection Hours
Total Inspection Hours
Operation
Post-Shutdown
Construction
Year
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NRC037

Figure 11

construction versus operation has also changed (Figure 11, bottom), it has not shifted as rapidly as the status of the plants themselves. As a result, as shown in Figure 12, average inspection times ballooned for facilities under construction. The average annual time inspectors spent monitoring plants in the construction phase increased to 64 weeks per plant in 1983, in that year surpassing the average length of time spent inspecting operating plants. Inspection time at plants under construction continued to rise after 1983, peaking at 112 weeks per plant in both 1985 and 1986, or twice the inspection time per operating plant in those years. By 1988, inspection time for plants undergoing construction returned to more typical levels -- that is, below the average per plant inspection time for operating facilities (Table I.5). Figure 12 also shows a smaller, but nonetheless dramatic spike, in 1979 for inspections of shut down facilities. This reflects the attention NRC gave to Three Mile Island 2, after the accident there (see Table III.2).

The rapid rise in the average inspection time for plants in the construction phase during the mid-eighties -- which raises questions about NRC staffing allocations -- is all the more striking because actual construction work had stopped on a number of the plants included in these averages, as a result of cost overruns and resulting financial problems for the affected utilities. So for some of these plants, there was actually little new construction for NRC inspectors to inspect.[16]

Inspection, Violation, and Penalty Trends Over Time of Plants Commissioned for Commercial Operation

• For operating plants, the frequency of inspections has been roughly unchanged for more than a decade. As the number of plants commissioned for operation rose, so did inspections (see Figure 13). While during the first few years after the agency was established, inspection frequency increased as the NRC added to its staff, by 1978 commissioned plants were being inspected an average of about 30 times per year and this has held roughly constant since then. (See Table I.4. Note the highlights in this and the following sections concern plants after they have been commissioned for commercial operation. Hence, references to Table Series I focus upon figures in the column for "Operation" period in these tables.)

What changed, however, was the staffing devoted to these inspections (Table I.5). In 1976, for example, the average time spent annually inspecting each commissioned plant took 21 (forty hour) weeks. By 1988, the inspections consumed

---

[16] For example, Washington Nuclear 1 and 3. It is the case that particular reactors are sometimes subjected to intense scrutiny by NRC. For example problems of workmanship at both Waterford and Comanche Peak in the mid-eighties, when these plants were under construction, led NRC to monitor their construction closely. But such incidents don't account for the steady, consistent, and dramatic rise in inspection times here. [See Table III.2.]

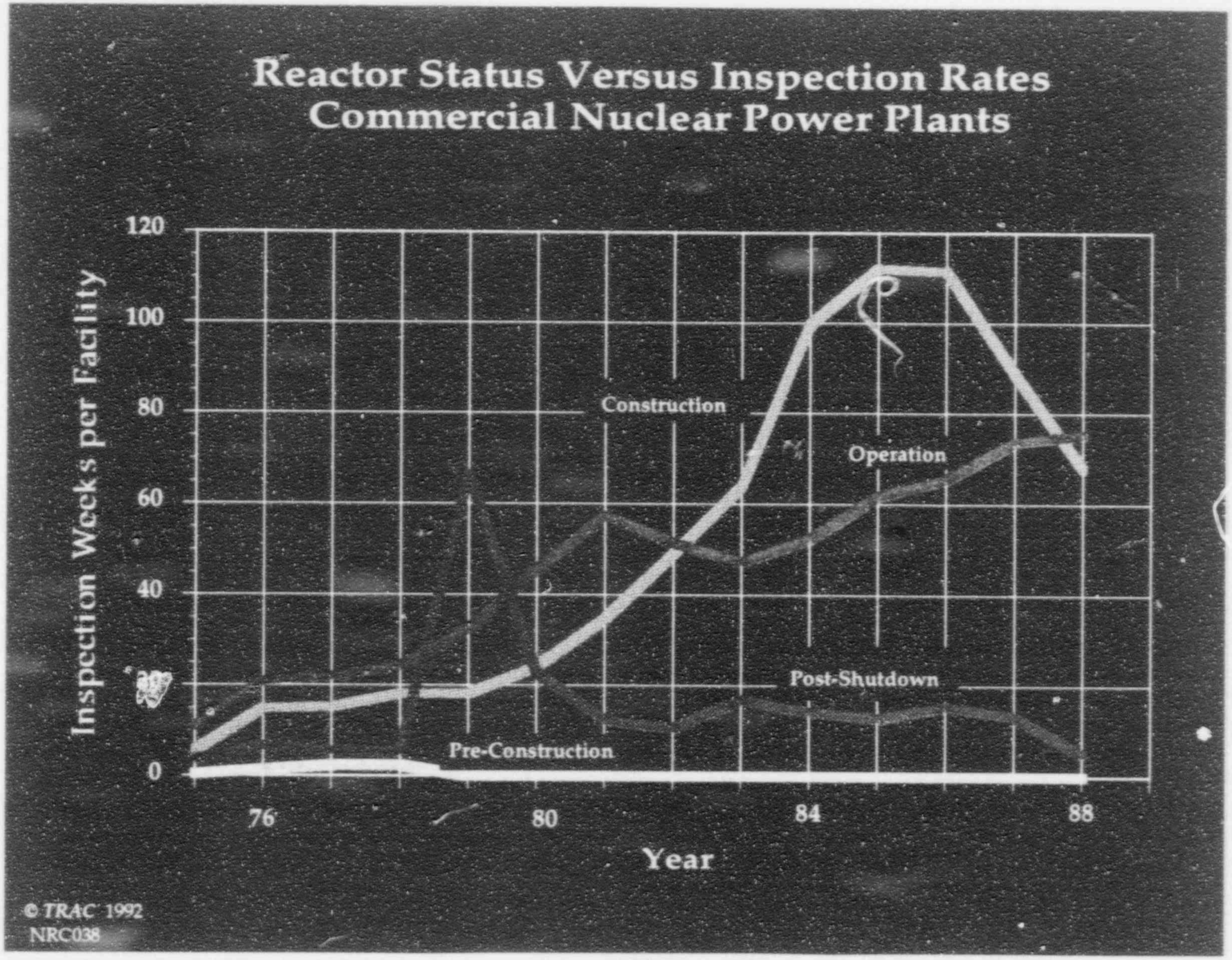
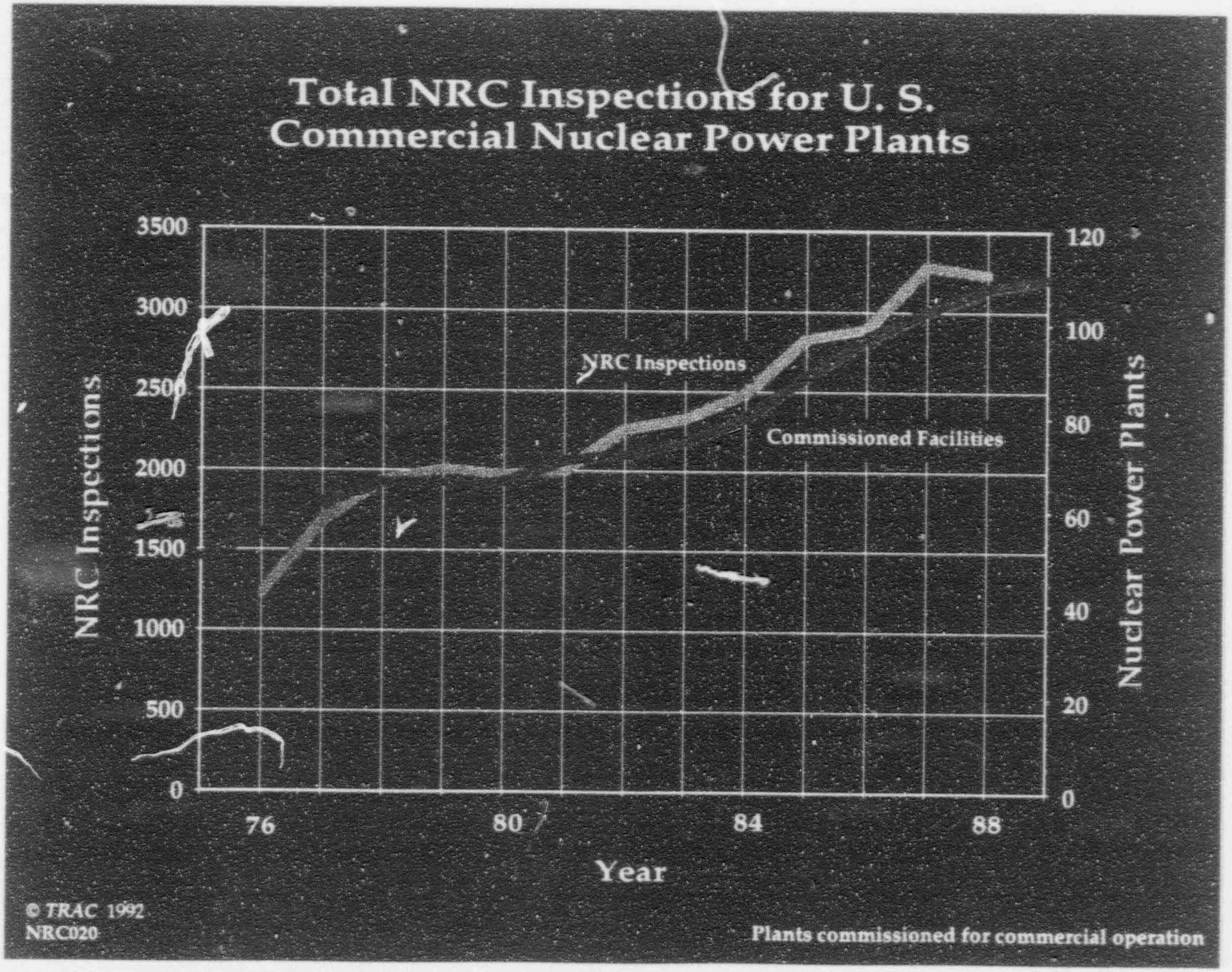

Reactor Status Versus Inspection Rates
Commercial Nuclear Power Plants
Inspection Weeks per Facility
120
100
80
60
40
20
0
Construction
Operation
Post-Shutdown
Pre-Construction
76
80
84
88
Year
© TRAC 1992
NRC038

Figure 12



Total NRC Inspections for U. S.
Commercial Nuclear Power Plants
NRC Inspections
Nuclear Power Plants
3500
3000
2500
2000
1500
1000
500
0
120
100
80
60
40
20
0
76
80
84
88
Year
NRC Inspections
Commissioned Facilities
© TRAC 1992
NRC020
Plants commissioned for commercial operation

Figure 13

75 (forty hour) weeks per operating plant -- almost a four-fold increase (see Figure 14).[17]

• In contrast, the total number of violations detected by NRC inspectors has been quite constant over this period. Since 1977, a total of about 1,400 violations have been detected each year (see Table I.6) for commissioned plants. Since the number of commissioned plants has grown over time, this means that on a "per plant" basis, the detected violation *rate* has steadily fallen to an average of 13 violations per plant in 1988 -- only a little more than half the detected violation rate of 23 violations per plant during 1976 (see Figure 15 and Table I.9). As also shown in Figure 15, the proportion of inspections turning up a violation has similarly fallen (see also, Table I.11). Rates for serious violations are more variable year-by-year during the last decade, but generally these too have fallen for commissioned plants at roughly the same pace as the overall violation rate (see Table I.10).

• As noted earlier, the imposition of penalties is generally rare. But trends in their imposition are quite the reverse of those for violations (see Tables I.13 and I.18). Prior to 1980, the NRC only proposed a handful of civil penalties each year against reactors commissioned for commercial operation -- a total of only 7 per year nationwide. There was a notable jump in 1980 (to 37 nationwide), after Three Mile Island, and these numbers continue to increase more gradually during the decade of the eighties. Increases since 1980 roughly follow the growth in the number of commissioned plants. So actual penalty rates -- on a per plant basis -- while fluctuating from year to year ended the decade where they began, at an average of 0.6 proposed penalties per plant a year, or a little more than one every two years per plant. But since (as previously noted) violation rates for this same period are down, the proportion of violations receiving penalties, while still very low, has risen -- to around 8 percent since 1987, while it was under 2 percent prior to 1980 (Table I.22). Figure 16 shows these contrasting trends.

Regional NRC Enforcement Highlights of Plants Commissioned for Commercial Operation

The NRC is divided into five administrative regions. These geographic divisions are depicted on the maps included in Appendix A. Generally speaking (see Figure 17), nuclear power plants tend to be concentrated in the eastern half of the United States, with relatively few located in the west-central and western regions of the nation. Even controlling for differences in the number of plants in each region and their periods since commissioning, the NRC data show extensive

---

[17] A number of data limitations make the soaring inspection times for plants in the construction phase, discussed earlier for 1983-1986, even more striking since we were assessing them *relative to* those for operating plants. Since times for operating plants were on the rise, the increase in inspection times for construction plants was extraordinarily rapid.

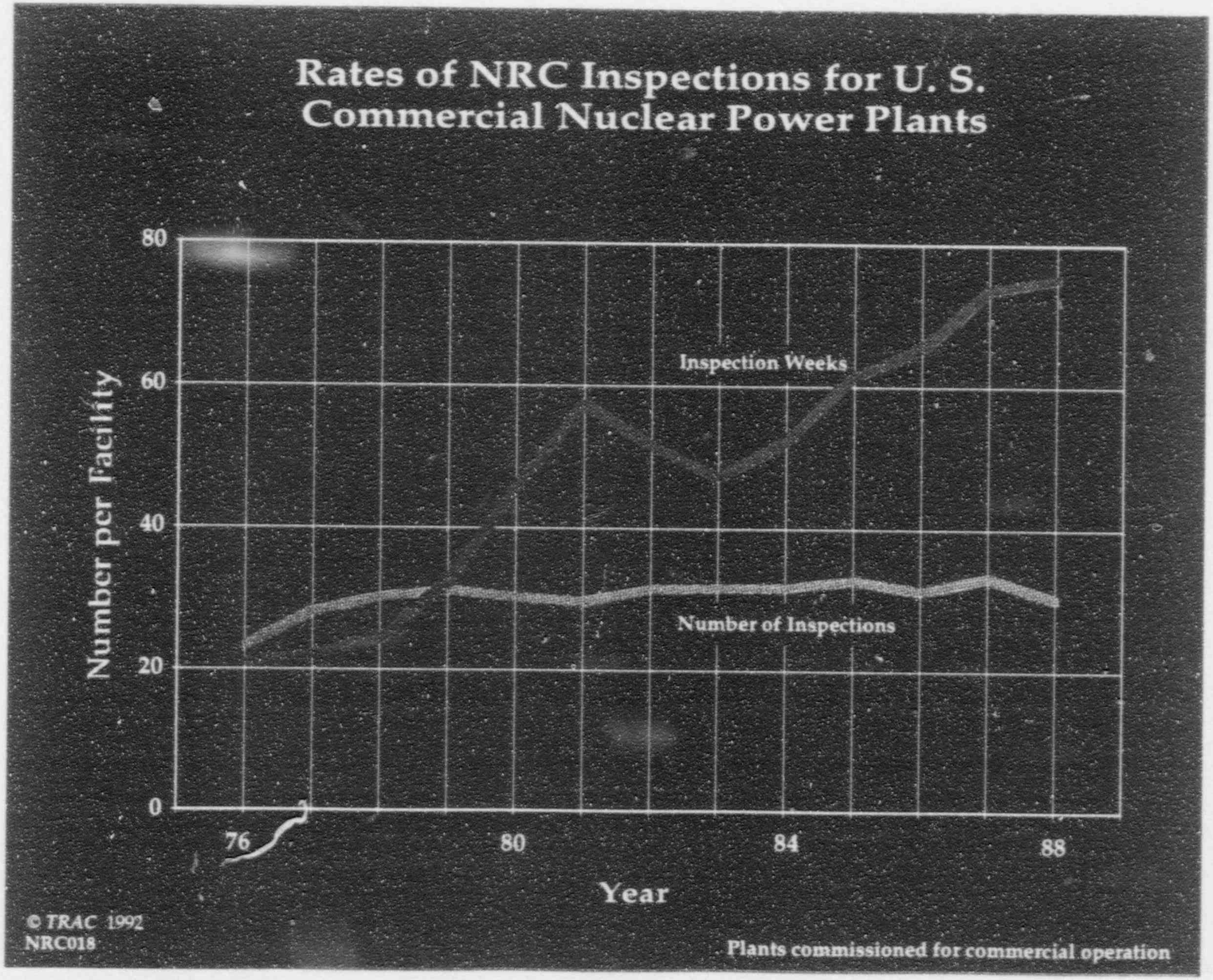
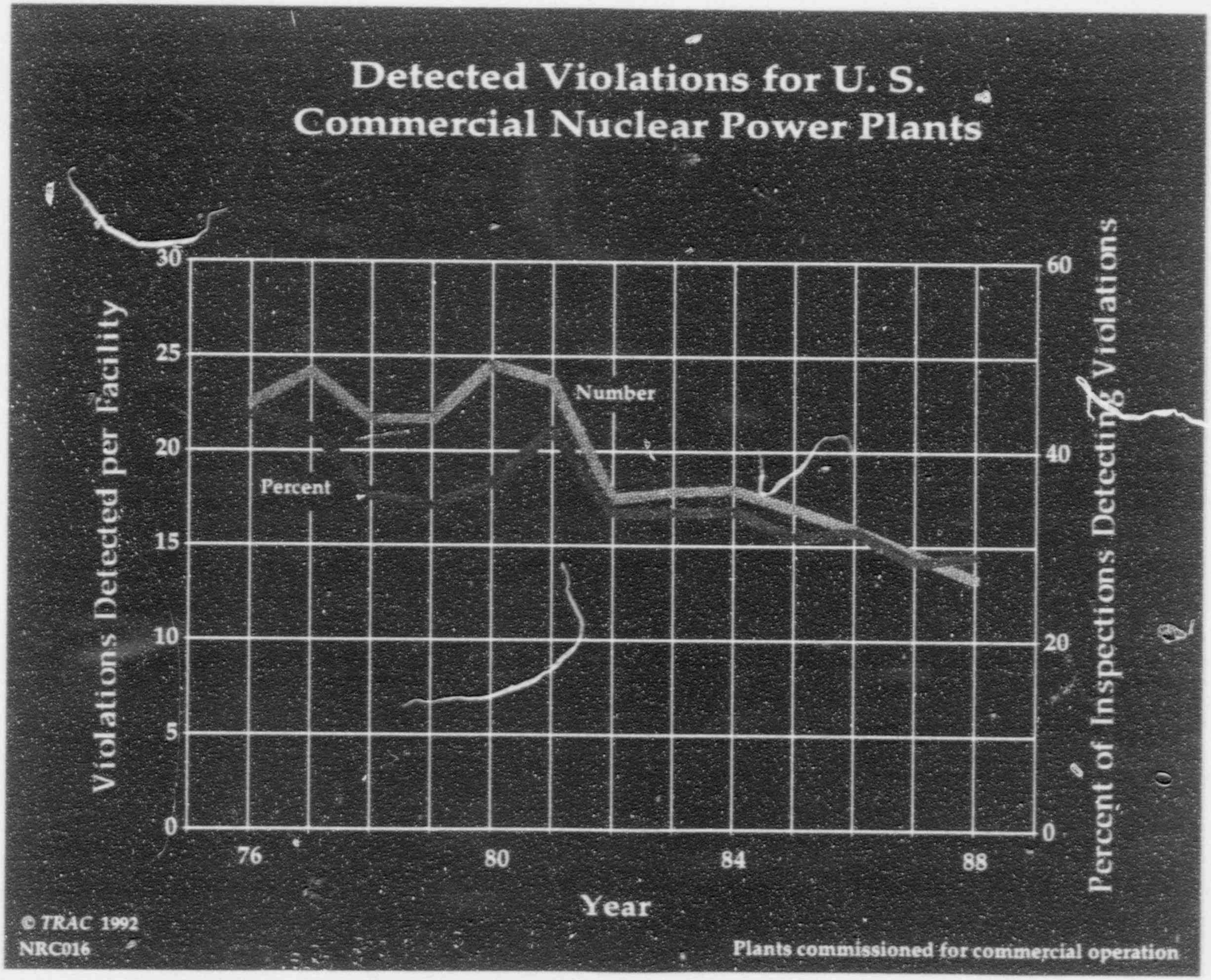

Rates of NRC Inspections for U. S.
Commercial Nuclear Power Plants
Number per Facility
80
60
40
20
0
Inspection Weeks
Number of Inspections
76
80
84
88
Year
© TRAC 1992
NRC018
Plants commissioned for commercial operation

Figure 14



Detected Violations for U. S.
Commercial Nuclear Power Plants
Violations Detected per Facility
Percent of Inspections Detecting Violations
Number
Percent
0
5
10
15
20
25
30
0
20
40
60
76
80
84
88
Year
© TRAC 1992
NRC016
Plants commissioned for commercial operation

Figure 15

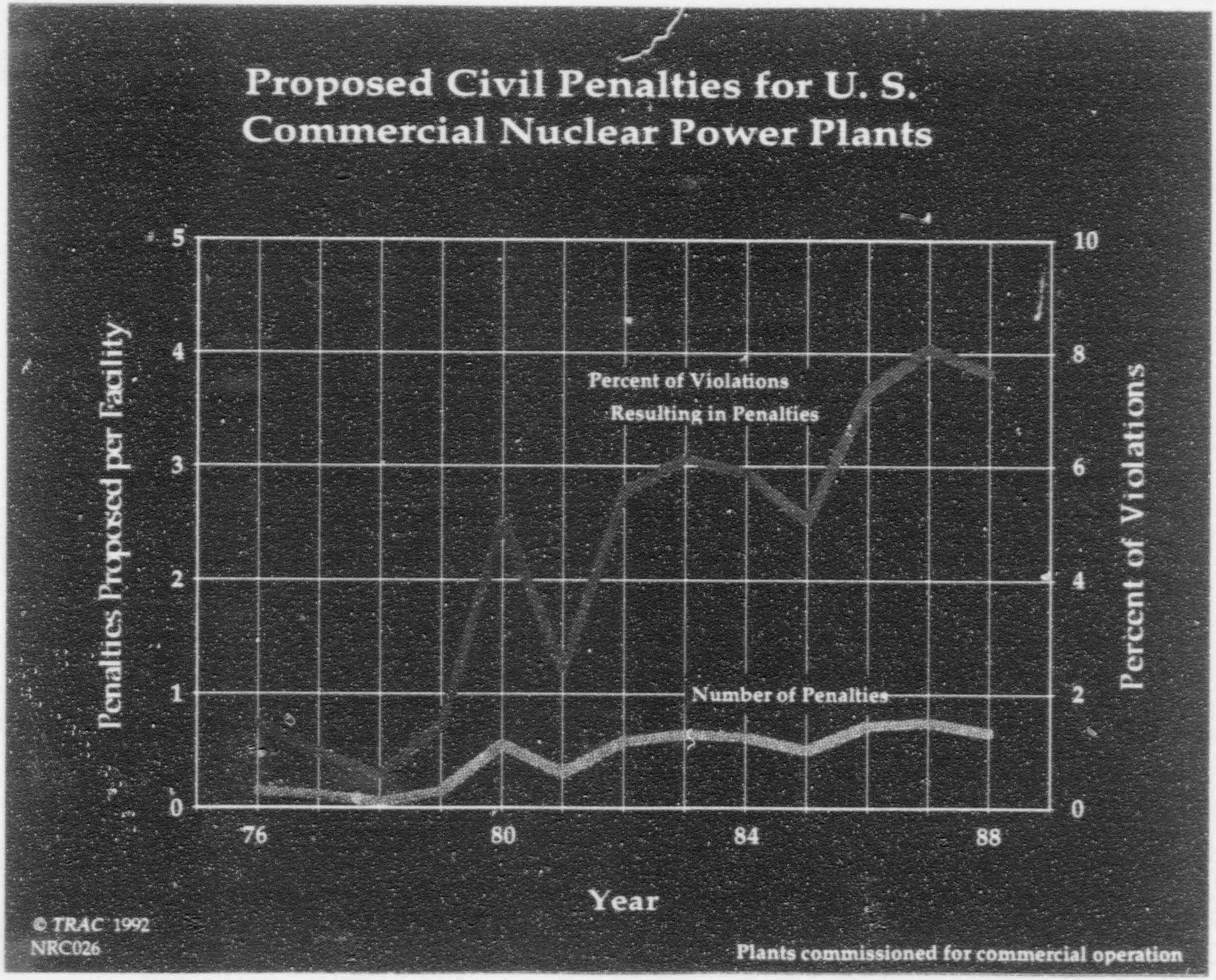

Proposed Civil Penalties for U. S.
Commercial Nuclear Power Plants
Penalties Proposed per Facility
Percent of Violations
Percent of Violations
Resulting in Penalties
Number of Penalties
0
1
2
3
4
5
0
2
4
6
8
10
76
80
84
88
Year
© TRAC 1992
NRC026
Plants commissioned for commercial operation

Figure 16

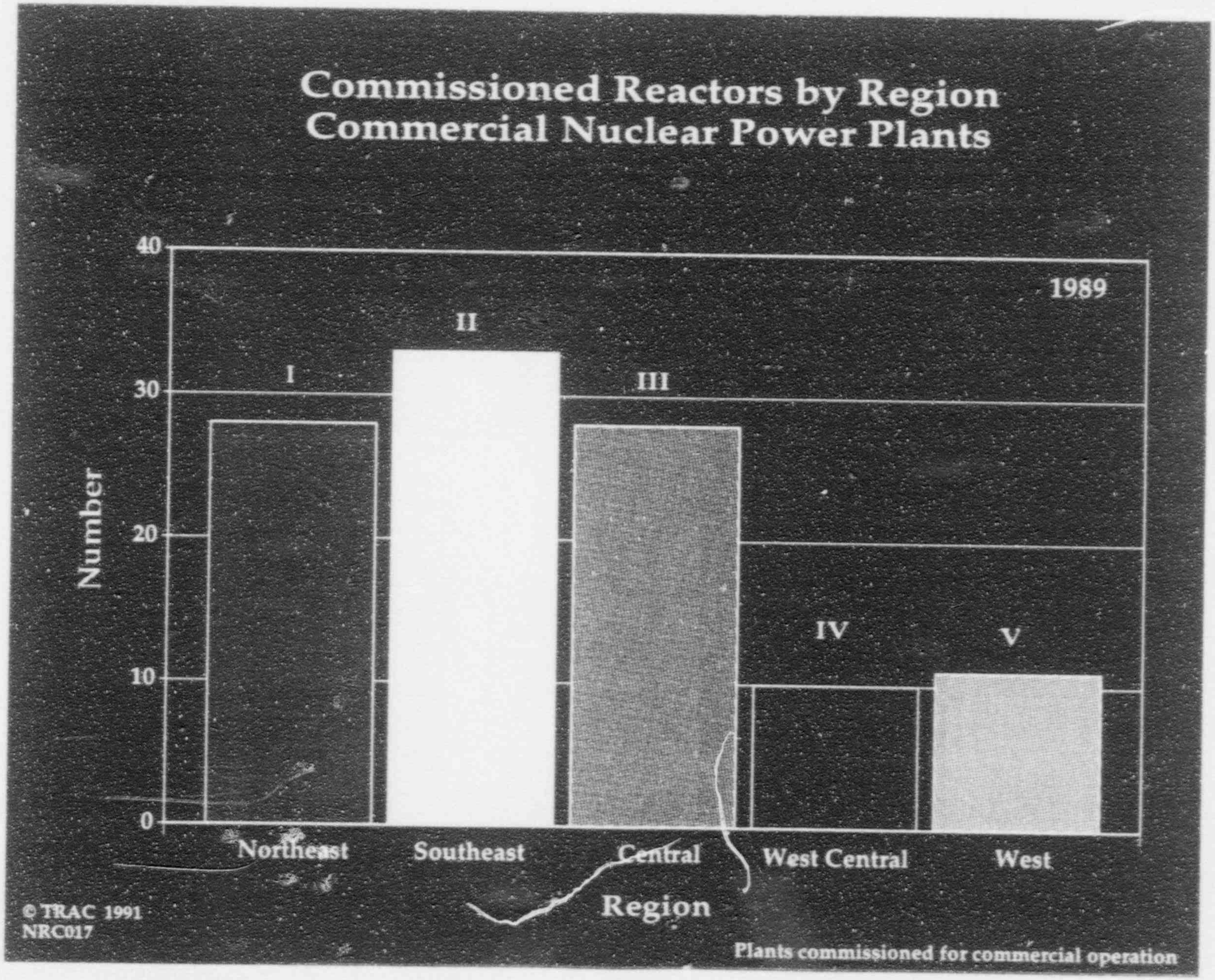

Commissioned Reactors by Region
Commercial Nuclear Power Plants
1989
Number
40
30
20
10
0
I
II
III
IV
V
Northeast
Southeast
Central
West Central
West
Region
© TRAC 1991
NRC017
Plants commissioned for commercial operation

Figure 17

region-to-region variations in the formal enforcement activities of the agency's inspectors:

• Inspection time spent by the NRC varied widely among the agency's five administrative regions (see Table II.5). For example, over this fifteen year period, inspectors in Region III (central) spent an average of 44 (forty-hour) weeks annually examining each plant under their jurisdiction. At the opposite end of the scale, in Region V (west) NRC inspectors spent fifty percent more time inspecting each plant, or 67 weeks annually per plant. This compared with 48 weeks annually per plant in Region I (northeast), 52 weeks annually per plant in Region II (southeast) and 61 weeks in Region IV (west central). (See Table II.5. Note the highlights in this and the following section concern plants after they have been commissioned for commercial operation. Hence reference to Table Series II focus upon numbers in the sub-tables headed "Period=Operation.")

In any single year average inspection times per plant often have been even more variable, and the relative ranking of the regions has changed with time. Regions II (southeast) and IV (west central) display the greatest increase in inspection times (see Figure 18).

• Violations also varied from region to region. In Region V (west), agency inspectors cited an average of 13 violations per plant each year. In Region IV (west central) they found 21 and in Region II (southeast) 22 -- nearly twice the rate of violations cited in Region V. The annual violation rates for Region I (northeast) and Region III (central) were both 16. (See Table II.9.)

• Considered over time, Region I (northeast) has shown the largest drop in violation rates: from an annual average of 26 per plant in 1976, down to only 6 in 1988 (the last year with complete data). Region III (central) experienced similar, although less abrupt, declines. (See Figure 19.) In contrast, Region II (southeast) and Region V (west) showed no consistent trends.

• The trend for Region IV (west central) in the detection of violations was the exact opposite of that for the United States as a whole. Instead of declining, violations detected per facility were up sharply from an annual per plant rate of 15 in 1976 to 27 by 1988 (see Figure 19 and Table II.9). Region IV also outstripped all other regions in the proportion of inspections turning up violations, particularly in the latter half of the eighties (Table II.11). By 1988, Region IV led the country in the rate of violations detected (on an annual per plant basis) as well as in the proportion of its inspections finding violations. While only 29% of inspections turned up violations in the nation as a whole, close to one in every two inspections (48%) in Region IV found one or more violations (see Figure 20).

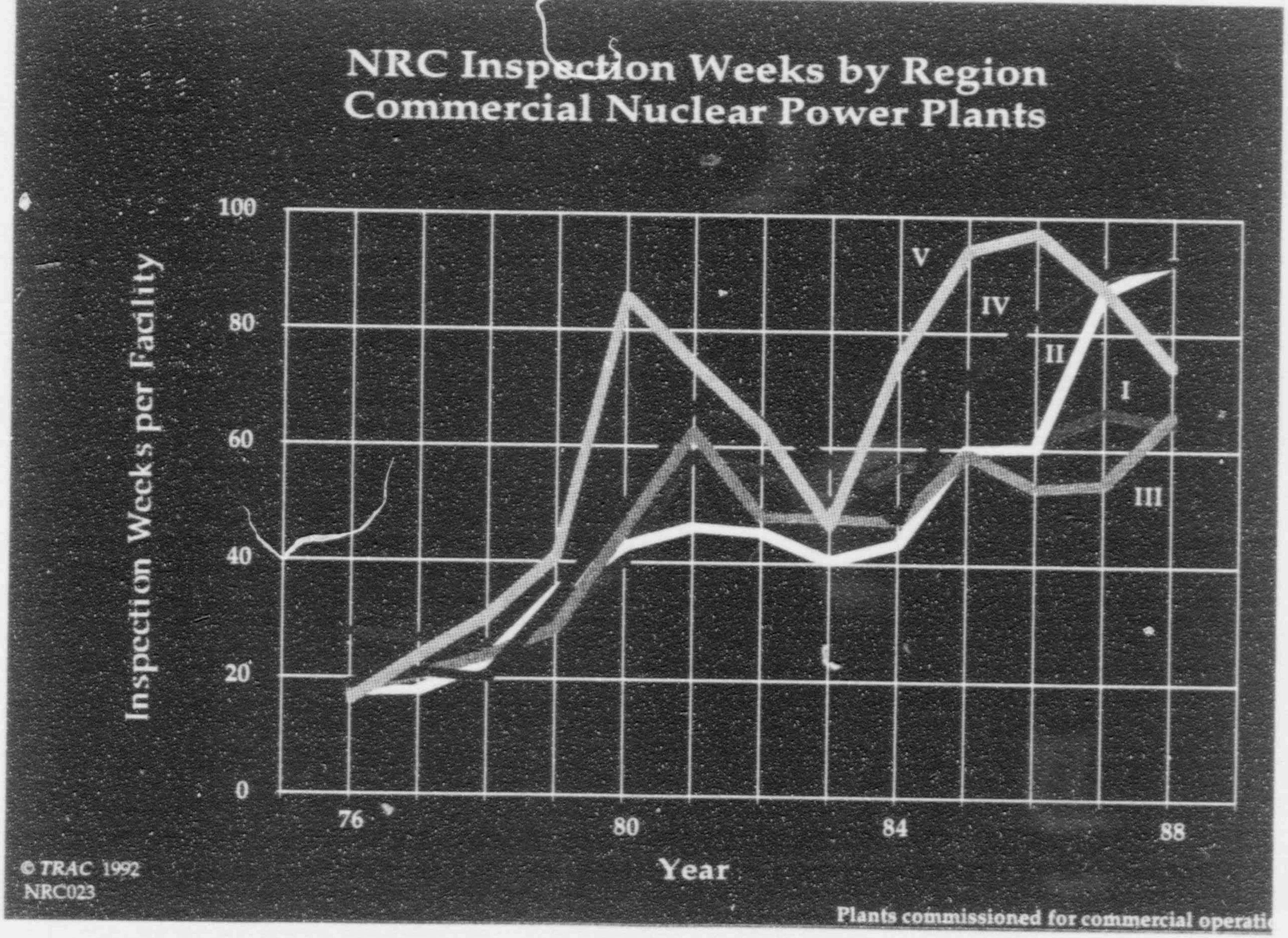
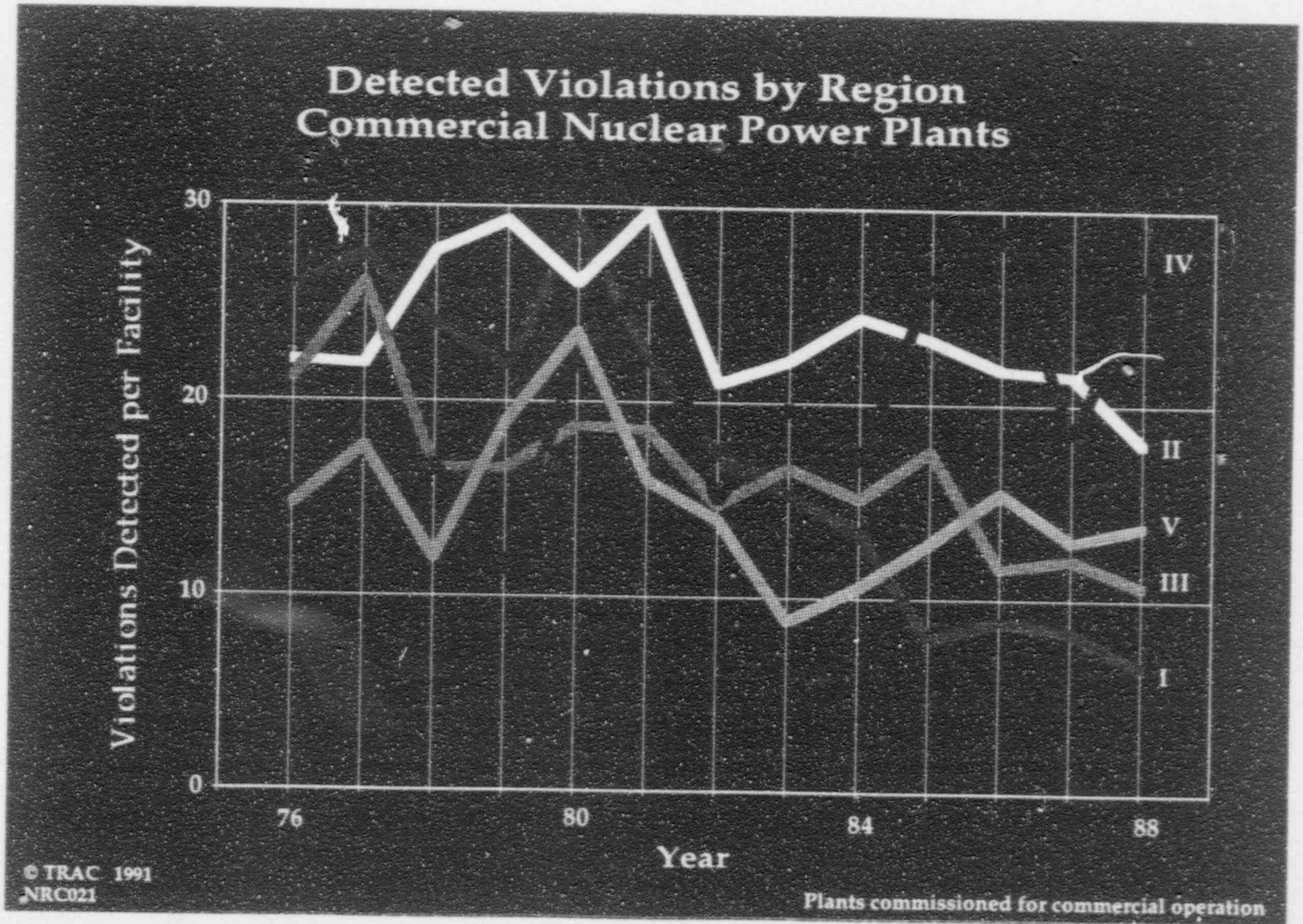

NRC Inspection Weeks by Region
Commercial Nuclear Power Plants
Inspection Weeks per Facility
100
80
60
40
20
0
76
80
84
88
Year
V
IV
II
I
III
© TRAC 1992
NRC023
Plants commissioned for commercial operati

Figure 18


Detected Violations by Region
Commercial Nuclear Power Plants
Violations Detected per Facility
30
20
10
0
76
80
84
88
Year
IV
II
V
III
I
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NRC021
Plants commissioned for commercial operation

Figure 19

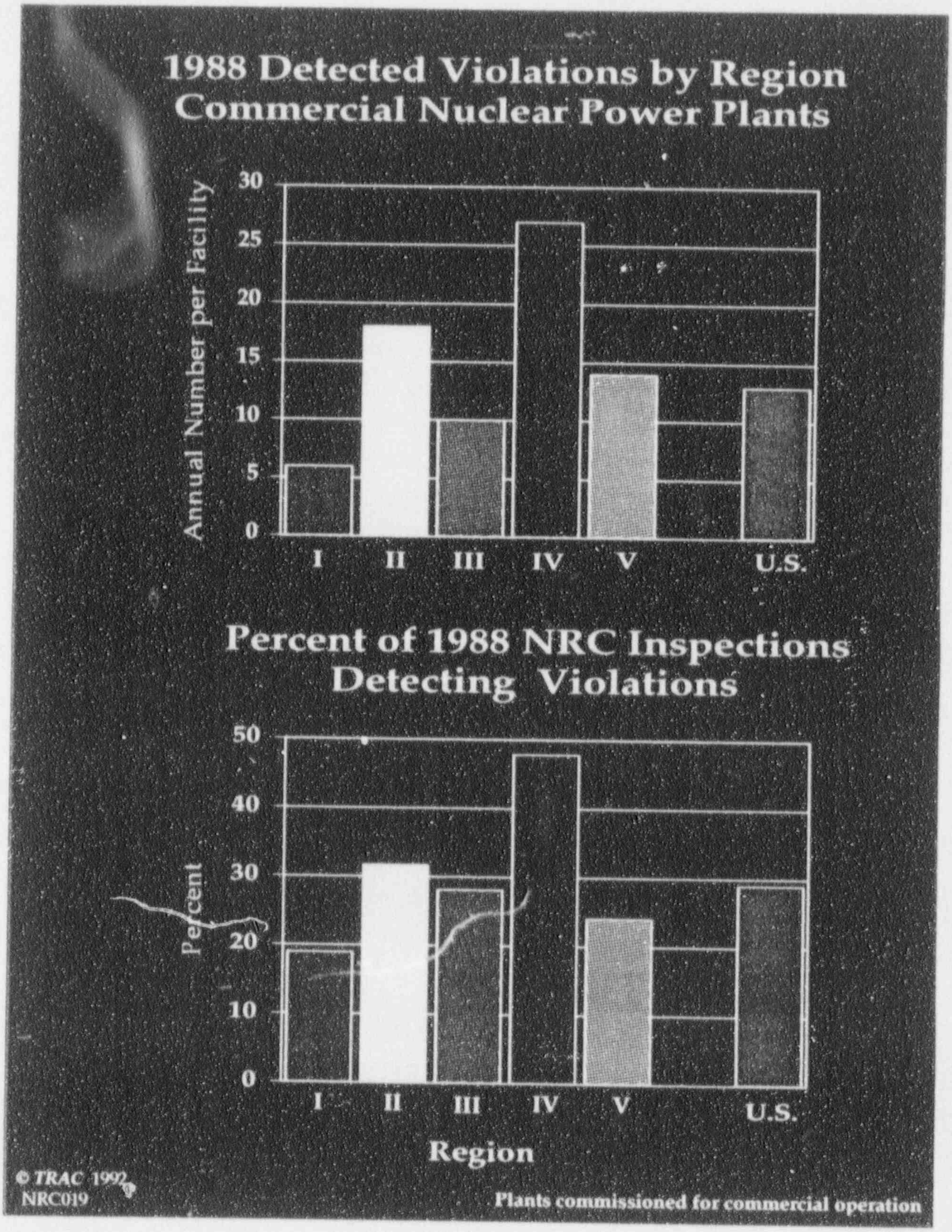

1988 Detected Violations by Region
Commercial Nuclear Power Plants
Annual Number per Facility
30
25
20
15
10
5
0
I
II
III
IV
V
U.S.
Percent of 1988 NRC Inspections
Detecting Violations
Percent
50
40
30
20
10
0
I
II
III
IV
V
U.S.
Region
© TRAC 1992
NRC019
Plants commissioned for commercial operation

Figure 20

• Turning to the rates for serious violations, variation across regions was even wider than that for violations overall.[18] Plants in Region I (northeast) had only half the likelihood of being cited for serious violations of those in Region II (southeast). These two regions, respectively, were also lowest and (second) highest in recent years in the rates of general violations detected (compare Figures 20 versus 21, and Tables II.9 versus II.10).

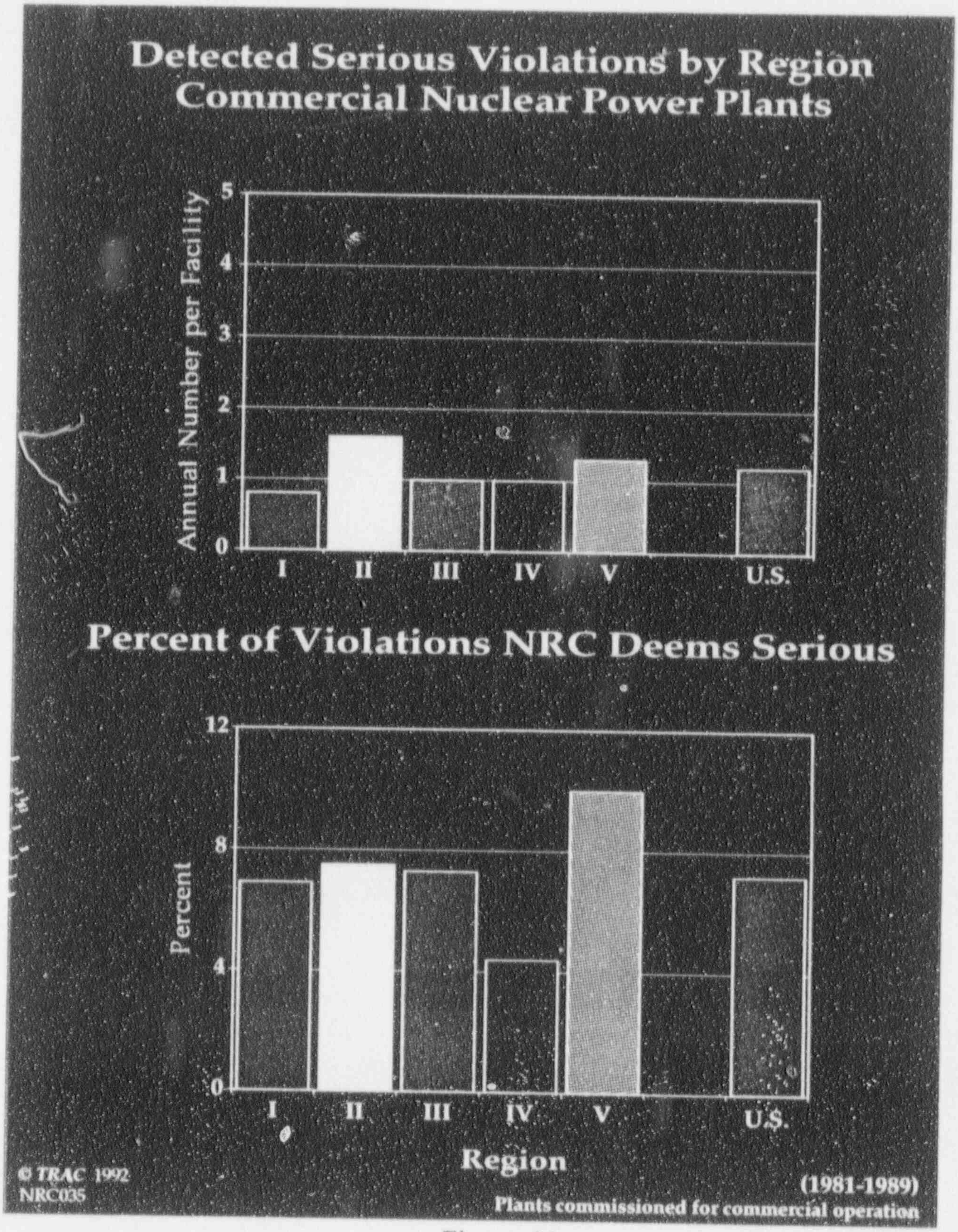
• The region with the highest rate of all kinds of violations -- Region IV (west central) -- had a below average rate for serious violations. This unexpected finding was caused by Region IV's tendency to cite many minor violations. Serious violations thus made up only a very small proportion of the total violations cited by inspectors inspecting plants in Region IV -- only 4 out of every 100 violations. In contrast, in adjacent Region V (west), 10 out of every 100 violations cited by NRC inspectors were classified as serious. (See Figure 21 (bottom) and Table II.8.)

• While NRC penalties are rare, there again is considerable regional variation in the number of penalties proposed by the inspectors in relation to the violations they have found. Not unexpectedly, given its high proportion of less serious violations, only 4.3 percent of the violations in Region IV (west central) involved a proposed penalty. In Region V (west), 7.3 percent of all violations led to a proposed penalty. (See Figure 22 and Table II.22.) On an annual per plant basis, the average dollar amount of penalties (measured in constant 1990 dollars) was also highest in Region V (west), where penalties averaged almost $49,000 per plant a year. This was twice that found in the lowest region, Region III (central) where penalties averaged slightly under $25,000 per plant a year. (See Figure 22 and Table II.20.)

These distinct patterns point to quite different enforcement cultures in different NRC regions. Region IV (west central), for example, was more likely to cite violations for less serious matters (one NRC official referred to Region IV as the "nit pickers"). Region V (west) was the reverse -- less likely to cite minor departures in any inspection, so violation rates (on an annual per plant basis) were lower than in Region IV. But as a consequence, a higher proportion of the violations Region V did cite were for those deemed serious (Table II.8).

There is also a considerable degree of variation in the allocation of staffing andinspection times across regions, even taking into account the number of plants and their periods of operation in each region. This might be understandable if these variations were the result of the NRC focusing its attention on problem facilities. If this were the case one might expect to see a strong correlation between the reactors where the NRC found many problems, and the length of time the NRC spent inspecting these plants. But there is little association in these data between the

[18] Level 1, 2, and 3 violations are classified as serious. As previously noted, the NRC used a different classification system prior to 1981. Hence, comparisons for serious violation rates are based only on the 1981-1989 period.



Detected Serious Violations by Region
Commercial Nuclear Power Plants
Annual Number per Facility
5
4
3
2
1
0
I
II
III
IV
V
U.S.
Percent of Violations NRC Deems Serious
12
8
4
0
Percent
I
II
III
IV
V
U.S.
Region
© TRAC 1992
NRC035
(1981-1989)
Plants commissioned for commercial operation

Figure 21

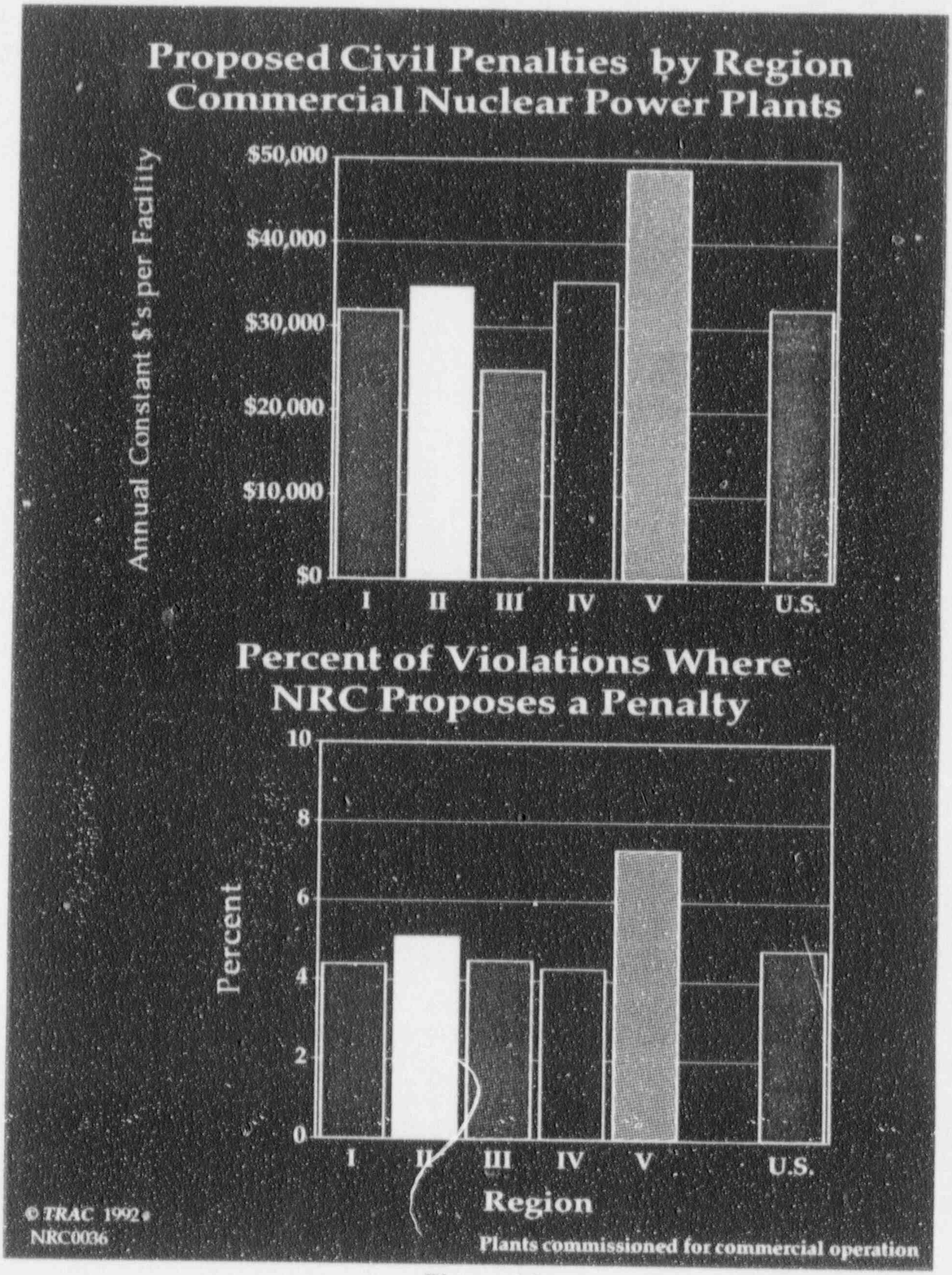

Proposed Civil Penalties by Region
Commercial Nuclear Power Plants
Annual Constant $'s per Facility
$50,000
$40,000
$30,000
$20,000
$10,000
$0
I
II
III
IV
V
U.S.
Percent of Violations Where NRC Proposes a Penalty
Percent
10
8
6
4
2
0
I
II
III
IV
V
U.S.
Region
© TRAC 1992
NRC0036
Plants commissioned for commercial operation

Figure 22

annual inspection weeks per plant spent by the NRC at each reactor, and that reactor's rate of serious violations or how frequently it was penalized.[19]

Because a sector of the economy as big and complex as the nuclear industry obviously does not and cannot operate in a uniform fashion, it is not surprising that there are regional variations in NRC enforcement activities. But because the rates take into account the number of reactors in each region and the years they have operated, the magnitude of these differences raises questions about whether the agency is adequately managed. Have the NRC commissioners hammered out clear and unambiguous enforcement policies? Have the commissioners articulated these policies in a way that can be understood by NRC staff? Has the staff been provided adequate training and supervision? Are staff members held accountable if they fail to follow established policies?

Comparing Records of Operating Utilities and Individual Commercial Nuclear Power Plants[20]

From the perspective of the industry, one of the key overall findings is that some of the nation's utilities that have chosen the nuclear option are far more problem prone than others.[21]

- After taking into account the number of reactors operated by each of the nuclear utilities and the length of time their reactors have been commissioned, NRC records show the agency found that some utilities were charged with *four or five times more violations* than others (see Figure 23 and Tables IV.9 and VII.4). Among those with the worst comparative records for all kinds of NRC violations were the Florida Power Corporation (Crystal River 3) with an average of 33

---

[19] The extent that each reactor's average annual NRC inspection times versus annual number of serious violations (or penalties) vary together is nil. A statistical measure of this, r^2 (which assesses the proportion of variation in common for two indices), indicates that variation in plant inspection times are related to a plant's rate of serious violations by less than 1%, and for penalty rate it is less than 2%. The degree of variation in common for NRC inspection times and overall violation rates is only 15%, while that of violation times and penalty dollars is less than 10%.

[20] Comparisons in this section focus exclusively upon records for plants that have been commissioned for commercial operation. Hence references to table series III and IV focus on numbers in the column for "Operation" period in these tables.

[21] Utilities which have limited experience operating nuclear power plants (less than 2 years of combined experience across their plants commissioned for commercial operation) are excluded from these comparisons since there is not enough information on which to reliably rank their performance. While such utilities are excluded from the "Ranking of Utilities" analyses discussed here (Table Series VII), full information on each utility's performance is provided in the regular tabulations concerning utilities (Table Series IV).

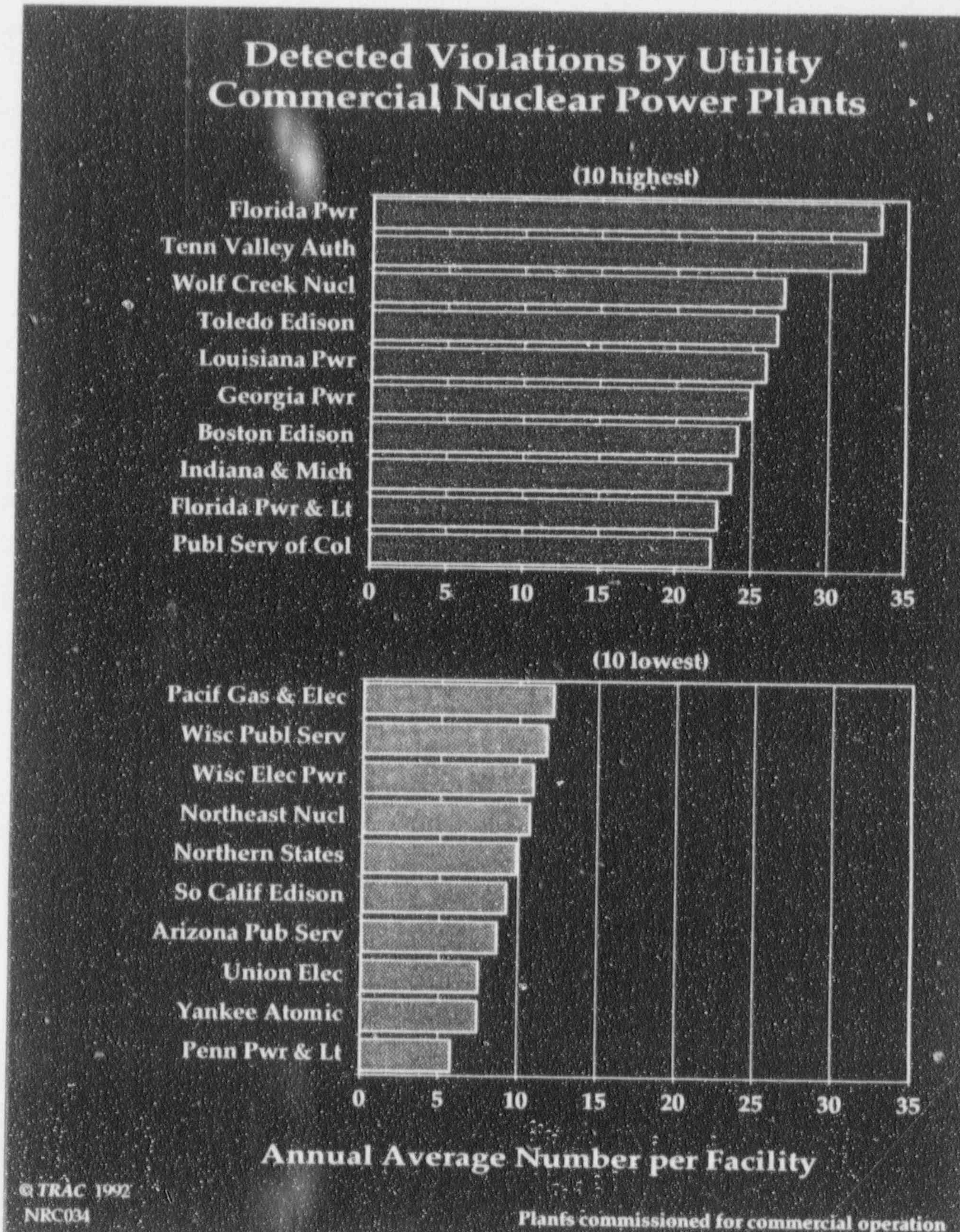

Detected Violations by Utility
Commercial Nuclear Power Plants
(10 highest)
Florida Pwr
Tenn Valley Auth
Wolf Creek Nucl
Toledo Edison
Louisiana Pwr
Georgia Pwr
Boston Edison
Indiana & Mich
Florida Pwr & Lt
Publ Serv of Col
0
5
10
15
20
25
30
35
(10 lowest)
Pacif Gas & Elec
Wisc Publ Serv
Wisc Elec Pwr
Northeast Nucl
Northern States
So Calif Edison
Arizona Pub Serv
Union Elec
Yankee Atomic
Penn Pwr & Lt
0
5
10
15
20
25
30
35
Annual Average Number per Facility
© TRAC 1992
NRC034
Plants commissioned for commercial operation

Figure 23

violations a year, the Tennessee Valley Authority (5 commissioned plants)[22] with violations averaging 32 per plant a year, the Wolf Creek Nuclear Power Company (Wolf Creek 1) and the Toledo Edison Company (Davis Besse 1) each with an average of 27 violations a year. Among those with the lowest rate of violations -- all less than 10 violations per plant a year -- were Southern California Edison (San Onofre 3), Arizona Public Service (Palo Verde 1, 2, and 3), Union Electric (Callaway), Yankee Atomic Electric Co. (Yankee Rowe) and Pennsylvania Power and Light (Susquehanna 1 and 2). It is interesting to note that multi-reactor utilities and single reactor utilities were found at both the top and the bottom of this and other performance lists. Many of these multi-unit utilities have had long experience in building and operating nuclear power plants. Thus, these data suggest that experience does not assure better performance.

• Looked at the same way in regard to the far smaller number of violations that NRC inspectors ruled were significant, the record indicates an even larger gap between the utilities with high and low rates of serious violations (see Figure 24 and Tables IV.10 and VII.5). Several utilities -- among them the Florida Power & Light Corp. (St. Lucie 1 and 2, Turkey Point 3 and 4), the Toledo Edison Co. (Davis Besse 1), the Tennessee Valley Authority (5 commissioned facilities), the Sacramento Utility District (Rancho Seco), and Maine Yankee Atomic Power (Maine Yankee) -- were cited for serious violations on average more than twice a year per plant, or *ten or more times more frequently* than those operating utilities with the best records.

At the other end of the spectrum were utilities with the lowest rates of serious violations. These included System Energy Resources (Grand Gulf 1), Baltimore Gas & Electric (Calvert Cliffs 1 and 2), the Wisconsin Public Service Corporation (Kewaunee), Rochester Gas & Electric (Ginna), Pacific Gas & Electric (Diablo Canyon 1 and 2, Humboldt Bay) and Pennsylvania Power and Light (Susquehanna 1 and 2). Each of their reactors were cited for a serious violation on an average of only once every five years, or less frequently, by the NRC.

• NRC civil penalties also were unevenly distributed among the nuclear utilities. Again adjusting for the number of reactors operated by each utility and the number of years these reactors have operated, penalties were proposed *fifteen or*

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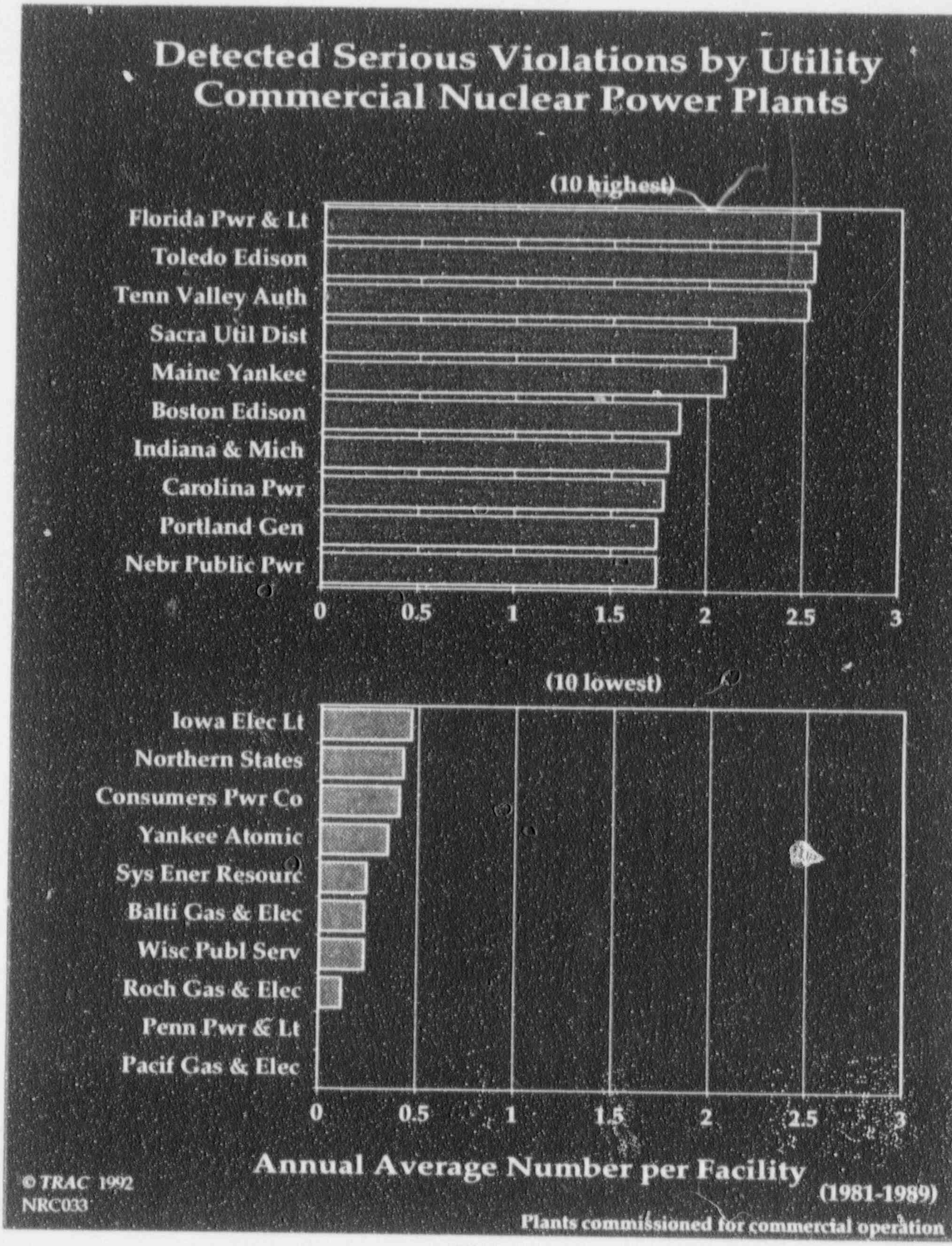
[22] Browns Ferry 1, 2, 3, Sequoyah 1 and 2. Four other reactors (Bellefonte 1 and 2 and Watts Bar 1 and 2) managed by TVA have yet to be commissioned for commercial operation although permits for their construction were all issued in 1973 and 1974. Despite TVA's extensive experience in the field, its commercial nuclear power plants have been particularly problem prone. For example, problems continued at the utility's multi-unit Browns Ferry facilities well into the 1980s. A fire in a reactor drywell in November of 1987 was only one in a lengthy list of serious problems. Leaking radioactive water, breaches of security, and complaints that the TVA had allowed individuals to become contaminated when radioactive liquid was used during an emergency drill in an effort to increase realism, are just a few of the difficulties that have been reported for Browns Ferry units. Indeed, recurrent problems with TVA's reactors, including those at Sequoyah and Watts Bar in Tennessee, accounted in part for the NRC's eventual decision to establish an Office of Special Projects. The office was established, the NRC said in its annual report for 1989, to address "particularly complex regulatory problems."



Detected Serious Violations by Utility
Commercial Nuclear Power Plants
(10 highest)
Florida Pwr & Lt
Toledo Edison
Tenn Valley Auth
Sacra Util Dist
Maine Yankee
Boston Edison
Indiana & Mich
Carolina Pwr
Portland Gen
Nebr Public Pwr
0
0.5
1
1.5
2
2.5
3
(10 lowest)
Iowa Elec Lt
Northern States
Consumers Pwr Co
Yankee Atomic
Sys Ener Resourc
Balti Gas & Elec
Wisc Publ Serv
Roch Gas & Elec
Penn Pwr & Lt
Pacif Gas & Elec
0
0.5
1
1.5
2
2.5
3
Annual Average Number per Facility
(1981-1989)
Plants commissioned for commercial operation
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NRC033

Figure 24

more times more frequently for some plants than for others (Tables IV.18 and VII.6).[23] The range of annual average proposed penalties was even more extensive. The dubious distinction of being the utility with the highest annual per-plant penalty rate, $137,349, was achieved by Toledo Edison (Davis Besse). The utilities with the next highest annual per-plant penalties, expressed in constant dollars, were $87,736 at Arizona Public Service (Palo Verde 1, 2, and 3), and over $76,302 for Portland General (Trojan). Two utilities received no penalties -- the Gulf States Utilities Company (River Bend 1) and System Energy Resources (Grand Gulf 1) whose plants were commissioned for commercial operation in 1986. (See Figure 25 and Tables IV.20 and VII.7.)

The records allow the comparison of individual reactors, as well as utilities. Because many of the utilities only operate a single reactor, the lists ranking the reactors often parallel the lists ranking the utilities.

TRAC's analysis of NRC data about multi-unit utilities, however, shows that the records of the reactors operated by power companies with more than one plant often are very similar.[24] That is, all of the reactors operated by a utility with a relatively poor overall ranking tend to have less than impressiv records. Looked at the other way, most of the reactors operated by utilities with good overall performance records turn up with a relatively good showing. Thus, in neither situation does it appear that a single reactor with a very good or very bad record has skewed the rankings of multi-unit utilities. This finding strongly suggests that the policies and management skills of different utilities play a significant role in determining the violation rates of the reactors they operate.

Figures 26, 27, and 28 display the 10 reactors with the "best" and "worst" records, respectively, on violations overall, on only serious violations, and on

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[23] Topping this list were the Arizona Public Service Company (Palo Verde 1, 2, and 3), the Tennessee Valley Authority (5 commissioned plants), the South Carolina Electric & Gas Co. (Summer) and the Portland General Electric Co. (Trojan). In contrast, the Gulf States Utilities Company (River Bend 1) and System Energy Resources (Grand Gulf 1) did not receive a single penalty over the period since their plants were commissioned for commercial operation in 1986. Others with the lowest penalty rates included Wisconsin Electric Power (Point Beach 1 and 2) and Yankee Atomic (Yankee Rowe). For these utilities, NRC proposed civil penalties for each of their reactors on an average of only once every ten years, or less frequently.

[24] For example, for utilities with multiple nuclear plants which have been commissioned for operation, variation in utility violation rates are much more strongly associated with variation in their respective individual reactor's violation rates than would be expected mathematically by chance. Some correspondence would be expected mathematically, since utility rates are a weighted average of the rates for their individual plants. Also, sometimes more than one plant is located at a single site, increasing the likelihood that sometimes they will have violations in common for a deficiency which affects safety at both plants. However, two-thirds of the variation in reactor violation rates parallels the variation in utility violation rates, with a correlation coefficient of .82. Correlations for serious violation rates is .65, while for penalty rates it is .69. In contrast, the association for average inspection times for the utility versus their individual plants is lower, at .55.

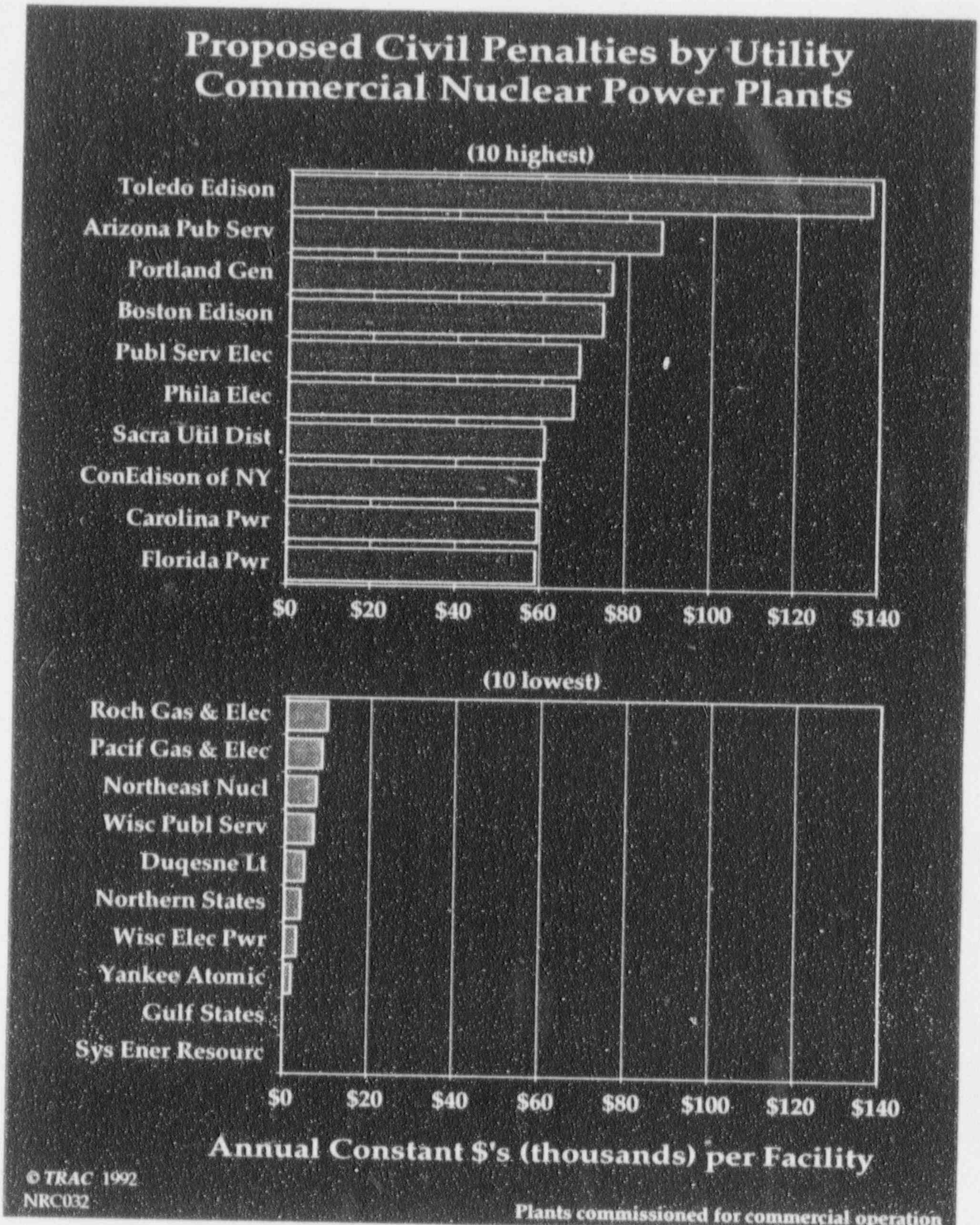

Proposed Civil Penalties by Utility
Commercial Nuclear Power Plants
(10 highest)
Toledo Edison
Arizona Pub Serv
Portland Gen
Boston Edison
Publ Serv Elec
Phila Elec
Sacra Util Dist
ConEdison of NY
Carolina Pwr
Florida Pwr
$0
$20
$40
$60
$80
$100
$120
$140
(10 lowest)
Roch Gas & Elec
Pacif Gas & Elec
Northeast Nucl
Wisc Publ Serv
Duqesne Lt
Northern States
Wisc Elec Pwr
Yankee Atomic
Gulf States
Sys Ener Resourc
$0
$20
$40
$60
$80
$100
$120
$140
Annual Constant $'s (thousands) per Facility
© TRAC 1992
NRC032
Plants commissioned for commercial operation

Figure 25

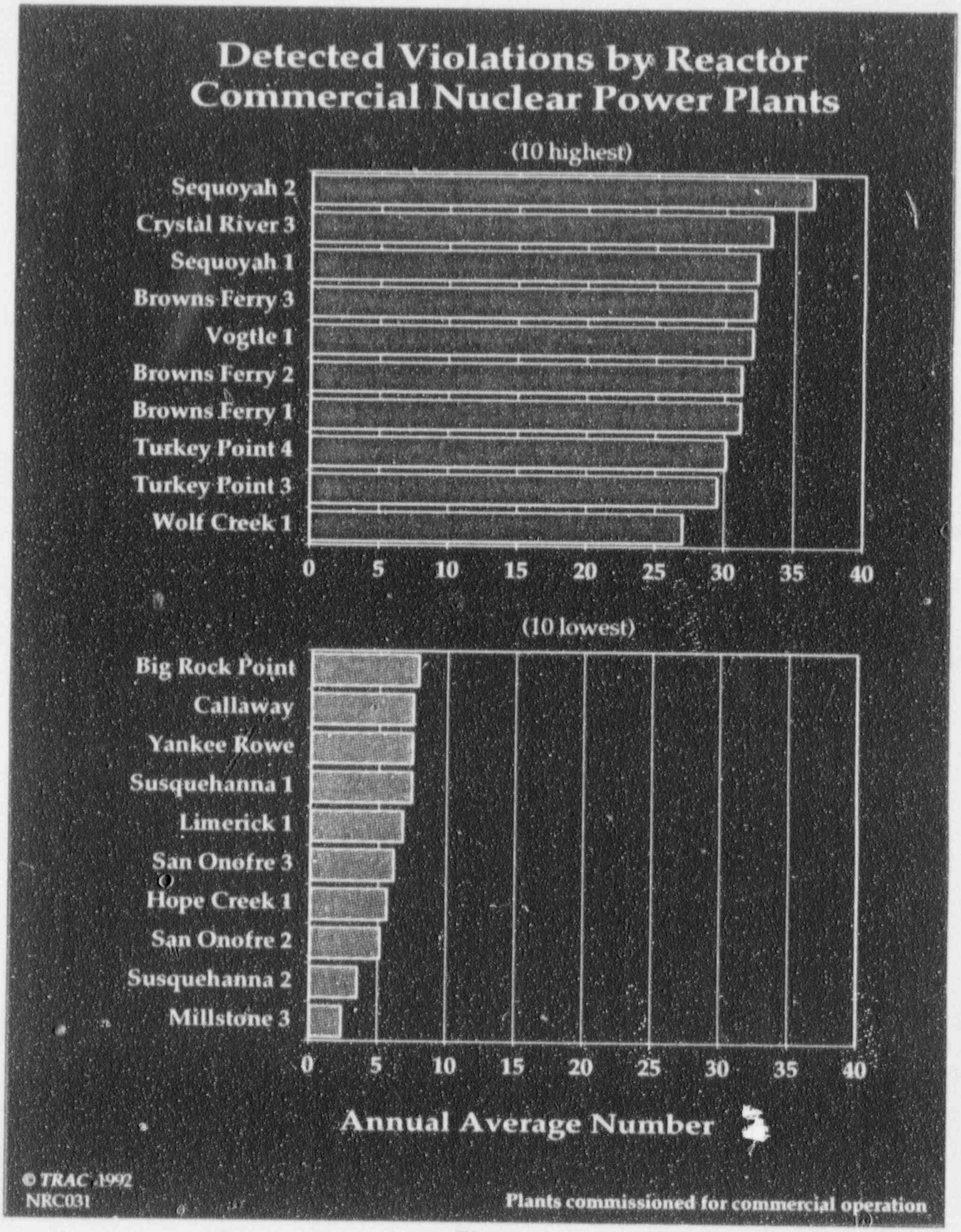
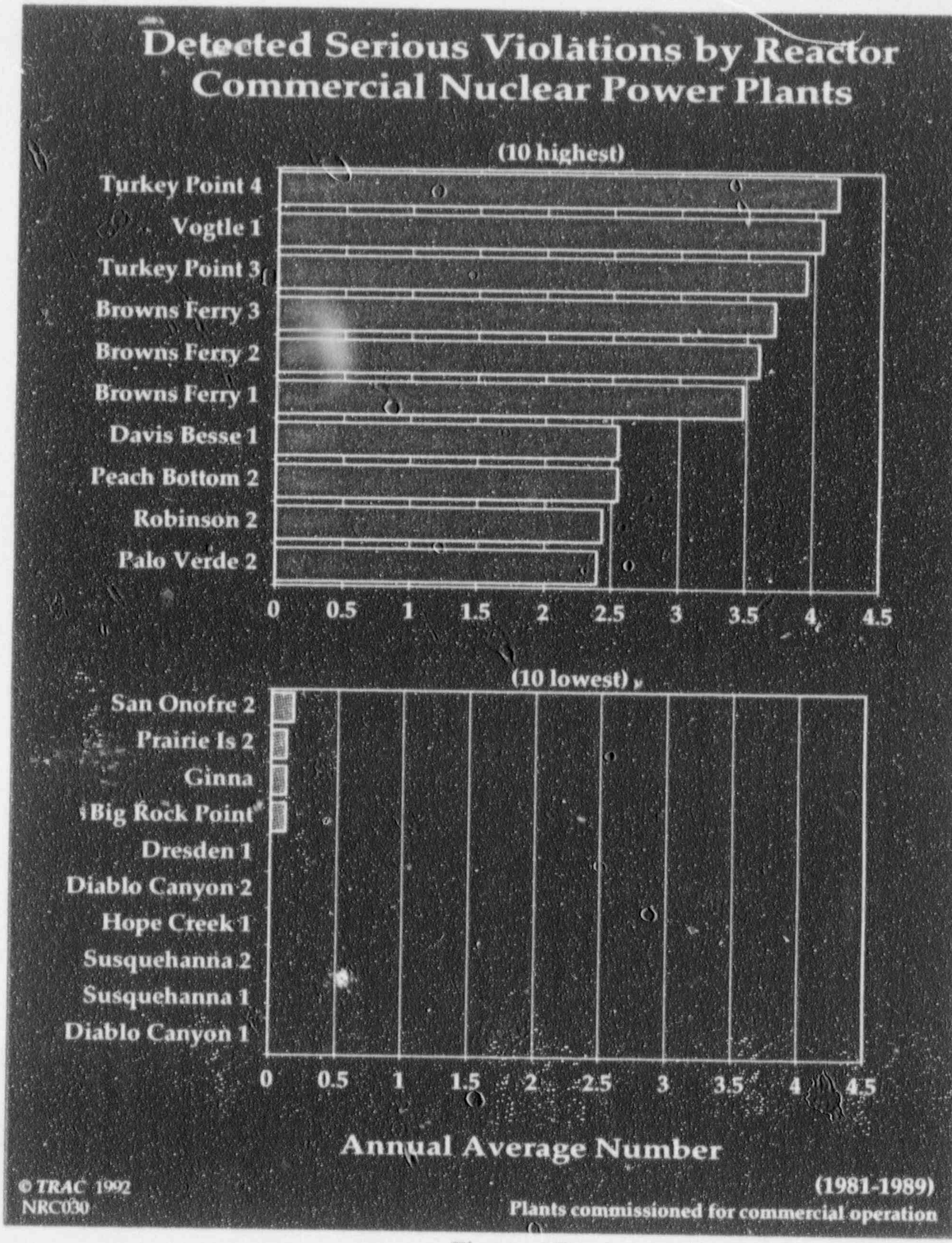

Detected Violations by Reactor
Commercial Nuclear Power Plants
(10 highest)
Sequoyah 2
Crystal River 3
Sequoyah 1
Browns Ferry 3
Vogtle 1
Browns Ferry 2
Browns Ferry 1
Turkey Point 4
Turkey Point 3
Wolf Creek 1
0
5
10
15
20
25
30
35
40
(10 lowest)
Big Rock Point
Callaway
Yankee Rowe
Susquehanna 1
Limerick 1
San Onofre 3
Hope Creek 1
San Onofre 2
Susquehanna 2
Millstone 3
0
5
10
15
20
25
30
35
40
Annual Average Number
© TRAC 1992
NRC031
Plants commissioned for commercial operation

Figure 26



Detected Serious Violations by Reactor
Commercial Nuclear Power Plants
(10 highest)
Turkey Point 4
Vogtle 1
Turkey Point 3
Browns Ferry 3
Browns Ferry 2
Browns Ferry 1
Davis Besse 1
Peach Bottom 2
Robinson 2
Palo Verde 2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
(10 lowest)
San Onofre 2
Prairie Is 2
Ginna
Big Rock Point
Dresden 1
Diablo Canyon 2
Hope Creek 1
Susquehanna 2
Susquehanna 1
Diablo Canyon 1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Annual Average Number
© TRAC 1992
NRC030
(1981-1989)
Plants commissioned for commercial operation

Figure 27

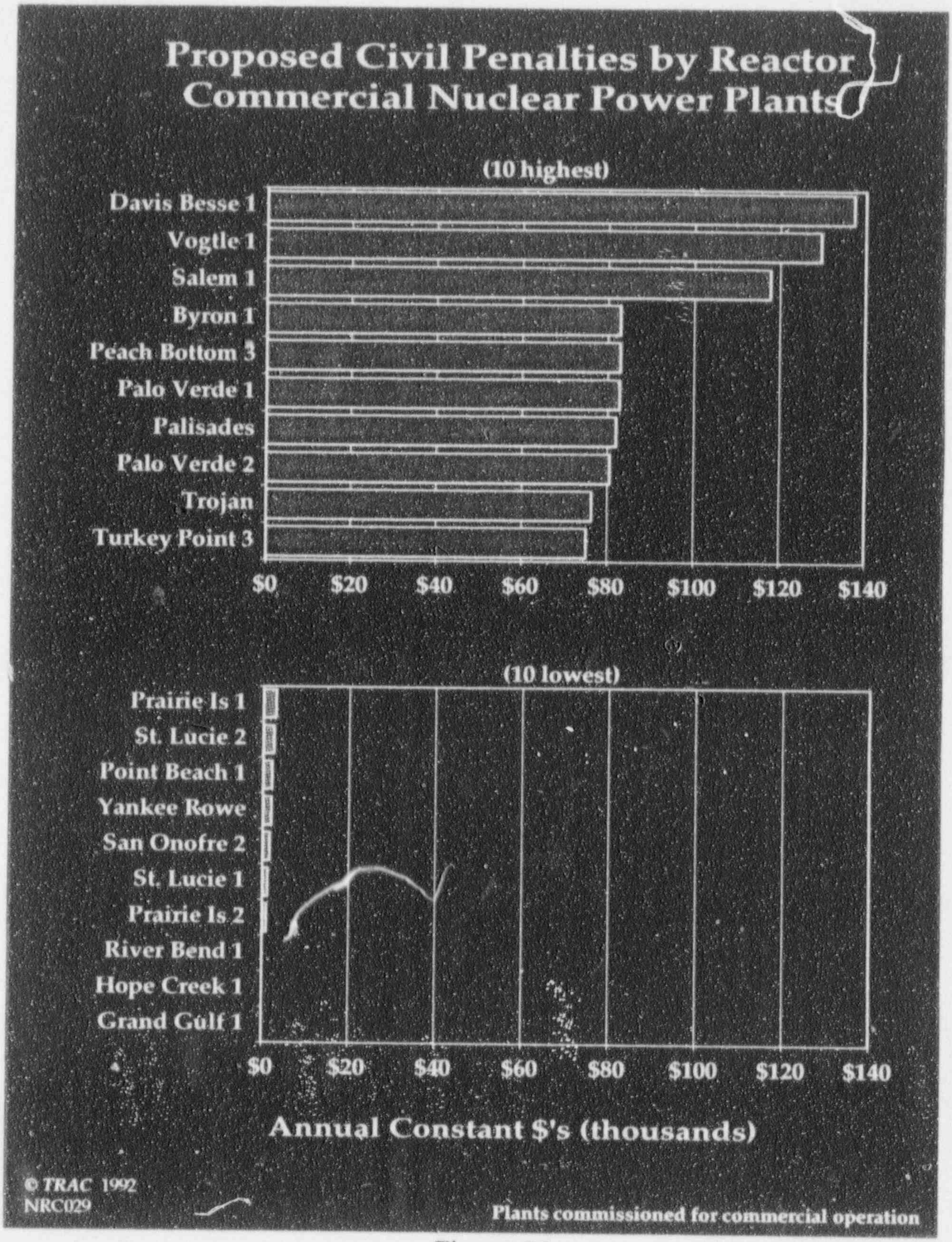

Proposed Civil Penalties by Reactor
Commercial Nuclear Power Plants
(10 highest)
Davis Besse 1
Vogtle 1
Salem 1
Byron 1
Peach Bottom 3
Palo Verde 1
Palisades
Palo Verde 2
Trojan
Turkey Point 3
$0
$20
$40
$60
$80
$100
$120
$140
(10 lowest)
Prairie Is 1
St. Lucie 2
Point Beach 1
Yankee Rowe
San Onofre 2
St. Lucie 1
Prairie Is 2
River Bend 1
Hope Creek 1
Grand Gulf 1
$0
$20
$40
$60
$80
$100
$120
$140
Annual Constant $'s (thousands)
© TRAC 1992
NRC029
Plants commissioned for commercial operation

Figure 28

penalties.[25] (See also Tables III.9, III.10, III.20 and Table Series VI.) All these comparisons are on a "per year" basis to control for differences in the length of time since each plant was commissioned for commercial operation.

For ten reactors (see Figure 28 and Table VI.7), for example, the NRC has proposed penalties of more than $80,000 on average for each year of their operating lives. (This summary does not include NRC fines proposed while plants were under construction.) The eight with the highest yearly average of proposed penalties, expressed in constant dollars, were Davis Besse (Ohio), $137,349; Vogtle 1 (Georgia), $129,612; Salem 1 (New Jersey), $117,763; Byron 1 (Illinois), $82,978; Peach Bottom 3 (Pennsylvania), $82,924; Palo Verde 1 (Arizona), $82,826; Palisades (Michigan), $82,068; Palo Verde 2 (Arizona), $80,590; Trojan (Oregon), $76,302; and Turkey Point 3 (Florida), $75,059. At the other end of the scale were three reactors against which the NRC has never proposed a penalty while they were operating and four whose annual proposed penalties were under $2,000. Those with no operating penalties were River Bend 1 (Louisiana), Grand Gulf 1 (Mississippi), and Hope Creek 1 (New Jersey). Those with an average annual operating penalty under $2,000 were Prairie Island 2 (Minnesota), St. Lucie 1 (Florida), and San Onofre 2 (California).

The NRC's proposed penalties appear to be minuscule in comparison to the assets of the utilities licensed to operate them. For example, while the total 1990 revenue of the Philadelphia Electric Company amounted to more than $3.7 billion dollars, the average annual proposed penalties for its Peach Bottom 3 reactor came to $82,924. An NRC penalty of course involves legal, public relations, and other costs in addition to the actual penalty. If the NRC requires that conditions causing the violation be remedied, for example, additional costs can be involved. But the relatively small size of most NRC sanctions raise a question about whether the agency is gaining the attention of either the managers or the stockholders of non-compliant utilities. Last year the NRC's executive director for operations, James Taylor, admitted as much. In an August 26 letter to the Tennessee Valley Authority, Taylor wrote: "I am not persuaded that (a fine or citation) can help bring about the necessary changes any more readily than the multitude of program changes TVA has unsuccessfully implemented at (Watts Bar) since the shut down of its nuclear program in 1986."[26]

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[25] Reactors which have been commissioned for only a limited time (less than 2 years) are excluded from these comparisons since there is not enough information on which to reliably rank their performance. While these reactors are excluded from the "Ranking of Facilities" analyses discussed here (Table Series VI), full information on each reactor's performance is provided in the regular tabulations covering individual facilities (Table Series III).

[26] Interestingly, out of 49 utilities with commissioned nuclear power plants, the Tennessee Valley Authority ranks on an annual "per plant" basis second worst in its overall violation rate, third when only serious violations are considered, and second again for the frequency of penalties. However, it is way down the pack -- 22nd -- when ranked on an annual "per plant" basis for the dollar size of proposed penalties the NRC has asserted against the utility.

Although the number of violations, serious violations and proposed penalties directed at the nuclear utilities probably provide a good indication of some aspects of a given utility's performance, the numbers cannot be directly used to measure the overall safety record of the utilities.

This is partly because NRC records concerning a particular utility or reactor are affected by official agency policy decisions such as how many inspectors have been assigned to a given region, the training and experience of these inspectors, and the extent to which NRC managers "target" problem reactors. Another, more subtle influence that probably affects the inspection outcome, is the difference among "enforcement cultures" found in the various offices and regions of the agency. A final factor affecting NRC enforcement findings that is outside the control of the operators -- at least once after the reactor is constructed -- is the type of the facility and its age.[27]

However, the disparities in the rates of violations, serious violations and proposed penalties received by individual utilities and reactors in many cases are far wider than the disparities found in NRC enforcement practices. Further, the assumption that the NRC may target problem facilities, and that differential enforcement gives rise to higher rates of observed violations, does not appear to be borne out in these data. As noted earlier, statistical analyses found little or no association between the inspection times and violation or penalty rates. Finally, the fact that reactors operated by the same utility frequently rank similarly in their performance lends further weight to the use of these rankings as one guide to judging utility performance.

The implications of the very large differentials in utility and reactor performance, judged on the basis of NRC enforcement actions, is both reassuring and distressing. The fact that some plants have achieved so much better performance records indicates what should be possible for many more. Improving standards of performance for others is indeed managerially and technically possible.

Yet the fact that some utilities have violations at each of their plants on average more than twice a month, or serious violations more than twice a year, is very troubling. It underlines the width of the chasm -- how far from acceptable performance standards actual behavior is. The startling variations in the violation rates of the "good" utilities and the "bad" ones suggest a number of possible conclusions. These need not be mutually exclusive. One possible conclusion is that there are real limits to what government regulators can hope to achieve, especially

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[27] In the short term, particularly when dealing with relatively infrequent events such as the detection of a serious violation or the imposition of a penalty, rankings can be unreliable because the events they are based upon occur only rarely. Hence, rankings based upon relatively short time periods will prove an unreliable guide to a utility's (or a reactor's) general performance. It was for this reason that utilities (and reactors) with less than two years of operating experience were excluded from the rankings.

in highly complex or technical situations that have little tolerance for error -- the conditions prevailing here. A second possible conclusion is that this federal government's regulatory approach to imposing a consistently high operating standard on the nation's nuclear utilities has not succeeded.

A HISTORICAL PERSPECTIVE ON NUCLEAR REGULATION

To understand the place of nuclear regulation in 1992, it is well to consider briefly the development of nuclear energy during the last five decades. Without at least a cursory knowledge of this history, the passionate political disputes that have periodically erupted in connection with various aspects of nuclear energy cannot be fathomed. Some of these disputes -- such as the long, divisive battle over the recent licensing of the Seabrook reactor in New Hampshire -- have gone directly to the competence of both the NRC and the industry it regulates. Other disputes have had no direct relation with nuclear power and the generation of electricity but nevertheless have profoundly influenced the general attitudes of the public about the whole technology and its regulation.

Nuclear energy has been an awesome and controversial force since August of 1945 when the United States exploded atomic bombs over the Japanese cities of Hiroshima and Nagasaki. Almost overnight, a new set of words - radioactive, uranium, fallout - were added to the world's languages.

In the years following World War II, the American government sought to find peacetime uses for the formidable energy released when atoms are split. Sponsoring a series of research projects in federally owned laboratories as well as in private industry, government officials turned their greatest attention to the ways in which nuclear energy could be used to generate electricity. The Atomic Energy Act of 1954, which gave private corporations the right to own and operate nuclear reactors, paved the way for the construction and operation of the large commercial reactors that today dot the United States and many other nations of the world.

In the 38 years since the passage of the Atomic Energy Act, nuclear power has become an important part of the world's electric power system and, at the same time, a source of controversy, concern and fear.

At first, the scientists, industrial leaders and government officials who directed the various projects to develop nuclear energy for peaceful purposes were supremely optimistic about the vast benefits they would bring to the world and this optimism was reflected in an uncritical press. Some scientists, for example, speculated that the electricity generated by reactors would be so cheap that it would not be metered. As late as 1974, toward the end of the Nixon Administration, energy planners anticipated the construction of a vast number of reactors in the United

States, some of which would involve a technology that would miraculously create more fuel than was burned. In a speech on February 26, 1974, William Doub, one of the five commissioners who governed the industry just prior to the creation of the NRC, forecast that there would be over 1,000 reactors producing electricity by the year 2000.

Nuclear power reactors were viewed as the easy solution to the world "energy crisis," a storm of public concern sparked partly by the realization that there are indeed finite limits to the world supplies of fossil fuels and partly by the 1973 formation of OPEC, the Organization of Petroleum Exporting Countries.

But the long period of largely-unchecked, public optimism about the benefits of nuclear power - articulated by the United States government, by companies like Westinghouse and General Electric and by many academics - was about to be challenged by a series of unanticipated events. These raised questions in the public mind about whether nuclear power was in fact the unmixed blessing that it had been told.

In 1974, for example, India exploded what it called a nuclear "device." The explosion vividly demonstrated the problem of nuclear proliferation, the slow spread of nuclear weapons from the great superpowers such as the United States and the Soviet Union to other nations. No longer could the world limit its concern to the possibility of a massive nuclear exchange between the USA and USSR. Now it also had to worry about whether India might become so angry at its traditional enemies that its leaders felt compelled to exercise the nuclear option.

While the spread of weapons technology to the smaller nations has been much slower than pessimists predicted during the 1970s, it has nonetheless been relentless. Israel's possession of nuclear weapons has been an open secret for at least a decade and a half. Late last year, UN inspectors reported that Iraq had been only a month or so away from being able to build its first nuclear weapon when development was stopped by American bombing raids. And in February of 1992, India's neighbor, Pakistan, announced that it now had the parts and materials it needed to fashion a weapon.

But there were other kinds of problems that raised public concern over risks posed by nuclear technology. A year after the 1974 explosion in India, an accident in Athens, Alabama raised the question of whether the utilities of the United States were up to the technical challenge of building reactors. The accident occurred at the Browns Ferry nuclear plant owned by the Tennessee Valley Authority when a workman was using a single candle to check the flow of air from a pressurized control room. The candle's flame, sucked in by the moving air, set fire to the polyurethane foam sealing the group of safety related control cables. By the time the fire was extinguished seven hours later, the cables from the control room to two reactors had been extensively damaged. TVA operators managed to shut down both reactors safely, despite the fact that the cooling system for one of them was inoperable for a period of time.

The fire at Browns Ferry is generally considered one of the major turning points in the history of nuclear energy in the United States because it dramatized, for the first time, the potential hazards of nuclear reactors to the public living near the plants. These early doubts about nuclear power were further reinforced by congressional hearings in 1975.

In September of 1977, another important accident occurred, this time at the Davis-Besse plant near Toledo, Ohio. Little immediate public attention was paid to the sequence of events in the accident, during which a valve stuck in the open position and the operators responded by turning off the emergency cooling system. It was subsequently revealed, however, that Davis Besse operators, like others involved in accidents at nuclear power plants, had not been adequately trained for emergency situations. Consequently, they were not in a position to appreciate that their response actually increased the probability of far more serious developments.

What makes the Davis-Besse accident so noteworthy is that John Kemeny, chair of the presidential commission appointed to investigate the accident at Three Mile Island (TMI) in Pennsylvania a few years later, suggested that closer attention to the Davis-Besse accident might have precluded the ensuing development of a full-blown crisis at TMI. An industry-wide attitude that Kemeny described as "nothing can possibly go wrong" prevailed at both Davis-Besse and TMI, with the net effect being that operators were not given clear guidelines on how to respond when malfunctions did occur and valuable knowledge gained from studying one accident was not shared with other utilities.

Certainly the most widely-publicized accident in the history of American reactors was the one occurring at TMI in March of 1979. Once again, initial problems caused by malfunctioning equipment were exacerbated by human error. Subsequent investigations of the TMI accident revealed that one of the greatest problems centered on the fuel rods, which were left uncovered at one point and began to melt. Without totally comprehending the gravity and nature of the problem confronting them, operators unwittingly corrected the situation and a meltdown of the entire core was averted.

Though the worst case outcome was avoided, more by luck than by skill, serious problems remained. TMI also had the effect of creating entirely new types of regulatory concerns. For example, a lingering dilemma at TMI was posed by the challenge of devising a means of safe disposal for the 293,000 pounds of radioactive debris generated by the accident.

Despite the early warning provided by the Browns Ferry and Davis Besse accidents, the number of nuclear reactors had continued to grow. The 1979 accident at Three Mile Island, however, was to prove a different matter. Partly because of the seriousness of the accident and partly because of the plant's proximity to heavily populated cities such as Philadelphia and New York, the TMI accident received intensive news coverage that eventually brought a de facto moratorium to the construction of new reactors in the United States, although some of those already under construction were completed. By 1989, ten years after the TMI accident, a total of 118 commercial reactors had been commissioned for operation in the United States,[28] a significant national investment but far fewer than had been predicted by the experts of the mid-1970s.

THE NUCLEAR REGULATORY COMMISSION: ITS GOALS AND ORGANIZATION

The federal government's regulatory role has helped shape, as well as been shaped by, evolving public attitudes towards nuclear technology. Federal regulatory efforts were initially directed toward issues of national security. Soon, however, increased knowledge about the dangers of exposure to radiation led to increased regulation to protect both workers in nuclear industries and the public in general. With the accidents at Browns Ferry, Davis Besse and Three Mile Island, the issue of reactor safety became paramount. More recently, with the gradual accumulation of various kinds of nuclear wastes and the approaching time when more and more commercial reactors will have to be dismantled, concerns about the difficulties of safely disposing of used nuclear materials have become important.

Since the beginning, the use of atomic energy to produce electricity has involved a complex mix of technology, business interests, environmental issues, government regulation, and political controversy. Organizationally, two government agencies, the Atomic Energy Commission (AEC) and the Nuclear Regulatory Commission (NRC), have played the lead roles in managing the growth and operations of the nuclear industry since the end of World War II. The AEC, which monitored both military and nonmilitary uses of nuclear materials, was disbanded in the mid-1970s. The Department of Energy ultimately took over the AEC's military functions, including supervision of certain research laboratories, running the processing plants for uranium and plutonium, and operating the so-called "production reactors."

The NRC, meanwhile, took on the task of overseeing non-military functions in 1975. The agency functions under guidelines supplied by two major pieces of legislation: the Atomic Energy Act, which was first passed in 1954, and the Energy Reorganization Act of 1974. Subsequent legislation, especially the Nuclear Waste Policy Act of 1982, expanded the NRC's responsibilities for safe disposal of

[28] This count does not include a few of the very early small power reactors.

radioactive material.

Over the years, the NRC has altered its organizational structure a number of times. Offices and positions have been abolished and new ones have been created. Throughout its sometimes stormy history, however, the agency has been headed by a board of five commissioners. Other important components of the NRC's organizational framework include: senior staff and support staff working at the agency's headquarters in the Washington D.C. area; regional office personnel employed at the five regional offices located throughout the country; and employees stationed at facilities whose performance is monitored by the NRC.

All five of the NRC commissioners are appointed by the President, subject to Senate confirmation. The commissioners, who in turn appoint other senior staff members, are assisted in fulfilling their duties by a commission staff and advisory committees. One of the five commissioners serves as chair.

Reporting to the NRC's Executive Director for Operations are a number of program and staff offices. "Program" offices include personnel responsible for reactor regulation, while "staff" offices consist of members of the Controller's staff, as well as the employees responsible for gathering and evaluating information about the various facilities licensed by the NRC. Staff at the regional offices also report to the Executive Director for Operations.

The key duty of the NRC is to regulate current and potential hazards associated with the use of atomic energy. In some of its recent yearly reports, the NRC explains its regulatory responsibilities this way:

> The mission of the NRC is to assure that civilian uses of nuclear materials in the United States - in the operation of nuclear power plants or in medical, industrial, or research applications - are carried out with proper regard and provision for the protection of public health and safety, of the environment, and of national security.

In performing these responsibilities, the actual operations of the NRC can be quite varied. Recorded in the budget that the commission presents to Congress each year are expenses for a range of programs, among them reactor safety, nuclear safety research, nuclear material and low-level waste safety, high-level nuclear waste regulation, and special reviews, investigation, and enforcement.

The NRC, acting in its capacity as the federal agency in charge of licensing and regulating the use of non-military nuclear materials in the United States, sends inspectors to a wide assortment of facilities and institutions. Included under the NRC's jurisdiction are not only such major installations as nuclear power plants and producers of the uranium fuel used in power plants, but also a vast number of other types of facilities where nuclear materials are used. NRC inspections take place at hospitals, medical clinics and laboratories, waste disposal sites, universities, and corporations throughout the country.

The agency's responsibilities, of course, involve such major matters as the accident at Three Mile Island in 1979. But it also must handle such seemingly minor matters as how to dispose of a load of scrap metal that set off radiation monitors at a scrap metal processing plant, and whether emergency drills are held as scheduled at a university conducting research on the use of nuclear materials.

In explaining how it monitors the power-producing reactors that are a main focus of this report, NRC publications identify two major types of inspections: "routine" (or planned) inspections and "reactive" inspections. "Routine" inspections allude to activities such as tours of a reactor's control room, evaluation of security, and observation of any plant modification work that has been undertaken. Most of these activities are conducted either by the resident inspector assigned permanently to each power facility or by inspectors from the regional office. Personnel working at NRC's headquarters become involved in actual inspections primarily through the Special Team Inspection program, which is intended to provide an independent evaluation of how a given facility is performing.

"Reactive" inspections take place in response to an occurrence at one of the facilities under NRC's jurisdiction. These are the inspections with which the American public is most familiar because like the events at Three Mile Island, they are widely reported by the media.

CONCLUSION

The NRC sits at the center of a network of conflicting pressures coming from industry, concerned legislators, and an aroused public. The agency's inspection and enforcement endeavors are directed at each plant's owner, as well as at equipment safety and the behavior of plant personnel. Routine inspections are conducted on a prescribed cycle that can be altered according to how well a particular facility performs. Plants identified as substandard in performance are supposed to be scrutinized more often and closely. When a "generic" problem that affects a number of reactors is discovered, special inspection teams of personnel from different NRC offices may be given the task of visiting all plants using the same or similar equipment.

Critics of the NRC's inspection and enforcement program, however, assert that it reflects a reactive, rather than proactive, set of beliefs about the nature of the regulatory process. Instead of launching an aggressive program of inspection and enforcement designed to ensure the safety of the American public, these critics say, the NRC is a passive agency that simply responds to crises.

Spokespersons for the nuclear power industry have consistently argued that nuclear energy provides a safe, clean alternative to the use of fossil fuels. In response to concerns raised by what happened at TMI and elsewhere, they claim that the problems that occurred have been addressed. They also argue that new self-regulation processes are in place: private groups such as the Nuclear Safety Analysis Center (NSAC) and the Institute of Nuclear Power Operations (INPO) assumed the task of regulating the industry effectively in the wake of TMI. These organizations are described as providing a forum through which the employees of utility companies relying on nuclear power, and employees of corporations that design and sell reactor components, can exchange useful information. According to the proponents of such groups, the probability of the recurrence of an incident like TMI has been reduced to near zero. Although the accident at Chernobyl in late April 1986 involved an aging and poorly designed Soviet reactor, the subsequent dispersal of massive amounts of radioactive material did not improve the general reputation of nuclear power as a safe source of energy.

The NRC thus faces problems of vital importance to the safety and economic well being of the American people. Assuming a new generation of reactors will be required, what is the best possible design? What kinds of organizations are best equipped to operate them? Considering only the radioactive wastes it is responsible for, can the NRC create a political consensus that will allow for its safe storage in permanent waste dumps? Understanding that the nation soon will have to decommission a large number of reactors, has the government and industry given adequate consideration to the technical challenges and cost of closing down these massive and highly radioactive plants?

The American people would like to believe that the serious and important problems of generating electricity by nuclear power can be safely left in the hands of the NRC and the industries it regulates. But the frequency of accidents such as those that have occurred at Browns Ferry, Davis Besse, Three Mile Island and Chernobyl, and the record of significant disparities in the performance of both the technicians who operate reactors and the inspectors who regulate them, suggests another approach may be desirable. Thus, this report is dedicated to the proposition that improved public understanding of how the government actually is functioning necessarily will improve its effectiveness in dealing with the challenges it confronts.

APPENDIX A

Table 1

COMMERCIAL NUCLEAR POWER REACTORS IN THE U.S. (1989)
By Name and State

Facility	State	Year: Construction Permit Issued	Year: Commissioned For Commercial Operation	Year: Permanent Shut Down	Year: Operating[1] License Expires
Arkansas 1	Arkansas	1968	1974	-	2008
Arkansas 2	Arkansas	1972	1980	-	2012
Beaver Valley 1	Pennsylvania	1970	1976	-	2016
Beaver Valley 2	Pennsylvania	1974	1987	-	2027
Bellefonte 1	Alabama	1974	-	-	-
Bellefonte 2	Alabama	1974	-	-	-
Big Rock Point	Michigan	1960	1963	-	2000
Braidwood 1	Illinois	1975	1988	-	2026
Braidwood 2	Illinois	1975	1988	-	2027
Browns Ferry 1	Alabama	1967	1974	-	2013
Browns Ferry 2	Alabama	1967	1975	-	2014
Browns Ferry 3	Alabama	1968	1977	-	2016
Brunswick 1	North Carolina	1970	1977	-	2010
Brunswick 2	North Carolina	1970	1975	-	2010
Byron 1	Illinois	1975	1985	-	2024
Byron 2	Illinois	1975	1987	-	2026
Callaway	Missouri	1976	1984	-	2024
Calvert Cliffs 1	Maryland	1969	1975	-	2014
Calvert Cliffs 2	Maryland	1969	1977	-	2016
Catawba 1	South Carolina	1975	1985	-	2024
Catawba 2	South Carolina	1975	1986	-	2026

[1]The expiration of a plant's commercial operating license has not always automatically resulted in it being shut down. As of 1989, Dresden 2, Oyster Creek, Palisades, and San Onofre continued to operate under the provisions of Section 2.109 of Title 10. Since 1989, all four of these licenses have been extended - until 2004 in the case of Oyster Creek and San Onofre, 2006 for Dresden 2, and 2007 for Palisades. Other plants approaching the end of their originally designated lifespans have also received extensions of their operating licenses. The table entries reflect status as of 1989, since this is the time period covered by NRC activities in this report.

Table 1 (con't)

Facility	State	Year			
		Construction Permit Issued	Commissioned For Commercial Operation	Permanent Shut Down	Operating License Expires
Clinton	Illinois	1976	1987	-	2026
Comanche Peak 1	Texas	1974	-	-	-
Comanche Peak 2	Texas	1974	-	-	-
Cook 1	Michigan	1969	1975	-	2009
Cook 2	Michigan	1969	1978	-	2009
Cooper Station	Nebraska	1968	1974	-	2008
Crystal River 3	Florida	1968	1977	-	2016
Davis Besse 1	Ohio	1971	1978	-	2011
Diablo Canyon 1	California	1968	1985	-	2008
Diablo Canyon 2	California	1970	1986	-	2010
Dresden 1	Illinois	1957	1960	1978	1978
Dresden 2	Illinois	1966	1970	-	1972
Dresden 3	Illinois	1966	1971	-	2006
Duane Arnold	Iowa	1970	1975	-	2010
Farley 1	Alabama	1972	1977	-	2017
Farley 2	Alabama	1972	1981	-	2021
Fermi 1	Michigan	1956	1966	1972	1972
Fermi 2	Michigan	1972	1988	-	2025
Fitzpatrick	New York	1970	1975	-	2014
Fort Calhoun 1	Nebraska	1968	1974	-	2008
Ft. St. Vrain	Colorado	1968	1976	1989	1989
Ginna	New York	1966	1970	-	2006
Grand Gulf 1	Mississippi	1974	1985	-	2022
Grand Gulf 2	Mississippi	1974	-	-	-
Haddam Neck	Connecticut	1964	1968	-	2007

Table 1 (con't)

Facility	State	Year: Construction Permit Issued	Commissioned For Commercial Operation	Permanent Shut Down	Operating License Expires
Harris 1	North Carolina	1978	1987	-	2026
Hatch 1	Georgia	1969	1975	-	2014
Hatch 2	Georgia	1972	1979	-	2018
Hope Creek 1	New Jersey	1974	1986	-	2026
Humboldt Bay	California	1960	1963	1976	1976
Indian Point 1	New York	1956	1962	1974	1974
Indian Point 2	New York	1966	1974	-	2013
Indian Point 3	New York	1969	1976	-	2009
Kewaunee	Wisconsin	1968	1974	-	2013
La Crosse	Wisconsin	1963	1968	1987	1987
La Salle 1	Illinois	1973	1984	-	2022
La Salle 2	Illinois	1973	1984	-	2023
Limerick 1	Pennsylvania	1974	1986	-	2024
Limerick 2[2]	Pennsylvania	1974	-	-	2029
Maine Yankee	Maine	1968	1972	-	2008
McGuire 1	North Carolina	1973	1981	-	2021
McGuire 2	North Carolina	1973	1984	-	2023
Millstone 1	Connecticut	1966	1971	-	2010
Millstone 2	Connecticut	1970	1975	-	2015
Millstone 3	Connecticut	1974	1986	-	2025
Monticello	Minnesota	1967	1971	-	2010
Nine Mile Pt 1	New York	1965	1969	-	2005
Nine Mile Pt 2	New York	1974	1988	-	2026
North Anna 2	Virginia	1971	1980	-	2020
North Anna 1	Virginia	1971	1978	-	2018

[2]Limerick 2 was subsequently commissioned for commercial operation in 1990.

Table 1 (con't)

Facility	State	Year: Construction Permit Issued	Commissioned For Commercial Operation	Permanent Shut Down	Operating License Expires
Oconee 1	South Carolina	1967	1973	-	2013
Oconee 2	South Carolina	1967	1974	-	2013
Oconee 3	South Carolina	1967	1974	-	2014
Palo Verde 1	Arizona	1976	1986	-	2024
Palo Verde 2	Arizona	1976	1986	-	2025
Oyster Creek	New Jersey	1964	1969	-	1972
Palisades	Michigan	1967	1971	-	1974
Palo Verde 3	Arizona	1976	1988	-	2027
Peach Bottom 1	Pennsylvania	1962	1967	1974	1974
Peach Bottom 2	Pennsylvania	1968	1974	-	2008
Peach Bottom 3	Pennsylvania	1968	1974	-	2008
Perry 1	Ohio	1977	1987	-	2026
Perry 2	Ohio	1977	-	-	-
Pilgrim 1	Massachusetts	1968	1972	-	2008
Point Beach 1	Wisconsin	1967	1970	-	2010
Point Beach 2	Wisconsin	1968	1972	-	2013
Prairie Is 1	Minnesota	1968	1973	-	2013
Prairie Is 2	Minnesota	1968	1974	-	2014
Quad Cities 1	Illinois	1967	1973	-	2007
Quad Cities 2	Illinois	1967	1973	-	2007
Rancho Seco[3]	California	1968	1975	1989	2008
River Bend 1	Louisiana	1977	1986	-	2025
Robinson 2	South Carolina	1967	1971	-	2007
Salem 1	New Jersey	1968	1977	-	2008
Salem 2	New Jersey	1968	1981	-	2008

[3] Seco was prematurely shut down in 1989.

Table 1 (con't)

Facility	State	Year			
		Construction Permit Issued	Commissioned For Commercial Operation	Permanent Shut Down	Operating License Expires
San Onofre 1	California	1964	1968	-	1972
San Onofre 2	California	1973	1983	-	2013
San Onofre 3	California	1973	1984	-	2013
Seabrook 1[4]	New Hampshire	1976	-	-	2026
Sequoyah 1	Tennessee	1970	1981	-	2020
Sequoyah 2	Tennessee	1970	1982	-	2021
Shoreham[5]	New York	1973	-	-	2013
South Texas 1	Texas	1975	1988	-	2027
South Texas 2	Texas	1975	1989	-	2028
St. Lucie 1	Florida	1970	1976	-	2016
St. Lucie 2	Florida	1977	1983	-	2023
Summer	South Carolina	1973	1984	-	2022
Surry 1	Virginia	1968	1972	-	2012
Surry 2	Virginia	1968	1973	-	2013
Susquehanna 1	Pennsylvania	1973	1983	-	2022
Susquehanna 2	Pennsylvania	1973	1985	-	2024
Three Mile Is 1	Pennsylvania	1968	1974	-	2008
Three Mile Is 2	Pennsylvania	1969	1978	1979	1979
Trojan	Oregon	1971	1976	-	2011
Turkey Point 3	Florida	1967	1972	-	2007
Turkey Point 4	Florida	1967	1973	-	2007

[4]Seabrook 1 has been the subject of extensive litigation. After being authorized to operate at low power in the 1980's, the plant was shut down in 1989 pending review of emergency response plans before the Atomic Safety and Licensing Board Panel (ASLBP). The NRC subsequently issued a full-power license for Seabrook in March 1990 and the plant began commercial operations in August of 1990.

[5]Shoreham was given an operating license in 1989, but never went into commercial operation and was prematurely shut down.

Table 1 (con't)

Facility	State	Year: Construction Permit Issued	Commissioned For Commercial Operation	Permanent Shut Down	Operating License Expires
Vermont Yankee	Vermont	1967	1972	-	2007
Vogtle 1	Georgia	1974	1987	-	2027
Vogtle 2	Georgia	1974	1989	-	2029
Wash Nuc 1	Washington	1975	-	-	-
Wash Nuc 2	Washington	1973	1984	-	2023
Wash Nuc 3	Washington	1978	-	-	-
Waterford 3	Louisiana	1974	1985	-	2024
Watts Bar 1	Tennessee	1973	-	-	-
Watts Bar 2	Tennessee	1973	-	-	-
Wolf Creek 1	Kansas	1977	1985	-	2025
Yankee Rowe	Massachusetts	1957	1961	-	2000
Zion 1	Illinois	1968	1973	-	2008
Zion 2	Illinois	1968	1974	-	2008

Sources:

The primary source of information was the 1990 NRC Information Digest. Information regarding reactors that were shut down (particularly those prior to 1989) or had 'unusual occurrences' were obtained from either NRC Annual Reports, Atomic Energy Annual Reports, Public Document Rooms, and in some instances, the licensee.

Table 2

COMMERCIAL NUCLEAR POWER REACTORS IN U.S. (1989)
By Operating Utility

Utility	Facility	State	Region	Capacity[1]	Reactor Type
Alabama Power Co.	Farley 1	Alabama	II	824	Pressurized Water
	Farley 2	Alabama	II	830	Pressurized Water
Arkansas Power & Light Co.	Arkansas 1	Arkansas	IV	836	Pressurized Water
	Arkansas 2	Arkansas	IV	858	Pressurized Water
Arizona Public Service Co.	Palo Verde 1	Arizona	V	1221	Pressurized Water
	Palo Verde 2	Arizona	V	1221	Pressurized Water
	Palo Verde 3	Arizona	V	1221	Pressurized Water
Baltimore Gas & Electric	Calvert Cliffs 1	Maryland	I	825	Pressurized Water
	Calvert Cliffs 2	Maryland	I	825	Pressurized Water
Boston Edison Co.	Pilgrim 1	Massachusetts	I	670	Boiling Water
Carolina Power & Light Co.	Brunswick 1	North Carolina	II	790	Boiling Water
	Brunswick 2	North Carolina	II	790	Boiling Water
	Harris 1	North Carolina	II	860	Pressurized Water
	Robinson 2	South Carolina	II	665	Pressurized Water
Cleveland Electric Illumination	Perry 1	Ohio	III	1205	Boiling Water
	Perry 2	Ohio	III	1205	Boiling Water
Commonwealth Edison Co.	Braidwood 1	Illinois	III	1120	Pressurized Water
	Braidwood 2	Illinois	III	1120	Pressurized Water
	Byron 1	Illinois	III	1105	Pressurized Water
	Byron 2	Illinois	III	1105	Pressurized Water
	Dresden 1	Illinois	III	184	Boiling Water
	Dresden 2	Illinois	III	772	Boiling Water
	Dresden 3	Illinois	III	773	Boiling Water
	La Salle 1	Illinois	III	1036	Boiling Water
	La Salle 2	Illinois	III	1036	Boiling Water
	Quad Cities 1	Illinois	III	769	Boiling Water
	Quad Cities 2	Illinois	III	769	Boiling Water
	Zion 1	Illinois	III	1040	Pressurized Water
	Zion 2	Illinois	III	1040	Pressurized Water
Connecticut Yankee Atomic Power	Haddam Neck	Connecticut	I	565	Pressurized Water
Consolidated Edison Co. of NY	Indian Point 1	New York	I	65	Pressurized Water

[1]Electrical generating capacity in megawatts.

Table 2 (con't)

Utility	Facility	State	Region	Capacity	Reactor Type
	Indian Point 2	New York	I	864	Pressurized Water
Consumers Power	Big Rock Point	Michigan	III	67	Boiling Water
	Palisades	Michigan	III	730	Pressurized Water
Dairyland Power Corp.	La Crosse	Wisconsin	III	50	Boiling Water
Detroit Edison Co.	Fermi 1	Michigan	III	0.9	Sodium Fast Breed
	Fermi 2	Michigan	III	1093	Boiling Water
Duke Power Co.	Catawba 1	South Carolina	II	1129	Pressurized Water
	Catawba 2	South Carolina	II	1129	Pressurized Water
	McGuire 1	North Carolina	II	1129	Pressurized Water
	McGuire 2	North Carolina	II	1129	Pressurized Water
	Oconee 1	South Carolina	II	846	Pressurized Water
	Oconee 2	South Carolina	II	846	Pressurized Water
	Oconee 3	South Carolina	II	846	Pressurized Water
Duquesne Light Co.	Beaver Valley 1	Pennsylvania	I	810	Pressurized Water
	Beaver Valley 2	Pennsylvania	I	833	Pressurized Water
Florida Power & Lighting Co.	St. Lucie 1	Florida	II	839	Pressurized Water
	St. Lucie 2	Florida	II	839	Pressurized Water
	Turkey Point 3	Florida	II	666	Pressurized Water
	Turkey Point 4	Florida	II	666	Pressurized Water
Florida Power	Crystal River 3	Florida	II	821	Pressurized Water
Georgia Power Co.	Hatch 1	Georgia	II	757	Boiling Water
	Hatch 2	Georgia	II	768	Boiling Water
	Vogtle 1	Georgia	II	1083	Pressurized Water
	Vogtle 2	Georgia	II	1083	Pressurized Water
Gulf States Utilities Co.	River Bend 1	Louisiana	IV	936	Boiling Water
GPU Nuclear Corp.	Oyster Creek	New Jersey	I	620	Boiling Water
	Three Mile Is 1	Pennsylvania	I	808	Pressurized Water
	Three Mile Is 2	Pennsylvania	I	906	Pressurized Water
Houston Lighting & Power Co.	South Texas 1	Texas	IV	1250	Pressurized Water
	South Texas 2	Texas	IV	1250	Pressurized Water
Illinois Power Co.	Clinton	Illinois	III	930	Boiling Water
Indiana & Michigan Power Co.	Cook 1	Michigan	III	1020	Pressurized Water
	Cook 2	Michigan	III	1060	Pressurized Water

Table 2 (con't)

Utility	Facility	State	Region	Capacity	Reactor Type
Iowa Electric Light & Power Co.	Duane Arnold	Iowa	III	538	Boiling Water
Long Island Lighting Co.	Shoreham	New York	I	820	Boiling Water
Louisiana Power & Light Co.	Waterford 3	Louisiana	IV	1075	Pressurized Water
Maine Yankee Atomic Power Co.	Maine Yankee	Maine	I	810	Pressurized Water
Nebraska Public Power District	Cooper	Nebraska	IV	764	Boiling Water
New York Power Authority	Fitzpatrick	New York	I	778	Boiling Water
	Indian Point 3	New York	I	965	Pressurized Water
Niagara Mohawk Power Corp.	Nine Mile Point 1	New York	I	610	Boiling Water
	Nine Mile Point 2	New York	I	1080	Boiling Water
Northeast Nuclear Energy Co.	Millstone 1	Connecticut	I	654	Boiling Water
	Millstone 2	Connecticut	I	863	Pressurized Water
	Millstone 3	Connecticut	I	1137	Pressurized Water
Northern States Power Co.	Monticello	Minnesota	III	545	Boiling Water
	Prairie Island 1	Minnesota	III	503	Pressurized Water
	Prairie Island 2	Minnesota	III	503	Pressurized Water
Omaha Public Power District	Fort Calhoun 1	Nebraska	IV	478	Pressurized Water
Pacific Gas & Electric Co.	Diablo Canyon 1	California	V	1073	Pressurized Water
	Diablo Canyon 2	California	V	1087	Pressurized Water
	Humboldt Bay	California	V	65	Boiling Water
Pennsylvania Power & Light Co.	Susquehanna 1	Pennsylvania	I	1032	Boiling Water
	Susquehanna 2	Pennsylvania	I	1038	Boiling Water
Philadelphia Electric Co.	Limerick 1	Pennsylvania	I	1055	Boiling Water
	Limerick 2	Pennsylvania	I	1065	Boiling Water
	Peach Bottom 1	Pennsylvania	I	40	HiTemp Gas Cool
	Peach Bottom 2	Pennsylvania	I	1051	Boiling Water
	Peach Bottom 3	Pennsylvania	I	1035	Boiling Water
Portland General Electric Co.	Trojan	Oregon	V	1095	Pressurized Water
Public Service Co. of Colorado	Ft. St. Vrain	Colorado	IV	330	HiTemp Gas Cool
Public Service Co. of NH	Seabrook 1	New Hampshire	I	1148	Pressurized Water
Public Service Electric & Gas	Hope Creek 1	New Jersey	I	1031	Boiling Water

Table 2 (con't)

Utility	Facility	State	Region	Capacity	Reactor Type
	Salem 1	New Jersey	I	1106	Pressurized Water
	Salem 2	New Jersey	I	1106	Pressurized Water
Rochester Gas & Electric	Ginna	New York	I	470	Pressurized Water
Sacramento Municipal Utilities District	Rancho Seco	California	V	873	Pressurized Water
South Carolina Electric & Gas	Summer	South Carolina	II	885	Pressurized Water
Southern California Edison Co.	San Onofre 1	California	V	436	Pressurized Water
	San Onofre 2	California	V	1070	Pressurized Water
	San Onofre 3	California	V	1080	Pressurized Water
System Energy Resources	Grand Gulf 1	Mississippi	II	1142	Boiling Water
	Grand Gulf 2	Mississippi	II	1250	Boiling Water
Tennessee Valley Authority	Bellefonte 1	Alabama	II	1235	Pressurized Water
	Bellefonte 2	Alabama	II	1235	Pressurized Water
	Browns Ferry 1	Alabama	II	1065	Boiling Water
	Browns Ferry 2	Alabama	II	1065	Boiling Water
	Browns Ferry 3	Alabama	II	1065	Boiling Water
	Sequoyah 1	Tennessee	II	1148	Pressurized Water
	Sequoyah 2	Tennessee	II	1148	Pressurized Water
	Watts Bar 1	Tennessee	II	1165	Pressurized Water
	Watts Bar 2	Tennessee	II	1165	Pressurized Water
Texas Utilities Electric Co.	Comanche Peak 1	Texas	IV	1150	Pressurized Water
	Comanche Peak 2	Texas	IV	1150	Pressurized Water
Toledo Edison Co.	Davis Besse 1	Ohio	III	860	Pressurized Water
Union Electric Co.	Callaway	Missouri	III	1118	Pressurized Water
Vermont Yankee Nuclear Power Co.	Vermont Yankee	Vermont	I	504	Boiling Water
Virginia Power Co.	North Anna 1	Virginia	II	915	Pressurized Water
	North Anna 2	Virginia	II	915	Pressurized Water
	Surry 1	Virginia	II	781	Pressurized Water
	Surry 2	Virginia	II	781	Pressurized Water
Washington Public Power Supply	Wash Nuc 1	Washington	V	1266	Pressurized Water
	Wash Nuc 2	Washington	V	1095	Boiling Water
	Wash Nuc 3	Washington	V	1242	Pressurized Water

Table 2 (con't)

Utility	Facility	State	Region	Capacity	Reactor Type
Wisconsin Electric Power Co.	Point Beach 1	Wisconsin	III	485	Pressurized Water
	Point Beach 2	Wisconsin	III	485	Pressurized Water
	Kewaunee	Wisconsin	III	503	Pressurized Water
Wolf Creek Nuclear Operating Co.	Wolf Creek 1	Kansas	IV	1135	Pressurized Water
Yankee Atomic Electric Co.	Yankee Rowe	Massachusetts	I	167	Pressurized Water

Sources:

The primary source of information was the 1990 NRC Information Digest. Information regarding reactors that were shut down (particularly those prior to 1989) or had 'unusual occurrences' were obtained from either NRC Annual Reports, Atomic Energy Annual Reports, Public Document Rooms, and in some instances, the licensee.

NRC REGION I
COMMERCIAL NUCLEAR POWER REACTOR SITES

Connecticut
- ▲ Haddam Neck
- ▲ Millstone 1, 2, and 3

Maine
- ▲ Maine Yankee

Maryland
- ▲ Calvert Cliffs 1 and 2

Massachusetts
- ▲ Pilgrim 1
- ▲ Yankee Rowe

New Hampshire
- ▲ Seabrook 1 (Commissioned 1990)

New Jersey
- ▲ Hope Creek 1
- ▲ Oyster Creek 1
- ▲ Salem 1 and 2

New York
- ▲ Fitzpatrick
- ▲ Ginna
- ▲ Indian Point 2 and 3
- ▲ Nine Mile Point 1 and 2
- ▲ Shoreham (Not Commissioned)

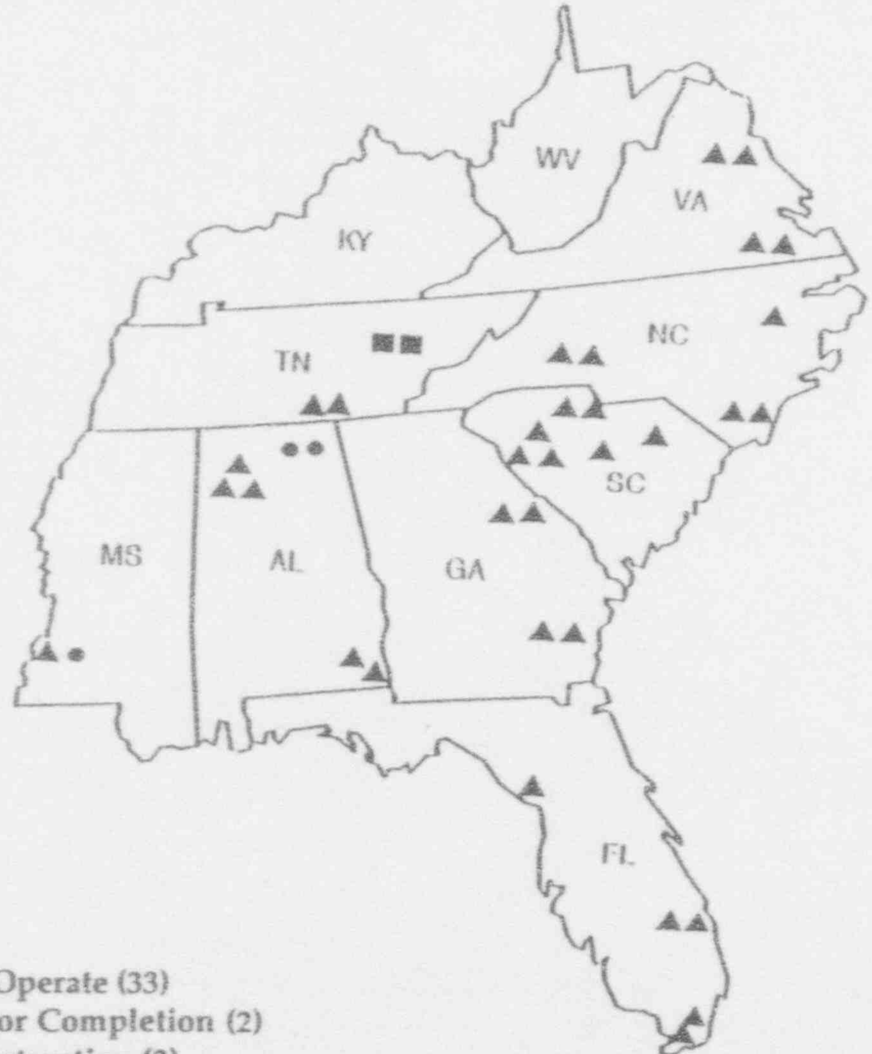
Pennsylvania
- ▲ Beaver Valley 1 and 2
- ▲ Limerick 1 and 2 (Limerick 2 Commissioned 1990)
- ▲ Peach Bottom 2 and 3
- ▲ Susquehanna 1 and 2
- ▲ Three Mile Island 1

Vermont
- ▲ Vermont Yankee

Legend
▲ Licensed To Operate
(30 commissioned, plus 1 licensed but not commissioned)

Excludes plants permanently shut down by 1989

NRC REGION II
COMMERCIAL NUCLEAR POWER REACTOR SITES



Legend
- ▲ Licensed To Operate (33)
- ■ Scheduled For Completion (2)
- • Deferred Construction (3)

Alabama
- ▲ Browns Ferry 1, 2, and 3
- ▲ Joseph M. Farley 1 and 2
- • Bellefonte 1 and 2

Florida
- ▲ Crystal River 3
- ▲ St. Lucie 1 and 2
- ▲ Turkey Point 3 and 4

Georgia
- ▲ Hatch 1 and 2
- ▲ Vogtle 1 and 2

Mississippi
- ▲ Grand Gulf 1
- • Grand Gulf 2

North Carolina
- ▲ Brunswick 1 and 2
- ▲ McGuire 1 and 2
- ▲ Shearon Harris 1

South Carolina
- ▲ Catawba 1 and 2
- ▲ Oconee 1, 2, and 3
- ▲ Robinson 2
- ▲ Summer 1

Tennessee
- ▲ Sequoyah 1 and 2
- ■ Watts Bar 1 and 2

Virginia
- ▲ North Anna 1 and 2
- ▲ Surry 1 and 2

Excludes plants permanently shut down by 1989

NRC REGION III
COMMERCIAL NUCLEAR POWER REACTOR SITES

Illinois
- ▲ Braidwood 1 and 2
- ▲ Byron 1 and 2
- ▲ Clinton 1
- ▲ Dresden 2 and 3
- ▲ LaSalle 1 and 2
- ▲ Quad Cities 1 and 2
- ▲ Zion 1 and 2

Iowa
- ▲ Duane Arnold 1

Michigan
- ▲ Monticello
- ▲ Prairie Island 1 and 2

Missouri
- ▲ Callaway 1

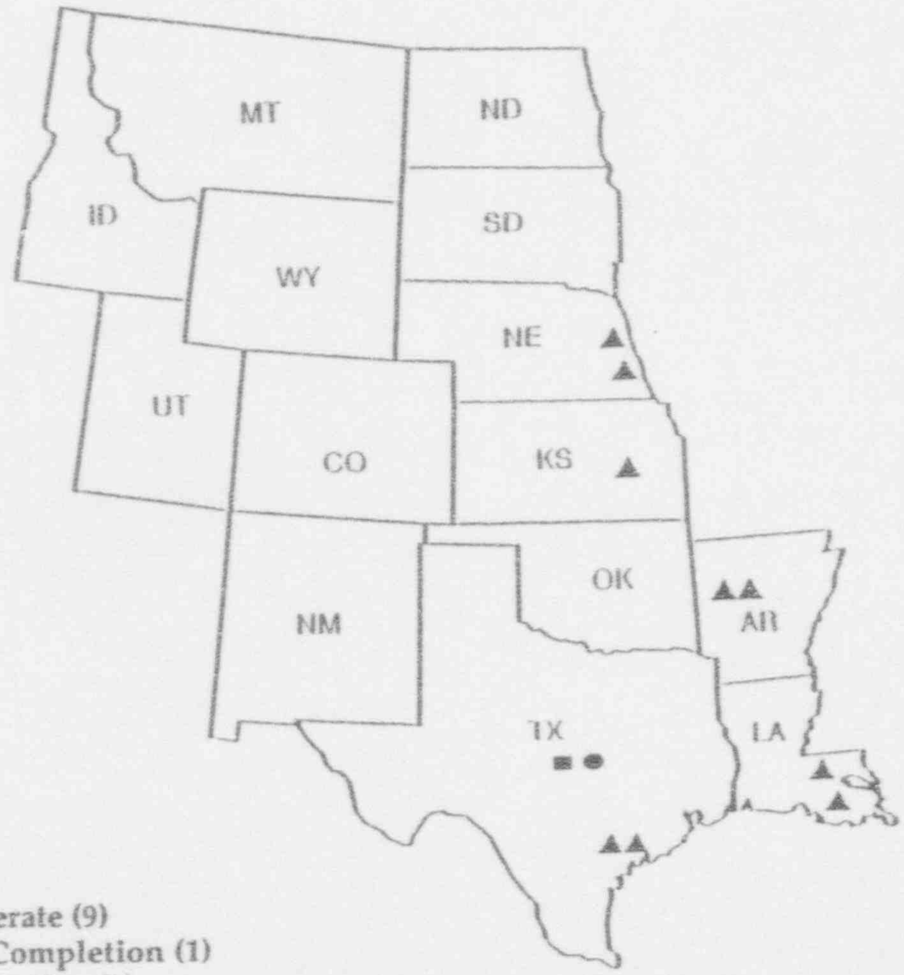
Ohio
- ▲ Davis Besse 1
- ▲ Perry 1
- • Perry 2

Wisconsin
- ▲ Kewaunee
- ▲ Point Beach 1 and 2

Excludes plants permanently shut down by 1989

Legend
- ▲ Licensed To Operate (28)
- • Deferred Construction (1)

NRC REGION IV
COMMERCIAL NUCLEAR POWER REACTOR SITES



Arkansas
- ▲ Arkansas 1 and 2

Kansas
- ▲ Wolf Creek

Louisiana
- ▲ River Bend
- ▲ Waterford 3

Nebraska
- ▲ Cooper Station
- ▲ Fort Calhoun

Texas
- ■ Comanche Peak 1
- • Comanche Peak 2
- ▲ South Texas 1 and 2

Legend
- ▲ Licensed To Operate (9)
- ■ Scheduled For Completion (1)
- • Deferred Construction (1)

Excludes plants permanently shut down by 1989

NRC REGION V
COMMERCIAL NUCLEAR POWER REACTOR SITES

Arizona
- ▲ Palo Verde 1, 2, and 3

California
- ▲ Diable Canyon 1 and 2
- ▲ San Onofre 1, 2, and 3

Oregon
- ▲ Trojan 1

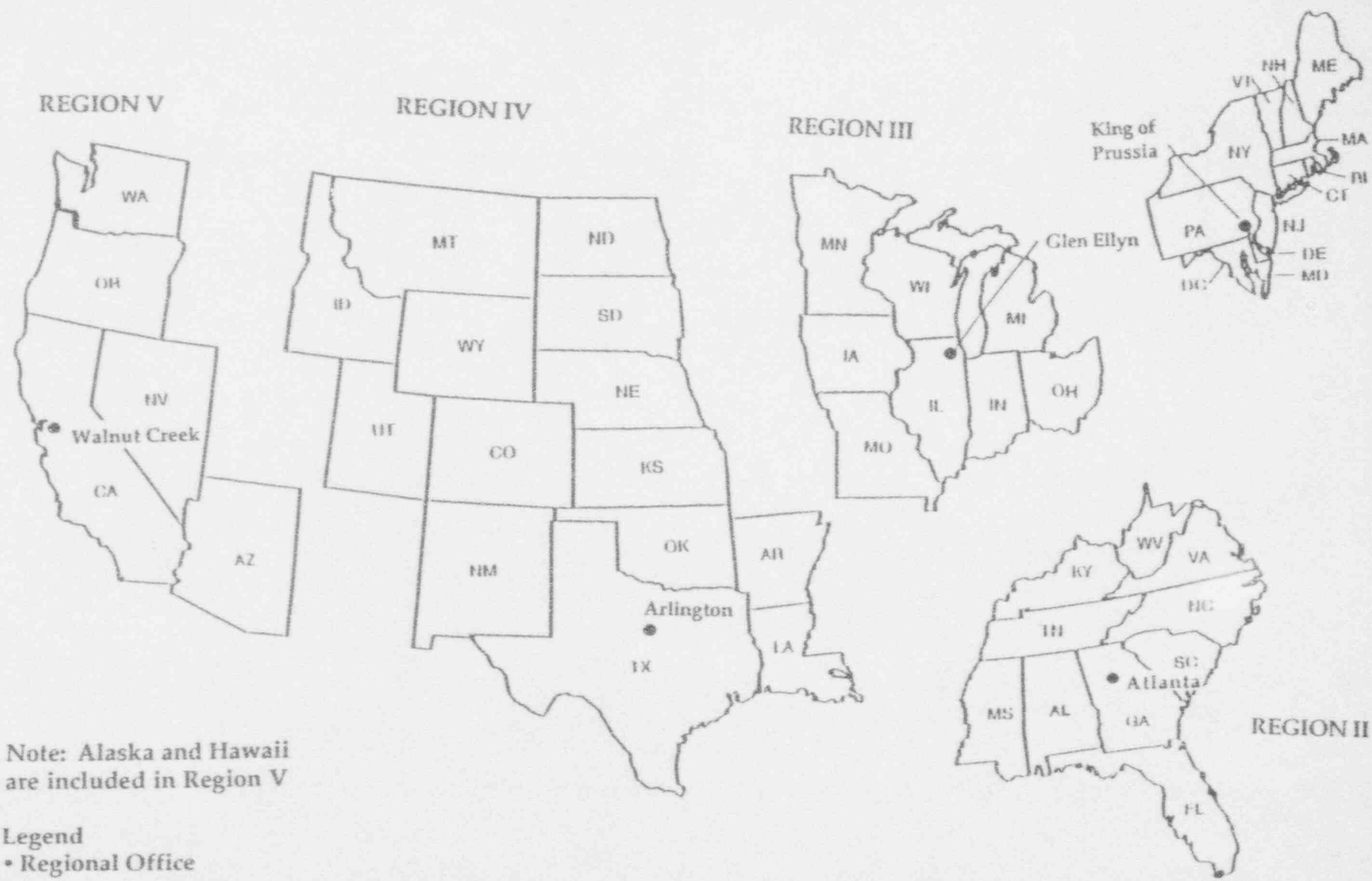
Washington
- • WPPSS 2
- • WPPSS 1
- • WPPSS 3

Note: There are no commercial reactors in Alaska or Hawaii

Legend
- ▲ Licensed To Operate (10)
- • Deferred Construction (2)

Excludes plants permanently shut down by 1989

U.S. Nuclear Regulatory Commission
Geographic Locations



Note: Alaska and Hawaii are included in Region V

Legend
• Regional Office

APPENDIX B

Organization and Contents Of Research Volumes

There are four *Research Volumes*. They are divided into eight series of tables -- designated by Roman numerals I through VIII. These cover the period 1975 to August of 1989. Each table series examines the NRC from a different perspective. For example, in the "Yearly Table Series I" NRC inspections, violations which are detected, and resulting proposed penalties are organized by *year*. In the "State Table Series V" these same NRC enforcement activities are summarized by *state*. The eight series, and the volumes they are located in, are listed below:

Series Number	Organization or Series Focus	Research Volume
I	Yearly	1st
II	Regional	1st
III	Facility	2nd
IV	Utility	3rd
V	State	3rd
VI	Ranking of Facilities	4th
VII	Ranking of Utilities	4th
VIII	Ranking of States	4th

The Basic Tabulations

The first three volumes contain the basic tabulations. Each table series within the first three volumes consists of 22 tables providing basic information on inspections, violations, and proposed civil penalties. (See following section, "A Guide to Individual Tables within Each Series" for an index to these tables.)

The first *Research Volume* (132 pages) contains two tables series: yearly and regional. *Series I* examines the NRC from the perspective of time. On a year-to-year basis, what NRC enforcement activities took place since the agency's establishment in 1975 to August of 1989? Separate tables within this series examine the number of NRC inspections, the length of inspections, the frequency of violations of all types, the volume of serious violations, and the number and dollar size of proposed penalties.

Where it is appropriate, the tables present rates in addition to the actual number or dollar amount. The NRC, for example, conducted a total of 49,900 inspections of commercial power reactors during the years covered in the report.

Expressed as a rate, the 49,900 inspections work out to an average of 26 inspections per reactor each year.

The year-to-year table series, as well as each other basic series, have one other refinement. In addition to providing the total numbers and rates of various enforcement activities, each table breaks down the enforcement actions according to what phase in the life of a reactor that these actions occurred. The four phases are the time prior to the issuance of a construction permit (pre-construction period), the time when a reactor is under construction (construction period), the time from when a reactor has been commissioned for commercial operation until it is permanently shut down (the operation period), or the time after final shutdown (post-shutdown period).

The second group of tables, *Series II*, included in the first *Research Volume* examines the NRC from the perspective of the agency's five regions. It allows the researcher to make a detailed comparison of how the official activities of NRC inspectors in one region compare with the activities in another, or with the activities of all inspectors working in the nation. Variation in NRC regional activity by year also may be examined with these tables. Once again, this table series presents the actual numbers of inspections, violations, and proposed penalties, as well as the appropriate rates. And once again, these enforcement activities are presented in total, and broken down according to the above four periods or phases in the lifespan of reactors.

The second *Research Volume* contains only a single table series, *Series III*. This extensive series (154 pages) presents all the information about NRC enforcement actions during each major phase of a reactor's life from the perspective of each of the 130 facilities or commercial nuclear power plants that the agency has regulated. Again, these tables present for each plant the actual numbers of enforcement activities, as well as the appropriate rates.

The third *Research Volume* (110 pages) has the remaining two basic table series. *Series IV* looks at NRC inspection activities from the perspective of the utilities licensed to operate the reactors. The remaining tables in this volume which make up *Series V* present the NRC activities according to the state where they occurred. As in all the other tables included in the basic tabulations, the information is presented in terms of both numbers and rates, and examines the frequency of each activity and outcome during each of the our phases of a reactor's life.

The Ranking Tabulations

The final *Research Volume* (42 pages) contains three table series (VI-VIII). These supplement information from the basic table series by ranking the results. Each of these three ranking series contains a set of 7 tables (see next section). Unlike tables in the basic tabulation series, ranking tables only focus on the events which occur during a reactor's operating phase. This period starts when a nuclear power plant is commissioned for commercial operation, and ends (where applicable) with its final shutdown.

The tables present selected information about both the NRC and the nuclear power industry in which the units under consideration are presented to the reader in rank order of outcome. *Series VI* in the final volume, for example, ranks the nation's nuclear facilities in five different ways. Which commercial nuclear power plants, during the phase in their lives from the time they have been commissioned to operate to the time they have been shutdown, have been subject to the most NRC inspections? Which to the least? Which reactors have the highest violations rates? Which the lowest? Which reactors have the highest penalty rates? Which have the lowest? Which reactors have had the largest proposed penalties? Which the smallest?

Series VII examines the same questions, but this time the operating utilities are ranked. The final series, *Series VIII*, ranks states based upon the outcome of NRC enforcement activities for reactors within their boundaries.

Reactors which were not yet commissioned for commercial operation in 1989, the end of the period covered by this analysis, are not included since the focus in the ranking series is on operating facilities. Nor are utilities and states which do not have nuclear plants included, nor whose reactors have not yet been commissioned for commercial electrical generation. Certain other reactors, utilities, and states are excluded from these rankings where information is not available for a sufficient period of time to reliably rank performance.[1] Full information for all 130 commercial nuclear power plants, plus operating utilities and states, of course is included in the basic tabulation series.

A Guide To Individual Tables Within Each Series

Each series is divided into individual tables which focus on different aspects of NRC enforcement activities. In the "basic tabulations" (*Series I-V*) each series contains 22 tables. For the "ranking tabulations" (*Series VI-VIII*), each series consists of 7 tables.

The focus of a particular numbered table is the same within each of the pertinent series. For example, in the basic tabulations, "Table 1" always presents information on the number of NRC inspections, while "Table 13" presents counts of the number of penalties NRC has proposed. Thus, if you want to compare how many inspections NRC conducted in 1975 and ten years later, you would turn to Table 1 in *Yearly Series I*. If you need to determine the total number of NRC

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[1]Nuclear reactors which have been commissioned for commercial operation less than two years during the period covered by these data are excluded. Similarly, utilities which have less than 2 years combined experience across their plants commissioned for commercial operation are excluded, as are states where there is less than 2 years of combined operating experience among reactors within their borders.

inspections in the northeast, you would turn to Table 1 in *Regional Series II*, and to compare the frequency of inspections in Florida and California you would turn to Table 1 in *State Series V*. However, if you want to examine the number of penalties NRC has proposed against some specific nuclear facility you would turn to Table 13 in *Facilities Series III*, while the same information gathered for individual utilities would be found in Table 13 in the *Utilities Series IV*.

The following index summarizes what information each numbered table in the basic tabulation series (I-V) presents:

Index to Tables in Series I - V

Table Number	Table Topic	Type of Measure
1	inspections	number
2	inspection length	weeks
3	inspection length	average hours (per inspection)
4	inspections	annual number (per plant)
5	inspection length	annual time (per plant)
6	all violations	number
7	serious violations	number
8	serious violations	percent (of violations)
9	all violations	annual number (per plant)
10	serious violations	annual number (per plant)
11	all violations	percent (of inspections detecting)
12	serious violations	percent (of inspections detecting)
13	civil penalties	number
14	civil penalty dollars	total dollars
15	civil penalty dollars	total constant dollars
16	civil penalty dollars	average dollars (per penalty)
17	civil penalty dollars	average constant dollars (per penalty)
18	civil penalties	annual number (per plant)
19	civil penalty dollars	annual dollars (per plant)
20	civil penalty dollars	annual constant dollars (per plant)
21	civil penalties	percent (of inspections)
22	civil penalties	percent (of violations)

There are only 7 tables in each of the ranking tabulation series (VI - VIII). Again, the focus of a particular numbered table is the same within each of the ranking series. Unlike the basic tables, ranking tables differ principally in how the information is ordered or ranked, rather than in what type of information is covered. These series rank activity or outcomes on five different factors:

- the annual inspection time (per plant) [from basic table number 5 above]
- the annual number of violations (per plant) [from basic table number 9 above]
- the annual number of serious violations (per plant) [from basic table number 10 above]
- the annual number of civil penalties proposed (per plant) [from basic table number 18 above]
- the annual dollars (constant) of civil penalties proposed (per plant) [from basic table number 20 above]

All five of these rates (or ranks) are reported side-by-side in each table, but how the information is ordered differs across tables. The following index summarizes the differences among tables in the ranking tabulation series (VI - VIII):

Index to Tables in Series VI - VIII

Table Number	Type of Order	Method of Ordering Rates
1	alphabetical	not sorted (rates)
2	alphabetical	not sorted (ranks)
3	descending order	by inspection time
4	descending order	by all violations
5	descending order	by serious violations
6	descending order	by civil penalties
7	descending order	by penalty dollars

Thus, if you want to locate which reactors had the highest serious violation rates you would turn to Table 5 in *Ranking of Facilities Series VI*, while to locate the utility with the lowest serious violation rate you would turn to Table 5 in *Ranking of Utilities Series VII*. Table 2 in each of these ranking series allows you to look up a particular facility (*Series VI*), utility (*Series VII*), or state (*Series VIII*), and see how it ranks on each of the five indicators, while Table 1 in the corresponding series presents side-by-side comparisons of the actual rates themselves. In this manner you can assess whether NRC focuses its inspection time on utilities with the highest violation rates. Or, you can determine whether nuclear power plants with the highest serious violation rates also typically receive the highest penalties.