THE UNTOLD STORY:

The Economic Benefits of Nuclear Technologies

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Chapter 1

Nuclear Technologies: What They Are, What They Do

The use of nuclear technologies in modern society is widespread and pervasive. Yet the benefits of these technologies—which include nuclear energy, medical and other radioisotopes and radioactive materials—are not widely known or sufficiently appreciated. Most people know that nuclear power plants produce electricity and that radioisotopes are used in research. But few realize that:

- The nation's 109 nuclear power plants produce 20 percent of America's total electricity, and do so cleanly. Nuclear plants emit no carbon dioxide, the chief greenhouse gas. In addition, they conserve fossil fuels and save millions of dollars a year in oil imports. In 1995, for example, the use of nuclear energy helped utilities avoid spending $650 million in oil purchases.

- One-third of Americans hospitalized every year are treated with nuclear medicine techniques.

- Many new drugs must be tested with radioactive materials before they can be approved by the Food and Drug Administration and sold to the public.

- American industry depends on radioisotopes and radioactive materials for measurement and automation, process development, quality control and testing, and cost reduction. In many cases, there are no feasible substitutes to these materials.

- Many common, widely used consumer products—such as smoke detectors, non-stick pans and radial tires—require radioisotope methods for their development, production, or operation.

- Radioactive materials are used in thousands of applications ranging from bridge and building construction to police work and anti-terrorism, from dating of archaeological artifacts to development of agricultural crops.

Nuclear Technologies Touch Everyone's Life

Nuclear technologies help drive our advanced industrial economy and improve our standard of living. For example:

- Testing and improving our automobiles,
- Improving health and saving lives while reducing health care costs,
- Increasing crop yields and improving the health and productivity of farm animals, and
- Generating enough electricity for 64 million homes without producing emissions that may contribute to global climate change.

The use of nuclear technologies touches virtually everyone's life in many ways. In a typical day, for example:

- Your lights, air conditioning, computers, appliances and other electrical conveniences may be powered by nuclear-generated electricity.
- The food you eat may have been produced and preserved using nuclear technologies.
- The book, magazine or newspaper you read may have been printed using nuclear technologies.

- The radio you listen to or the television you watch may have been produced using nuclear technologies.

- The car you drive used a variety of nuclear technologies for research and development, testing, inspection and gauging.

A comprehensive listing of examples is provided in Appendix A.

The Benefits of Nuclear Generated Electricity

Most people know that nuclear energy is used to produce electricity. But they may not appreciate how important nuclear-generated electricity is to the U.S. economy and environment.

The 109 U.S. nuclear power plants are located throughout the country (see Figure 1). In 1995, these plants generated 673 billion kilowatt-hours of electricity—20 percent of total U.S. electricity production. In some states, nuclear electricity accounts for much more than one-fifth of electricity production (see Figure 2). For example:

- Six states—Vermont, Connecticut, South Carolina, New Jersey, New Hampshire and Illinois—rely on nuclear energy for more than half of their electricity.

- Four states—North Carolina, Arizona, Pennsylvania and Virginia—relied on nuclear energy for at least one-third of their electricity.

Figure 1
Nuclear Power Plants Operating in the United States in 1995

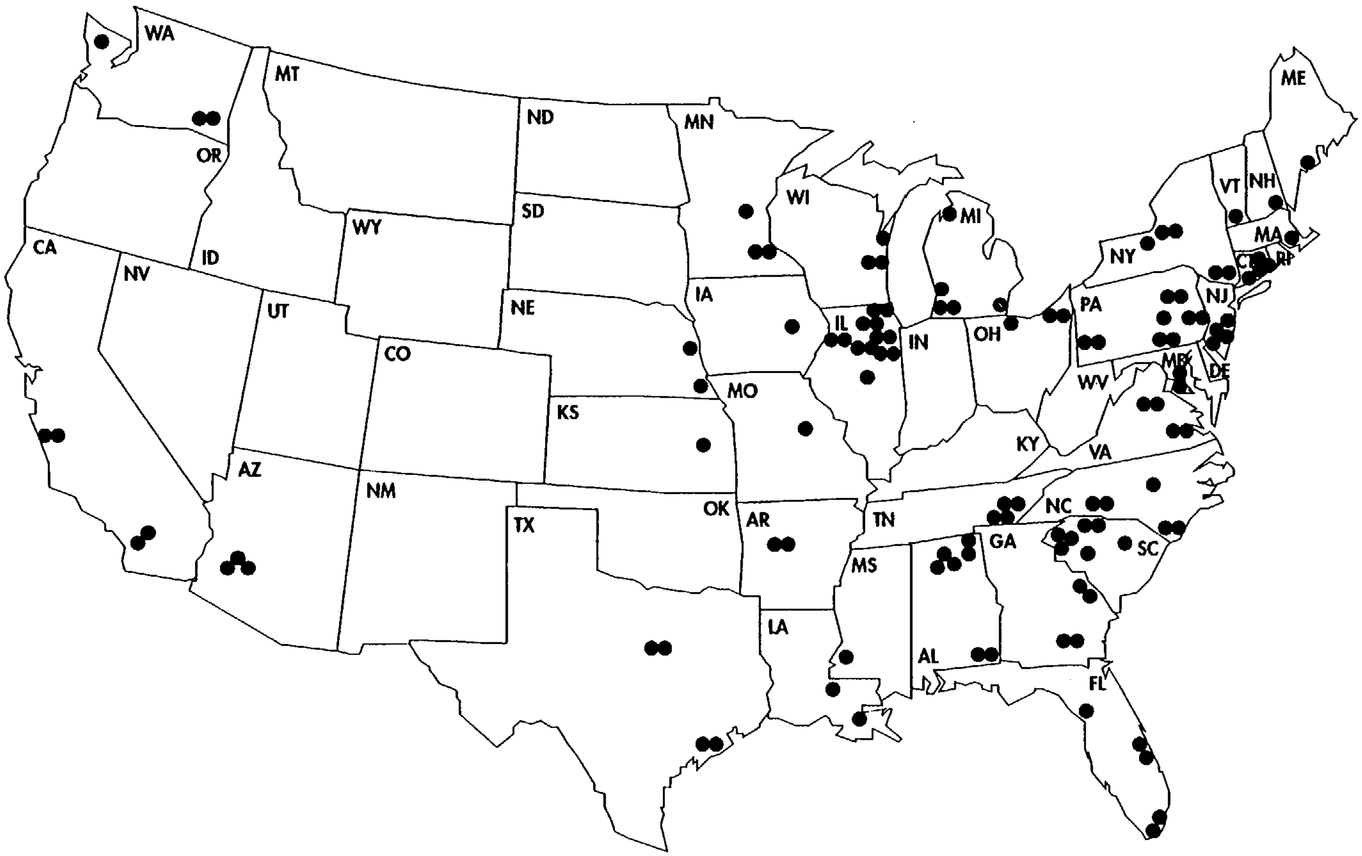
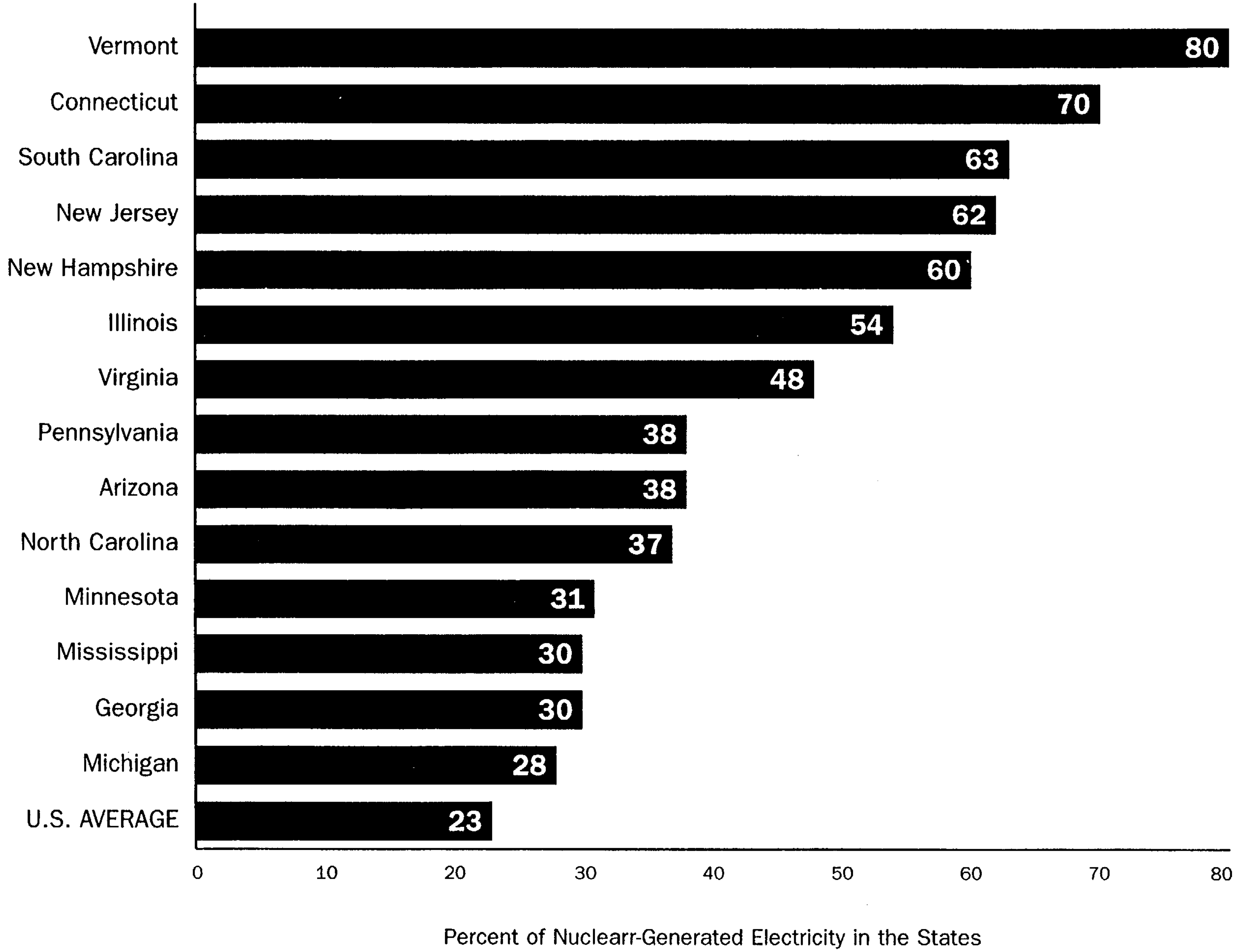


Figure 2
Percent of Electricity Produced by Nuclear Energy in 1995 in Selected States



Ten states—Minnesota, Mississippi, Georgia, Nebraska, Arkansas, Maryland, Michigan, Kansas, New York and California—relied on nuclear energy for at least one-quarter of their electricity.

Nuclear energy has enabled utilities to diversify their choice of fuels and to use less fossil fuel. In 1995, for example, nuclear energy displaced: 262 million tons of domestic coal; 52 million barrels of oil, which saved utilities $650 million in oil purchases; and 1.1 trillion cubic feet of natural gas.

Because nuclear power plants do not burn fuel, they emit no combustion by-products into the atmosphere. By substituting for other fuels in electricity production, nuclear energy has significantly reduced emissions of carbon dioxide, the chief greenhouse gas, and of other emissions.

The Clinton administration's Climate Change Action Plan is intended to achieve the president's pledge to limit U.S. carbon dioxide emissions to 1990 levels by the year 2000. The plan calls for a reduction of 108 million metric tons of carbon to be achieved in the year 2000. In 1995, the use of nuclear energy to generate electricity prevented the emission of 146 million metric tons of carbon—more than the target of the administration's plan.

Emissions of nitrogen oxide and sulfur dioxide are regulated by the 1990 Clean Air Act amendments. In 1995, the nation's nuclear power plants prevented the emission of 5.1 million tons of sulfur dioxide; and 2.5 million tons of nitrogen oxide.

The Benefits of Radioisotopes and Nuclear Materials

Nuclear technologies are pervasive, ubiquitous and important throughout all aspects of life. Consider these examples:

- Radioactive iodine is the most reliable treatment available for hyperthyroidism.
- Radiography is used to check the welds on virtually all new oil and gas pipelines and to examine the structural integrity of bridges.
- Non-stick pans are treated with radiation to ensure that the plastic coating adheres.
- The exploration of space would be impossible without small, radioisotope-powered generators.
- Radionuclides were key in determining the structure of DNA—the carrier of the genetic code.
- Smoke detectors rely on a tiny radioactive source to function.
- Radioactive materials are used to measure pollution in reservoirs and coastal aquifers.

Nuclear technologies save money:

- Pipeline leaks can be detected using nuclear technologies in a matter of days or weeks at a cost of $25,000-$50,000; alternative methods can take six months to a year and cost $500,000-$1 million, plus many millions of dollars in pipeline downtime costs.

- In recent decades the application of a single nuclear technique—tracers—in one industry—machine tools—has saved the U.S. economy between $60 billion and $70 billion.

Nuclear technologies protect the environment:

- Electricity production avoids emissions of carbon dioxide, sulfur dioxide and nitrogen oxides.

- Nuclear electron beam processing can eliminate the air pollutants that cause acid rain and global warming, without producing harmful by-products.

- Solid wastes and sewage can be treated with nuclear technologies without using toxic chemicals.

Finally, in many cases there are no adequate substitutes for nuclear technologies at virtually any price.

A fuller listing of examples is provided in Appendix A.

Report Organization

The remainder of this report details the economic benefits resulting from the widespread use of nuclear technologies. Chapter 2 describes the economic and employment impacts at the national level, and Chapter 3 illustrates the benefits derived by individual states.

Appendix A contains examples of the uses and benefits of nuclear technologies, Appendix B describes the methodology used to determine the economic impact of nuclear technologies at the national, state and regional levels, Appendix C lists the technologies' economic and job impacts state by state, and Appendix D consists of tables and graphs.

Chapter 2

National Economic and Job Benefits

Nuclear technologies produce significant economic and employment benefits for the United States. In 1995, they generated:

- 4.4 million jobs,
- $421 billion in sales,
- $79 billion in tax revenues to federal, state and local governments.

Summary of 1995 Economic and Job Benefits

	Sales (billions)	Jobs (millions)	Taxes (billions)
Nuclear Energy	$90.2	0.442	$17.8
Radioisotope Technologies	$330.7	3.953	$60.9
Total	**$420.9**	**4.395**	**$78.7**

More than three-quarters of these economic and employment benefits were generated by the use of radioisotopes and radioactive materials (see Figure 3).

Direct and Indirect Economic Impacts

The revenue and jobs generated through the use of nuclear technologies are both direct and indirect.

The concept of a direct sale or job is straightforward. The sale of a turbine to a nuclear power plant or the sale of a smoke detector are examples of direct sales. A job for an engineer at a nuclear power plant or for a nuclear medicine technician at a hospital or medical center are examples of direct jobs.

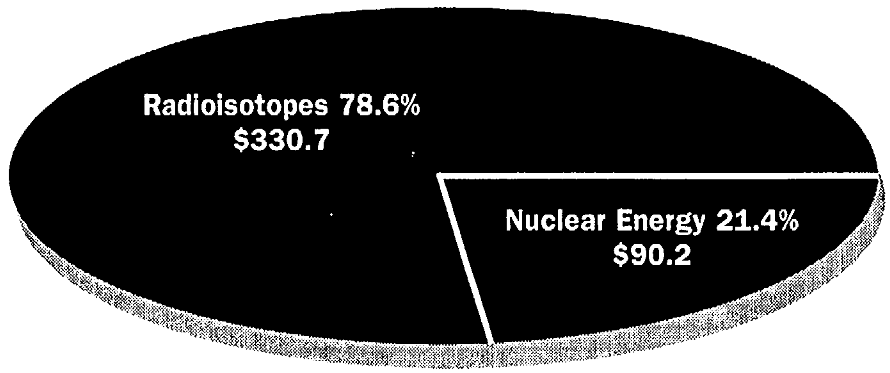
"Indirect" revenue and jobs are those generated throughout the economy by the direct economic impacts. For example:

- If the engineer in the nuclear plant goes to lunch at a nearby restaurant, the restaurant's revenues represent indirect sales created, and the jobs of the waiters, cooks and other workers in the restaurant represent indirect jobs generated. In addition, the revenues and jobs generated in providing food and supplies to the restaurant represent indirect economic benefits.

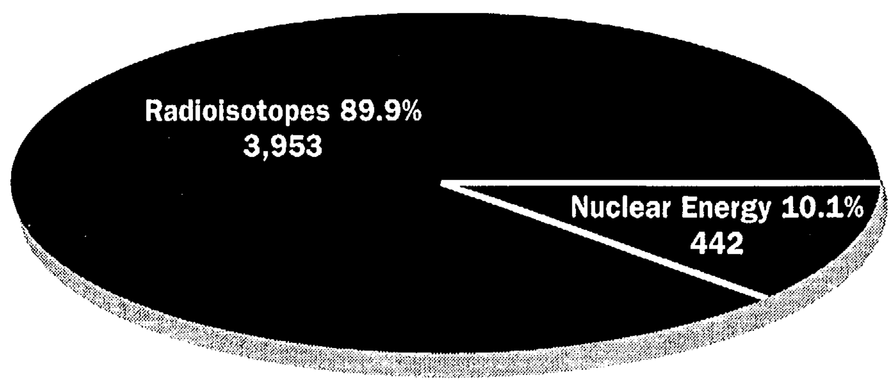
- If the nuclear medicine technician buys an American automobile, this represents creation of indirect sales and jobs—both in the local car dealership and at the factory in Michigan. The sales and jobs created by the provision of parts and supplies to the factory also represent indirect economic benefits.

Figure 3
Distribution of Economic and Job Benefits to the U.S. Economy Produced by Nuclear Technologies in 1995

Sales Created
(Billions of Dollars)



Jobs Created
(In Thousands)



The concept of indirect economic benefits is crucial. For every direct sale and job created by nuclear technologies, at least one indirect sale and job are also created.

Perspective on Nuclear Technology Benefits

One way of grasping the magnitude of nuclear technologies' benefits in 1995—nearly $421 billion in sales and 4.4 million jobs created—is to view them in the context of the U.S. economy as a whole. They represented:

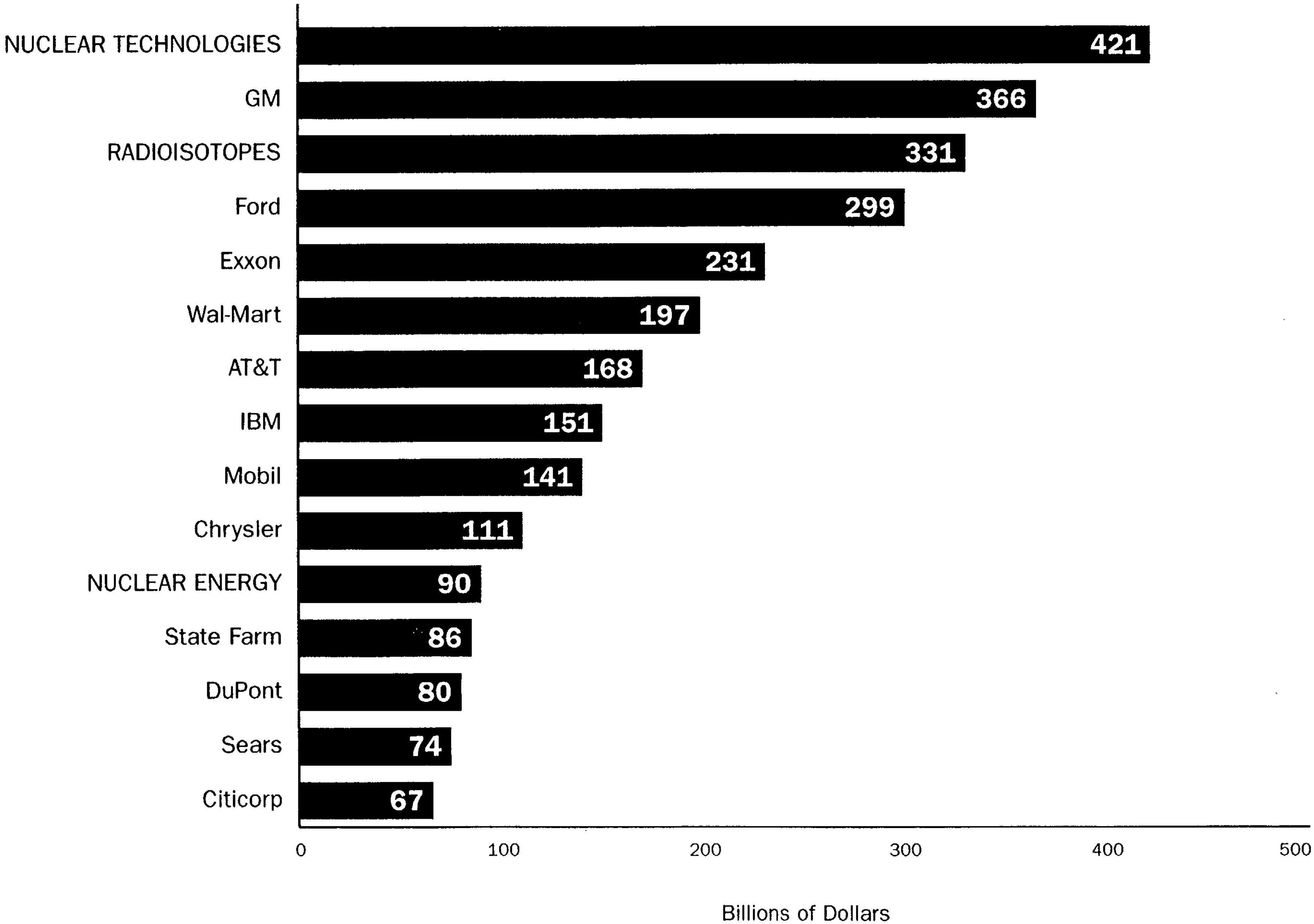
- Four percent of total U.S. employment,
- Six percent of total U.S. gross domestic product,
- Five percent of total U.S. tax revenues.

Because the U.S. economy and labor force are so huge, however, the impact of any program or technology—however significant—will appear relatively small by comparison.

Another way of looking at these benefits is to compare them with the impacts of the largest U.S. corporations—the nation's Fortune 500 companies (see Figure 4). If "Nuclear Technologies" were a company:

- It would have an impact on the U.S. economy 15 percent greater than that of the largest corporation in the country—General Motors.
- It would have an impact twice the size of that of Exxon—the nation's third largest corporation.

Figure 4
Comparison of the 1995 Economic Impact of Nuclear Technologies With That of Fortune 500 Companies



- It would have an impact three times the size of IBM—the seventh largest U.S. corporation.

- It would have an impact six times the size of Citicorp—the nation's largest bank and 17th largest corporation.

Even if the economic impacts of the two components of nuclear technologies—nuclear energy and radioisotopes and radioactive materials—are considered separately, they rank very high:

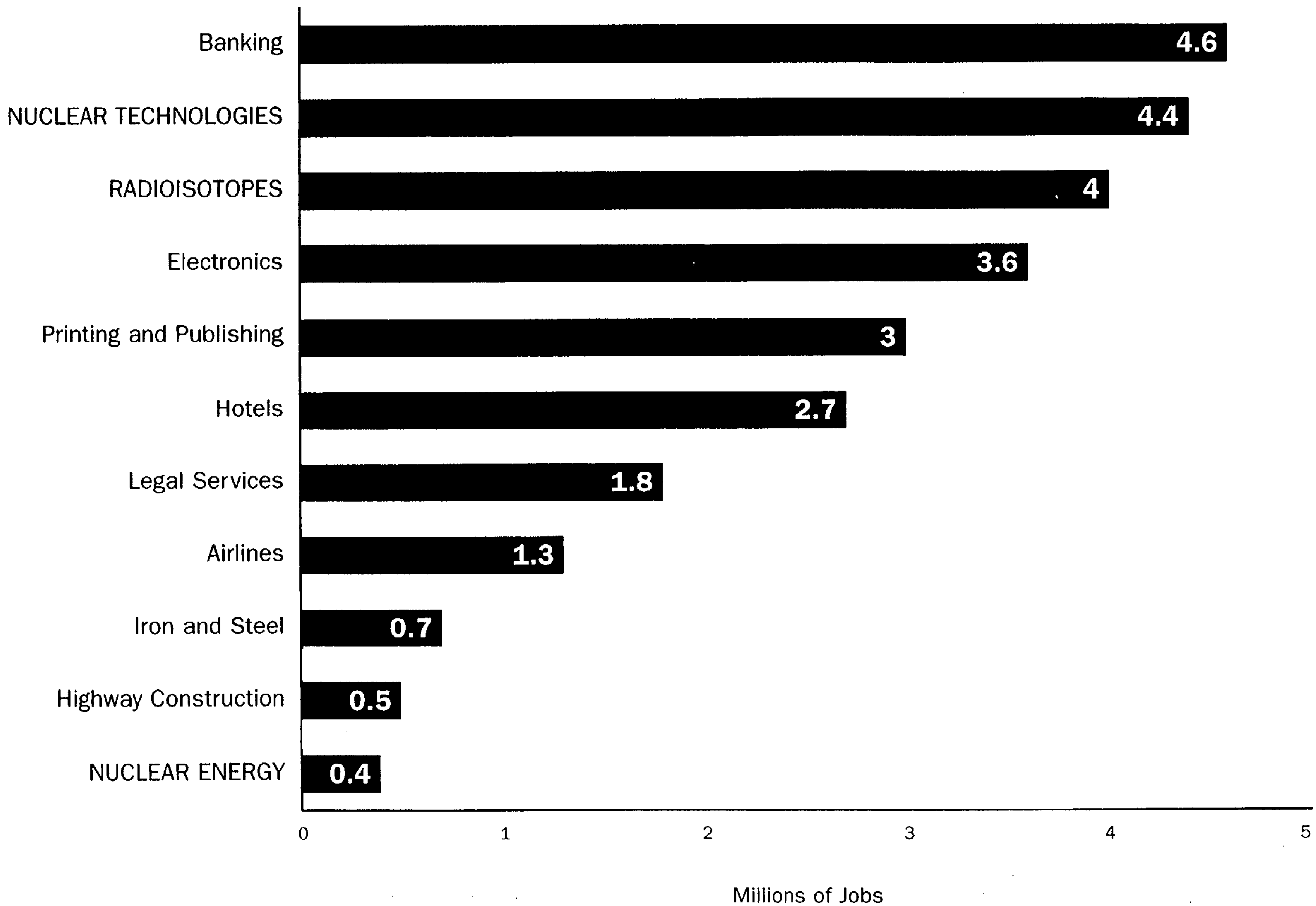
- The economic impact of radioisotopes and radioactive materials was larger in 1995 than that of any U.S. corporation except General Motors, and its impact was 10 percent greater than that of Ford—the nation's second largest company.

- The economic impact of nuclear energy in 1995 was greater than that of 490 of the Fortune 500 companies—including such firms as State Farm, DuPont, Sears and Citicorp.

Another way to gauge the impact of nuclear technologies is to compare the total number of jobs they generated in 1995 with the total number of jobs generated (directly and indirectly) by other industries and sectors (see Figure 5). For example:

- Nuclear technologies generated more jobs than most industries or sectors and almost as many jobs as the banking industry.

Figure 5
Comparison of the Jobs Created by Nuclear Technologies With Those Created by Major Industries



Radioisotopes and radioactive materials generated:

—significantly more jobs than such major industries as electronics, printing and publishing, and hotels.

—more than twice as many jobs as legal services.

—three times as many jobs as the airline industry.

- Nuclear energy generated nearly as many jobs as highway construction.

Yet another way of viewing the economic impact of nuclear technologies is to compare it with the economies of nations of the world. Such comparisons are difficult because of such factors as differences in exchange rates, stages of economic development, purchasing power parities and economic interdependencies. Nonetheless, they illustrate orders of magnitude.

The economic importance of nuclear technologies rivaled that of many countries and exceeded that of many others in 1995 (see Figure 6). For example, the gross sales impact of nuclear technologies:

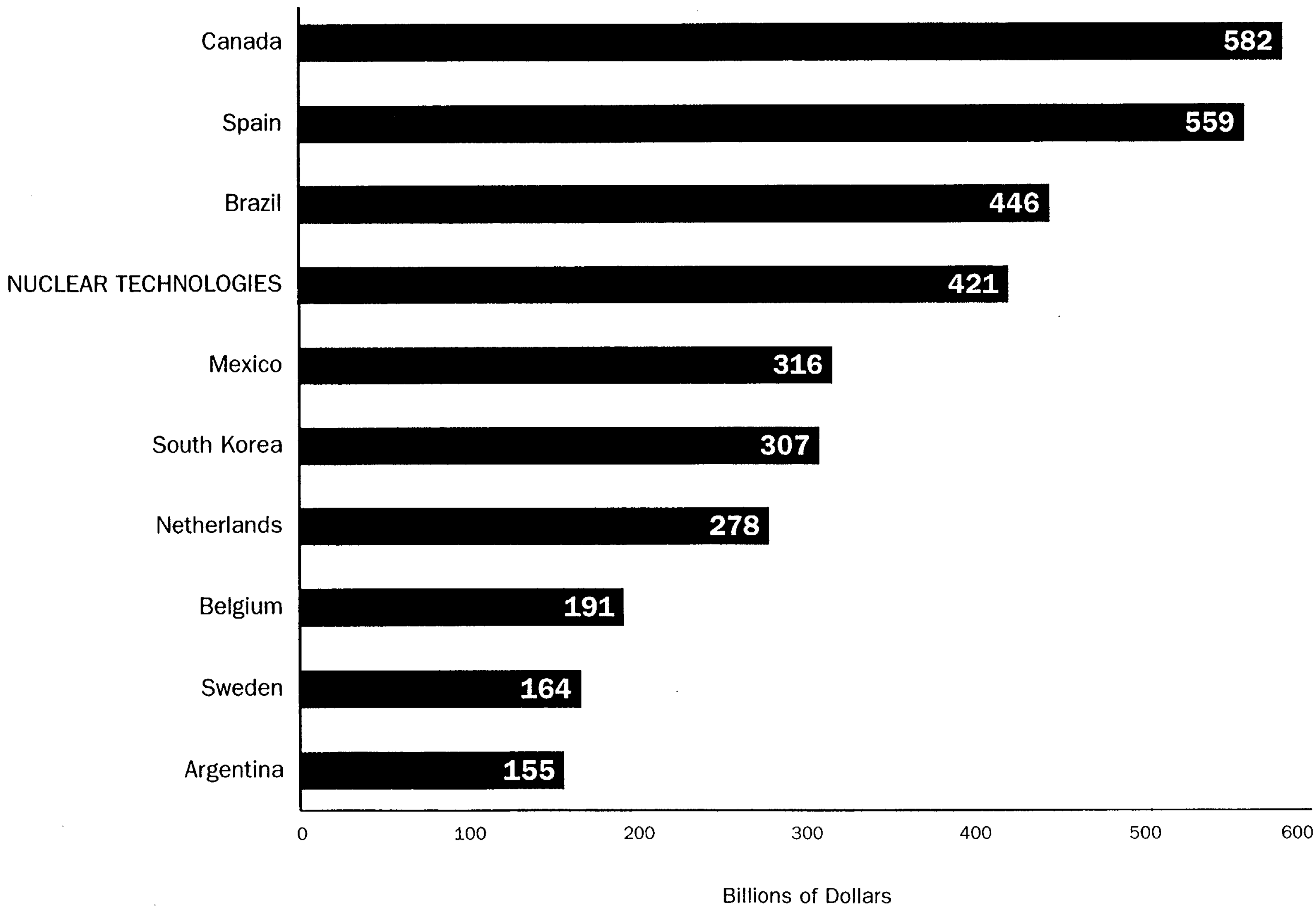
- Was equal to 72 percent of the economy of Canada and 75 percent of the economy of Spain.

- Was larger than the economies of Australia, Mexico, South Korea and the Netherlands.

- Was at least twice as large as the economies of Belgium, Sweden and Argentina.

- Was six times larger than the economy of Israel and eight times larger than the economy of Ireland.

Figure 6
Comparison of the 1995 Economic Impact of Nuclear Technologies With the Gross Domestic Products of Major Countries



The point is that, however measured—in relation to the largest U.S. corporations, the jobs generated by major industries and sectors of the U.S. economy, or the economies of other nations—the economic and job impacts of nuclear technologies are enormous.

Jobs and Sales Created Within Specific Industries

The revenue and job benefits of nuclear energy, radioisotopes and radioactive materials are shared by all industries and sectors of the economy (see Appendix D, page 110). But some industries and sectors benefit more than others. In 1995, for example, nuclear technologies created:

- $1.8 billion in sales and 16,000 jobs in the livestock and livestock products industry, but $9.8 billion in sales and 85,000 jobs in the maintenance and repair construction industry.

- $1.7 billion in sales and 8,500 jobs in the engines and turbines industry, but $7.6 billion and 46,000 jobs in iron and steel manufacturing.

- $2 billion in sales and 18,000 jobs in the general industrial machinery industry, but $17.7 billion in sales and 277,000 jobs in business services.

The jobs generated across industries often differed by a factor of 10 or more (see Appendix D, page 111). This differential job impact is caused by two factors:

- Nuclear technologies affect some industries substantially more than others.

- Some industries are much larger than others and will contain more jobs under almost any circumstances.

Jobs Generated Within Specific Occupations

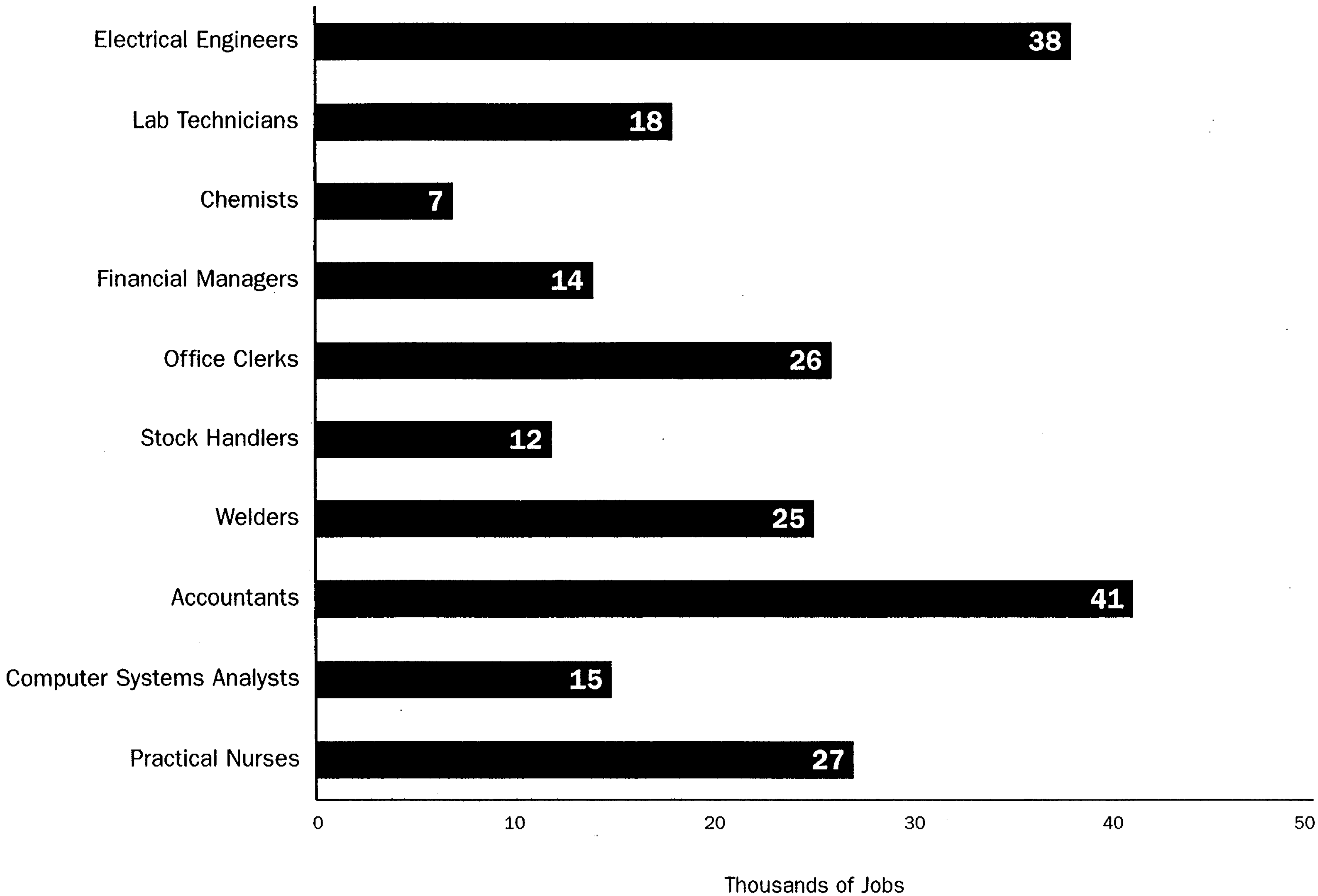
While the economic impact of nuclear technologies generates jobs for all occupations and skills, as with the impact on specific industries, the impact on specific occupations is highly disparate. This study disaggregated the economic effects of nuclear technologies into jobs generated within 475 occupations (see Appendix D, page 112). For example, in 1995 nuclear technologies generated:

- Jobs for 800 surveyors, but 44,000 jobs for industrial machinery repairers;
- Jobs for 600 proofreaders, but 39,000 jobs for electrical engineers;
- Jobs for 700 forging machine operators, but 25,000 jobs for welders.

This wide diversity in occupational job creation is illustrated in Figure 7, which shows the number of jobs generated by nuclear technologies in selected occupations. Such diversity is true even within specific, highly specialized occupational categories. Of the 121,000 engineering jobs generated, for example, electrical engineers greatly outnumber chemical engineers (see Appendix D, page 113). This diversity must be evaluated in the context of total employment in different occupations, however. Electrical engineers outnumber chemical engineers 20-fold, so one would expect nuclear technologies—or any other industrial category—to generate more jobs for electrical engineers than for chemical engineers.

It is important to note that while the jobs generated by nuclear technologies are often disproportionately in technical, skilled and specialized occupations, significant numbers of jobs are also generated for workers in all occupations at all skill levels.

Figure 7
Jobs Created Within Selected Occupations



As expected, nuclear technologies generated many jobs in scientific, engineering and high-tech occupations in 1995, including jobs for: 121,000 engineers, 18,000 lab technicians, 15,000 computer systems analysts and 25,000 scientists.

In addition, nuclear technologies generated large numbers of jobs within occupations that few would associate directly with nuclear technologies, including jobs for: 77,000 truck drivers, 170,000 secretaries, 13,000 plumbers and 14,000 personnel specialists.

Although the jobs generated by nuclear technologies are often disproportionately in technical, skilled and specialized occupations, a significant number of jobs are also generated for workers in all occupations at all skill levels. For example, in 1995 nuclear technologies generated four times as many jobs for truck drivers (77,000) as for mechanical engineers (19,800), more than six times as many jobs for janitors (90,000) as for computer systems analysts (16,000) and seven times as many jobs for secretaries (170,000) as for scientists (25,000).

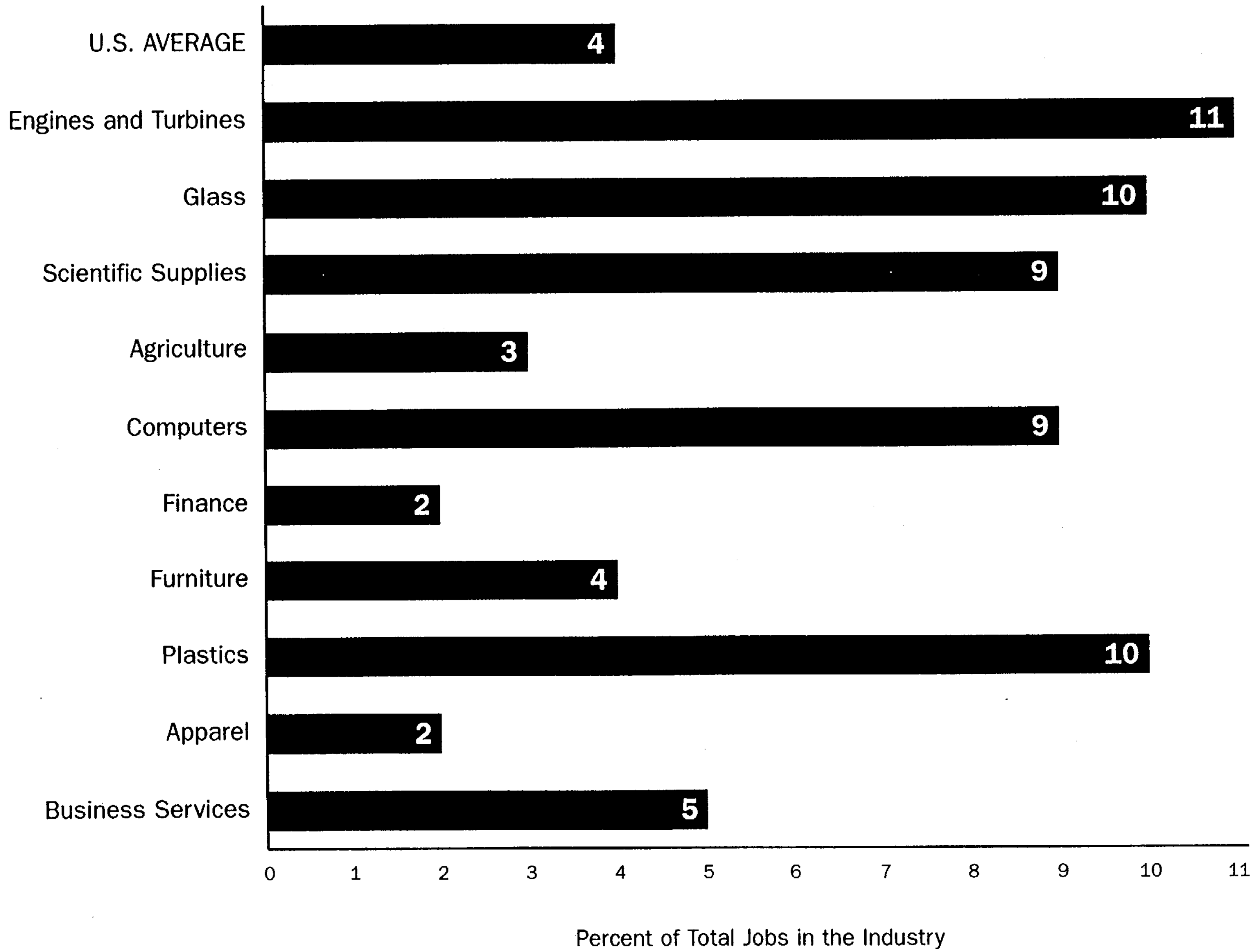
These examples illustrate the ubiquitous, pervasive impact on the job market of nuclear technologies.

Significance to Specific Industries and Occupations

To obtain a better idea of the significance of nuclear technologies to specific industries and occupations, the study normalized the differences by examining the percentage impact within each industry or occupation. The jobs generated within 10 selected industries as a percentage of total 1995 employment within each industry are shown in Figure 8.

Even normalized by industry size, the impact of nuclear technologies varied greatly among industries. For example, in industries such as furniture, the impact was about equal

Figure 8
Percent of Jobs Within Selected Industries Created in 1995 by Nuclear Technologies



to the national average of 4 percent. In industries such as engines and turbines, and glass and plastics, the impact was much greater than average, and was five times that of industries such as finance and apparel. In industries such as finance and apparel, the impact was much less than the national average.

The impact of nuclear technologies on normalized employment categorized by occupation exhibits a similar pattern (see Appendix D, page 114). In occupations such as underwriters and paralegals, the job impact of nuclear technologies is relatively minor. In occupations such as accountants and practical nurses, the impact is about equal to the national average of 4 percent. In occupations such as medical scientists, electrical engineers and welders, the job impact is significant.

Finally, the disparity of relative job impacts is evident even within a specific, specialized occupational grouping such as engineers (see Appendix D, page 115). This figure shows the percentage of different types of engineering jobs generated by nuclear technologies in 1995. For example, nuclear technologies:

- Generated twice as many engineering jobs as the economy-wide average—4 percent of all jobs in the economy were generated by nuclear technologies, while 8 percent of all engineering jobs resulted from nuclear technologies.

- Significantly affected some categories of engineers, such as nuclear, industrial, metallurgical and electrical, while having little effect on such categories as aeronautical and civil—even less than the labor market average of 4 percent.

Chapter 3

State Economic and Employment Benefits

To determine the economic and job impacts of nuclear technologies on a state basis, the study had to answer several questions:

- How are the economic and job benefits distributed among the states?
- In which states are the most sales and jobs created?
- Which states benefit the most from nuclear technologies—in relation to the size of their economies and labor force?
- Are the economic benefits concentrated in only a few states, or are they widely distributed throughout the nation?
- How do the economic benefits in the states compare with those generated by states' economic development and tax incentive programs?

Disaggregating National Effects to the State and Regional Level

To separate out—disaggregate—the national economic and employment impacts to the state and regional level, the study used the MISI state interindustry modeling system (see Appendix B for a description of the methodology). This type of model is used by the U.S. Department of Commerce to compile the national income and product accounts, by the U.S. Department of Labor to develop its long-range economic and employment forecasts, and by the U.S. Department of Energy's Energy Information Administration to development its long-term energy forecasts.

In disaggregating the national data, we took account of the fact that the U.S. economy is highly integrated, and there are strong interactions among all of the state economies—economic and job benefits created in one state have strong "ripple" effects in many other states.

For example, a major medical center in Texas is heavily dependent on nuclear technologies, and this center creates substantial sales, jobs and tax revenues within Texas. However, some of the components and supplies for this center are produced in Ohio, so the center indirectly produces economic benefits in Ohio.

The production of these components and supplies in Ohio, in turn, requires inputs from California, so the use of nuclear technologies in Texas also produces sales, jobs and tax revenues in California. To deliver the required inputs to Ohio, California needs goods and materials from Georgia. Georgia, in turn, needs goods and materials from Wisconsin, and Wisconsin needs them from New York. So the medical center creates economic benefits in Ohio, California, Georgia, Wisconsin and New York, as well as Texas.

The económic and job benefits of nuclear technologies in a given state are the sum of those generated directly within the state and those generated indirectly within the state by nuclear technologies in other states.

Economic and Employment Benefits to States

If the national benefits of nuclear technologies are averaged for the states, each state received about $8.4 billion in sales, 88,000 jobs and $1.6 billion in tax revenues. In fact, the actual distribution among the states is uneven and diverse. Some states—

Pennsylvania, Virginia, California, Texas, Tennessee, South Carolina, Oregon, Washington, New York, Minnesota and North Carolina—benefited substantially from the use of nuclear technologies in 1995. Others—Montana, Rhode Island, North Dakota, Delaware and Wyoming—benefited relatively less (see Figure 9).

Before discussing state benefits in more detail, it is useful to examine them in the context of state economic development initiatives aimed at attracting new business.

Perspective on State Economic and Job Benefits

The number of jobs generated by nuclear technologies within a state in 1995 varied widely, from as few as 5,000 to as many as 100,000. How does this range compare with the employment generated by other means?

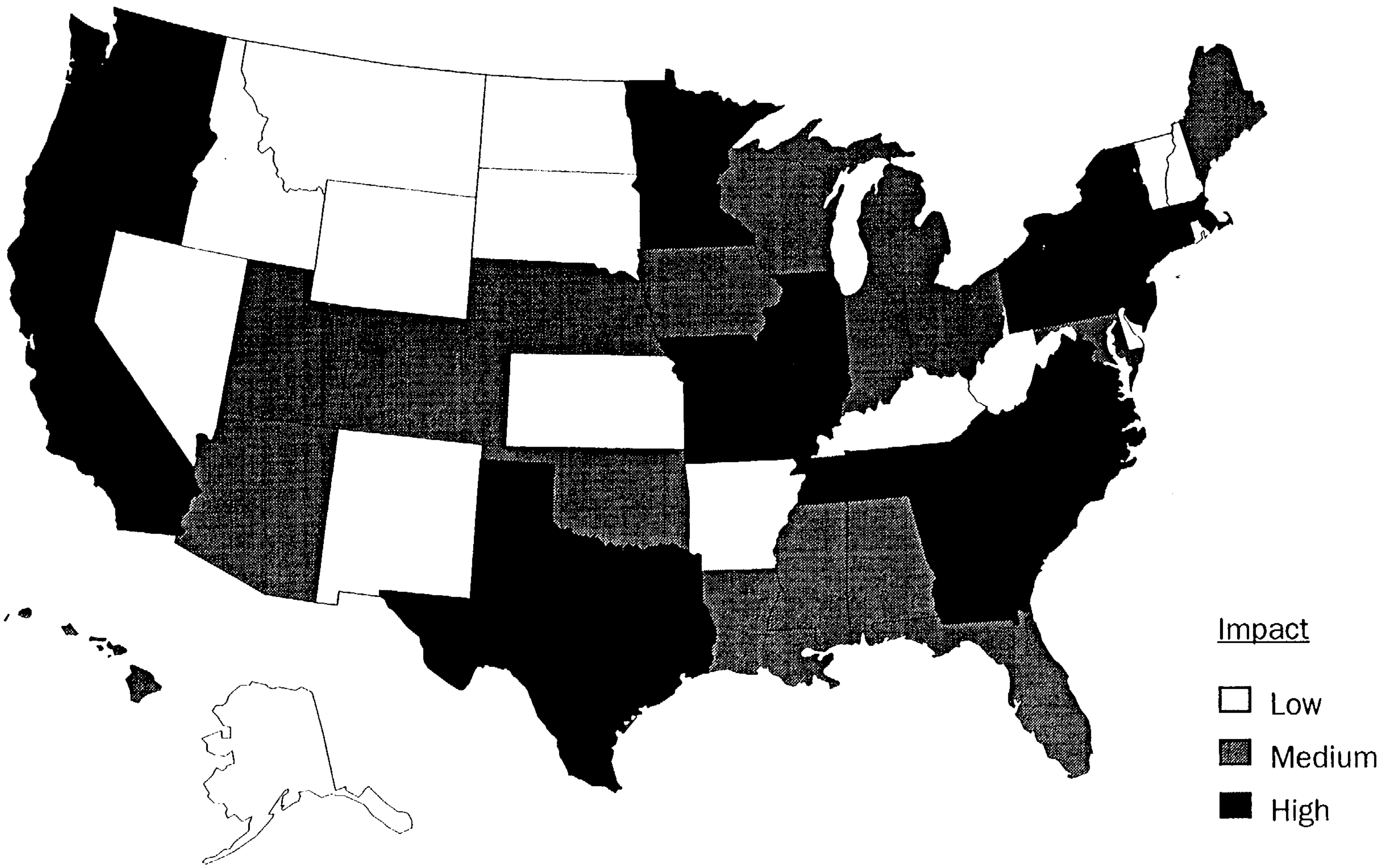
One way to answer this question is to examine the jobs generated by representative state development initiatives in recent years—and the costs to states of these initiatives. Over the past two decades, state government economic development programs have been distinguished by what has become known as the "new war among the states." In an effort to create jobs, states have been aggressively bidding against one another for manufacturing plants, commercial facilities and corporate headquarters. The costs of this bidding war have rapidly escalated:

- In the mid-1980s, Tennessee outbid other states for General Motors' new Saturn automobile factory at a cost to the state of $16,500 per on-site job created.

- In 1986, Fuji-Isuzu agreed to locate a new plant in Indiana, at a cost to the state of $50,000 per on-site job created.

Figure 9

Economic and Employment Impacts, by State, of the Use of Nuclear Technologies in 1995



- In 1993, Mercedes-Benz announced that it would locate a new assembly plant in Alabama, at a cost to the state of $170,000 per on-site job created.

- In 1996, Blue Water Fibre received $80 million in inducements from Michigan for a paper-recycling mill that employs 34 workers—costing the state $2.4 million per on-site job created.

It is interesting to compare examples of the number—and cost—of jobs created by a state economic initiative with those generated through nuclear technologies.

Efforts to attract a new operation:

- Alabama won the bidding war in 1993 to attract Mercedes-Benz to the state—at a cost of $300 million in incentives. Today, that plant generates a total of about 3,000 jobs in the state. In contrast, in 1995 nuclear technologies generated 43,000 jobs in Alabama.

- In 1993 the state of Kentucky outbid Ohio and Pennsylvania for a Canadian steel mill that would create 800 jobs—at a cost to Kentucky of $14 million in foregone tax revenues. In contrast, in 1995 nuclear technologies generated 18,000 jobs in Kentucky, 70,000 jobs in Ohio, and 630,000 jobs in Pennsylvania.

- In 1992, South Carolina granted the German automobile manufacturer BMW $150 million in tax breaks and other incentives to build an automobile assembly plant near Spartanburg that, by 1995, was generating about 3,000 jobs in the state. In contrast, in 1995 nuclear technologies generated 240,000 jobs in South Carolina.

- In 1992, Kentucky—at a cost of $39 million in incentives—outbid Tennessee for an International Paper Co. label manufacturing plant that currently generates about 800 jobs. In contrast, in 1995 nuclear technologies generated 18,000 jobs in Kentucky and 325,000 jobs in Tennessee.

- In the late 1980s, Nebraska gave ConAgra $10 million in incentives to build a new laboratory in the state that currently generates about 800 jobs. In contrast, in 1995 nuclear technologies generated 15,000 jobs in Nebraska.

- In 1995, Virginia offered $165 million in incentives to the Disney Company to build a Disney America theme park that would have generated about 12,000 jobs. In contrast, in 1995 nuclear technologies generated 379,000 jobs in Virginia.

Efforts to attract an operation from another state:

- In response to a generous package of tax incentives, Hughes Aircraft relocated substantial operations from California to Arizona during 1993 and 1994, resulting in the transfer of about 12,000 jobs. In contrast, in 1995 nuclear technologies generated 250,000 jobs in California and 26,000 jobs in Arizona.

- In 1992, New Jersey offered $50 million to First Chicago Corp. in a successful effort to induce it to move to the state from New York, thus creating about 2,500 jobs in New Jersey. In contrast, in 1995 nuclear technologies generated 127,000 jobs in New Jersey and 148,000 jobs in New York.

Effort to prevent company relocation:

- In 1993 and 1994, the city of Ypsilanti, Mich., took General Motors to court in a futile attempt to prevent the relocation of the Willow Run Assembly Plant to Arlington, Texas. The effort eventually cost the state of Michigan about 9,000 jobs. In contrast, in 1995, nuclear technologies generated 38,000 jobs in Michigan and 220,000 jobs in Texas.

Effort to retain jobs:

- In the early 1990s, Illinois undertook the "largest job-retention effort in the state's history"—a $250 million campaign—to prevent Sears, Roebuck & Co. from moving out of the state, and thus preserved about 8,000 jobs for Illinois. In contrast, in 1995 nuclear technologies generated 125,000 jobs in Illinois.

To further illustrate the relative importance of the jobs generated in different states by nuclear technologies, we examine in more depth several recent developments in the nation's three largest states—Texas, California and New York.

Texas. In 1993, Congress voted to terminate work on the Superconducting Super Collider (SSC), which was being constructed near Waxahachie. The decision resulted from continuing cost overruns in the project and Congress' mood of fiscal restraint, and was made despite the fact that $2.7 billion had been committed for the $11 billion project, which was already 20 percent complete.

The Texas state government and congressional delegation lobbied intensely to save the project—largely out of concern for the economic development and jobs it would mean for Texas, and worried that the SSC's demise was a major blow to the Texas economy. When terminated, the SSC was generating about 5,000 jobs in Texas, and it would have generated about 14,000 jobs had the complex been completed.

However, despite the widespread concern in the state over loss of the SSC and related jobs, nuclear technologies were already generating 220,000 jobs in Texas—nearly 16 times the number of jobs that even a fully operational SSC would have created.

California. California, and especially southern California, has been disproportionately affected by the defense and aerospace industries since World War II. During the early 1990s, due at least in part to reductions in federal defense and aerospace spending, California suffered from one of the most severe recessions in the state's recent history. Economic growth declined, the real estate and construction industries collapsed and, for virtually the first time in history, the state experienced significant out-migration of businesses and population.

Between 1991 and 1995, the state lost, on average, about 40,000 jobs per year due to downturns in defense spending and the aerospace industry. These job losses were well recognized and publicized, and were often taken as a precursor of austere times for the California economy. Yet at the same time, nuclear technologies were generating, on an annual basis, 250,000 jobs in the state—more than six times as many as were lost in any single year in the defense and aerospace-related industries.

New York. In 1992 and 1993, the state and city of New York granted $362 million in tax incentives and other concessions to four corporations and five commodities exchanges to deter them from moving to Connecticut or New Jersey—despite a pact among the three states to prevent such competition. For example:

- In 1993, CBS Inc. received $50 million in tax incentives in return for a pledge to keep its headquarters in New York for 15 years. About 6,000 total jobs were preserved for New York by this agreement.

- In 1993, Prudential Securities received $106 million in tax incentives and low-cost energy rates in return for a pledge to keep its employees in New York for 20 years. This agreement preserved a total of about 8,000 jobs for New York.

At the same time that New York was providing costly incentives to retain CBS, Prudential Securities and other companies, nuclear technologies were generating 148,000 jobs in the state—25 times as many jobs as CBS and nearly 20 times as many jobs as Prudential Securities.

The point of these examples is not to criticize economic development strategies and tax incentives policies in Texas, California, New York or any other state. Nor is it to purport that nuclear technologies offer a panacea for states' economic and employment problems. Rather, states should recognize the significant economic growth, jobs and tax revenues generated by nuclear technologies, which are often more substantial than those provided by projects and corporations that in some cases have proven costly to attract and retain.

The Economic and Employment Benefits to Each State

The state impacts of nuclear technologies reflect many factors: the location of specific plants and activity, the facilities that fabricate commodities using the technology, the final user of the commodities and services, the final waste disposal site and related factors. In addition, indirect impacts accrue to states that are either major suppliers of the inputs to these industries or major users of the goods and services produced. They also accrue to those that are major contributors to the general infrastructure of the U.S. economy. Obviously, many states fall into all of these categories.

The distribution of sales, jobs and tax revenues generated by nuclear technologies within each state during 1995 is shown in Appendix D, page 116.

While each state received an average of about $8.4 billion in sales, 88,000 jobs and $1.6 billion in tax revenues, the actual distribution among the states was very uneven and diverse. For example, some states benefited substantially from the use of nuclear technologies:

- In Pennsylvania, $63 billion in industry sales, 630,000 jobs, and $11.2 billion in federal, state and local government tax revenues were created.

- In California, $27 billion in industry sales, 250,000 jobs, and $5.2 billion in tax revenues were created.

- In Texas, $22 billion in industry sales, 220,000 jobs, and $3.9 billion in tax revenues were created.

- In Illinois, $16 billion in industry sales, 125,000 jobs, and $2.9 billion in tax revenues were created.

- In Minnesota, $13 billion in industry sales, 132,000 jobs, and $2.4 billion in tax revenues were created.

Other states benefit relatively less:

- In Delaware, $800 million in industry sales, 8,100 jobs, and $145 million in tax revenues were created.

- In Wyoming, $335 million in industry sales, 4,300 jobs, and $65 million in tax revenues were created.

- In Montana, $350 million in industry sales, 4,600 jobs, and $66 million in federal, state and local government tax revenues were created.

- In Rhode Island, $300 million in industry sales, 3,200 jobs, and $54 million in tax revenues were created.

- In North Dakota, $112 million in industry sales, 1,000 jobs, and $22 million in tax revenues were created.

This uneven distribution of the economic benefits among states is somewhat misleading, however. Because states differ in the size of their populations and labor forces, more sales, jobs and tax revenues will be generated in populous states such as California, New York and Texas than in less populous states such as Wyoming, Delaware and Vermont (See Appendix D, page 117).

A more accurate illustration of the importance of nuclear technologies to each state is obtained by normalizing for the states' economies and labor forces. The percentage of the number of jobs generated by nuclear technologies in selected states in 1995 is shown in Appendix D, page 118.

This figure gives a more accurate representation of the importance of nuclear technologies to the economies and labor markets of different states. But even on a per capita basis, the impact on different states varies considerably. The impact on job markets in Tennessee, South Carolina and Virginia, for example, is more than 10 times as great as that in Mississippi and Arizona. Moreover, even small states, where relatively few jobs are generated by nuclear technologies, benefit substantially. In New Hampshire, for example, one out of every 11 jobs in the state was generated by nuclear technologies in 1995.

The economic benefits of nuclear technologies are widely distributed throughout the nation. In terms of industry sales and jobs, every state benefits in some way from the use of nuclear technologies.

Economic and Employment Benefits in Each of the Ten Compact Regions

In addition to listing the sales, jobs and tax revenues generated by nuclear technologies for each state, the study lists the benefits for each of the nine regional interstate compacts for low-level radioactive waste disposal and for states not currently affiliated with a disposal compact (See Appendix D, pages 119 & 120).

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Management Information Services, Inc.

Management Information Services, Inc. is a Washington, D.C.-based economic research and management consulting firm specializing in estimating the economic and employment effects of energy programs, economic forecasting, IM/MIS, Internet/Intranet systems, environmental, utility, regulatory, and human resource issues. It serves both U.S. and foreign clients. Over the past decade MISI has conducted extensive proprietary research, and since 1985 has assisted hundreds of clients with:

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Information Systems and Services

Expert Witness Testimony

APPENDIX A

Examples of Uses for Nuclear Technologies

This appendix provides examples of the numerous applications, both general and specific, of nuclear technologies in our economy and society. The diversity, pervasiveness and necessity of these applications is not recognized and appreciated by many of us.

General Uses

Nuclear technologies play a critical role in:

- The generation of electricity in a non-polluting, environmentally benign manner.
- Maintaining the safety and structural integrity of the buildings in which we work, the airplanes in which we fly, and the roads and bridges over which we travel.
- Maintaining the health and quality of the foods we eat and the liquids we drink.
- Testing and improving the automobiles we drive.
- Improving health and saving lives—while at the same time reducing the costs of health care.
- Increasing crop yields and improving the health and productivity of farm animals.
- Reducing the costs of energy exploration and production, and increasing energy efficiency.
- Reducing the threat of terrorism in air travel and in public places.
- Controlling insect pests in an environmentally benign manner.
- Controlling and abating air, water, chemical and solid waste pollution.
- Facilitating R&D breakthroughs in all fields of science, industry and technology.

The standard of living for most people in developed countries would not be possible without nuclear technologies. They are ubiquitous and extraordinarily important in many ways, both large and small, throughout all aspects of life.

- Glenn Seaborg, one of the most prominent scientists of recent decades, has stated that even if not one watt of electrical power had ever been generated from nuclear energy, all of the money invested in the nuclear energy field from the Manhattan Project forward would have been justified many times over by radioisotopes and radioactive materials.

- The use of nuclear technologies in chemistry has had as profound an impact in that field of science as use of the electron microscope has had in physics.

- U.S. businesses in all fields of industry and commerce rely heavily on nuclear technologies to maintain and enhance their competitiveness in an increasingly competitive world.

- Nuclear technologies have been used to resolve two of the most controversial archaeological disputes in recent decades: the Dead Sea Scrolls and the Shroud of Turin.

- Nuclear technologies have been used to estimate the age of the earth and, most recently, to support the theory that a cataclysmic impact of a huge asteroid was responsible for extinction of the dinosaurs and the evolution of current species, including homo-sapiens.

- Nuclear medicine techniques permit the detection, treatment and cure of breast cancer and prostate cancer—and many other diseases—without surgery.

- One-third to one-half of the food produced in the world is lost due to spoilage and infestation between production and consumption, and nuclear technologies can prevent most of this loss.

- Without nuclear technologies, the exploration of space would be impossible.

- Use of nuclear technologies has reduced the number of patients in the United States treated annually using surgery for hyperthyroidism from 3,000 to 50.

In Our Everyday Lives

The use of nuclear technologies touches virtually everyone's life in many ways large and small—even though few people are aware of it. But this point can be expressed in another way. For example, consider a typical day in the life of an average person:

- Your lights, air conditioning, appliances and other electrical conveniences may be running off of nuclear-generated electricity.

- The food you eat has been improved, produced and preserved using nuclear technologies.
  - A glass of water on the table owes its quality and safety to nuclear technologies.
  - The can of soft drink or beer consumed was likely filled to a precise level using nuclear technologies.
  - The dishes and utensils used at the meal were likely produced using nuclear technology quality control and inspection methods.

- Your clothes relied upon nuclear technologies in their production.

- The buildings, highways, and bridges you used were constructed and tested using nuclear technologies—the same holds true if a subway or train was used for transportation.

- The books, magazines and newspapers you read were produced using nuclear technologies in printing.

- The smoke detector in your home or office is likely powered by nuclear technologies.

- The original painting, antique or artifact you viewed in a museum was likely authenticated using nuclear technologies.

- The radio, television or sound system you heard or watched during the day was produced using nuclear technologies.

- The automobile you drove required extensive use of a variety of nuclear technologies for R&D, testing, inspection and gauging. In addition:

  - The tires of the automobile owe much of their quality to nuclear technologies.
  - The gasoline in the car was produced and transported using nuclear technologies.

- In a doctor's office or hospital visited, all aspects of the diagnosis and treatment were profoundly affected by nuclear technologies.

- In traveling by air, nuclear techniques helped ensure that no bombs were smuggled aboard the airplane and that the aircraft, its components and its engines were safe, cost-effective and efficient.

- The furniture in your home and office was produced using radioactive sources for measurement of the lumber, production of the fabrics and applications of finish.

Nuclear technology methods also work to benefit all of us by helping to protect the environment we share:

- Insect pests can be controlled using nuclear sterile insect techniques instead of harmful and often carcinogenic insecticides.
- Nuclear technologies can substantially reduce the need for agricultural fertilizers.
- Nuclear technologies can reduce the need for water in irrigation systems by 50 percent or more.
- Solid wastes and sewage can be treated with nuclear technologies without using toxic chemicals.

Finally, it should be recognized that radioactive materials are used for a purpose often because they are both more effective and less expensive than currently available alternatives, if any. A few examples demonstrate this point:

- Pipeline leaks can be detected using nuclear technologies in a matter of days or weeks at a cost of $25,000 - $50,000; alternative methods can take six months to a year and cost $500,000 - $1 million, and the additional downtime costs of the pipeline will cost many millions of dollars more.
- Wear and corrosion tests on engines are at least 10 times cheaper using nuclear technologies instead of alternative methods.
- Nuclear medicine can reduce or eliminate the necessity for prostate cancer surgery—which currently costs $300 million per year.
- Nuclear medical *in vitro* diagnostic techniques are millions of times more sensitive than the alternatives.

Appendix A continued on next page

The following table—which is a partial list—identifies some of the major categories and specific uses of radioactive materials in the 1990s:

Medicine

Nuclear medicine procedures are used to select patients for coronary surgery, assess treatment and prevent recurrence.

Lung scans use radioactive materials to detect the presence of blood clots.

Bone scans can detect the spread of cancer six to 18 months sooner than X-rays.

Radioactive materials reduce the need for prostate cancer surgery.

Renal scans are much more sensitive than X-rays or ultrasound procedures in fully evaluating kidney function.

Radioactive iodine is the most reliable treatment available for hyperthyroidism.

Imaging with radioactive technetium-99m can help diagnose bone infections in young children at the earliest possible stage.

Strontium-89 is used to decrease the pain of bone metastasis.

Phosphorus-32 is used to treat leukemia.

Radioactive tracer compounds are used to test most drugs to obtain FDA approval. Often this is the only viable method available.

Radiation is used to sterilize surgical instruments and medical supplies.

Radionuclides are used to diagnose brain function disorders.

Radionuclides are used in lung ventilation and blood flow studies.

Industry

The paper industry uses radioactive materials in the production of coated paper.

Manufacturers of cans use radioactive materials to obtain the proper thickness of tin and aluminum.

Radioisotopes help produce wire and cable with improved resistance to heat and chemicals.

Radiation gauges are used to regulate blast furnaces, liquid metal in molds, and load levels in kilns.

Construction crews use radioactive materials to gauge the density of road surfaces.

Radiography is used to check the welds on virtually all new oil and gas pipelines and to examine the structural integrity of bridges.

Oil, gas and mining companies use radioactive materials to map the contours of test wells and mine bores.

Industry (continued)

Wear and corrosion tests on engines are 10 times cheaper using radioactive materials than alternative methods.

Museums rely on radioactive materials to verify the authenticity of paintings and art objects.

Radioactive tracers are used in the machine tools industry to measure wear and tear on cutting tools and drills.

Radiation is used to toughen plastics and electronic components.

Radioactive materials are used in luminous paint and luminous products including exit signs, airport runway lights, dials, gauges and watches.

Consumer Products

Radiation is used to toughen the rubber in radial tires and to align the steel belts in those tires.

Radioactive materials are used to make biscuits, cakes, chocolate, cheese and chewing gum.

Non-stick pans are treated with radiation to ensure that the plastic coating adheres.

Photocopiers use small amounts of radiation to eliminate static and prevent paper from sticking together and jamming the machine.

Cosmetics, hair products and contact lens solutions are sterilized with radiation.

Consumer Products (continued)

Textiles are treated with radioactive materials to give them desirable qualities, like the ability to repel water.

Radiation is used to measure the correct amount of air whipped into ice cream.

Scientific Research

Nuclear materials are widely used in biotechnology to analyze specific molecules.

The exploration of space would be impossible without small, nuclear-powered generators.

Radioactive materials are an essential part of biomedical research on diseases like AIDS, cancer and Alzheimer's disease.

Carbon-14 dating has revolutionized archaeology and is used to determine the age of archaeological and historical objects—including the Dead Sea Scrolls and the Shroud of Turin.

Radioactive materials are used to estimate the age of the earth, and have validated the hypothesis that the impact of a huge asteroid caused extinction of the dinosaurs.

Radionuclides are essential for genetic research and were key in determining the structure of DNA.

Radioactive materials are critical in geology to and in surveys of rock, soil and water.

Scientific Research (continued)

The use of radioactive materials has been as important in chemistry as the discovery of the electron microscope in physics.

Radioisotope tracers are extensively used in metallurgical research to identify metal alloys, purify metals and analyze self-diffusion.

Human, animal and plant physiological measurements are made using radioactive tracers.

Research in nutrition uses radioactive tracers.

Agriculture

Radioisotopes are used to reduce post-harvest losses by suppressing sprouting and contamination.

Scientists use radioactive materials to breed disease-resistant livestock.

Research into how plants absorb fertilizer helps prevent the over-use of fertilizers.

Radioactive carbon-14 is used to determine whether irrigation can be introduced on a sustainable basis.

Radiation is used to preserve seeds and food products and breed disease-resistant plants (as well as animals).

Law Enforcement and Public Safety

Police use radioisotope methods to check for poisons in crimes.

Radiation is used to scan luggage at a growing number of airports to detect explosives and concealed weapons.

Radiation is used to check packages for illegal narcotics.

Smoke detectors—installed in most U.S. homes and commercial buildings—rely on a tiny radioactive source to function.

Environmental Protection

Radionuclides help determine plant and sea assimilation of greenhouse gases.

Solid wastes and sewage are treated with radiation techniques instead of toxic chemicals.

Radioactive materials are essential in climatological investigations to determine if the earth's climate is actually warming.

Nucleonic gauges are used to monitor and control the ash and moisture content in coal.

Insects are controlled using radiation-induced sterilization instead of harmful insecticides.

Radioactive materials measure carbon dioxide releases from an industrial area.

Radioactive materials are used to measure pollution in reservoirs and coastal aquifers.

APPENDIX B

Methodology and Data Base

Estimating the National Economic and Employment Effects of Nuclear Technologies

Important economic benefits of nuclear technologies are generated directly and indirectly by the sales, profits, jobs and tax revenues resulting from the widespread use of these technologies throughout the economy. Here we assess this impact by estimating the economic benefits of the use of nuclear technologies on the U.S. economy and on specific states. Specifically, we estimate the effects on the economy in 1995 of the myriad uses of nuclear technologies in that year, focusing on the following impacts:

- *Direct and indirect economic effects.* The impacts estimated here include those resulting from the initial use of nuclear technologies as well as those generated indirectly throughout the economy by the expenditures. The effects on each of 80 all-inclusive two-digit Standard Industrial Code industries are estimated, including the output, sales and profits generated by nuclear technologies.

- *Employment.* The total numbers of jobs created in each of the 80 industries and in each of 475 all-inclusive occupations are estimated.

- *National impacts.* Output, sales, profits and employment are estimated for each industry at the national level, and for each occupation, the total number of jobs created nationwide is derived.

- *State-specific effects.* Output, sales and employment are estimated at the state level, and the tax revenues generated in the state are computed.

The economic and employment effects of the use of nuclear technologies were estimated using the Management Information Services Inc. (MISI) data base and information system. A simplified version of the MISI model as applied in this study is shown in Figure 1 page 4.

The first step is the translation of expenditures for nuclear technologies applications and programs into per unit output requirements from every industry in the economy. This is determined by four major factors:

1) the state of technology

2) the distribution of expenditures

3) the specific expenditure/program configuration

4) the direct industry requirements structure

While the model contains 500 industries, in the work conducted here an 80-order industry scheme was used. Each nuclear technologies application was classified by the industry purchasing and using the technology by applying direct input coefficients available from the latest national input-output table of the U.S. economy from the Commerce Department's Bureau of Economic Analysis. The resulting estimates represent the direct impact on the U.S. economy of the use of the nuclear technologies among all industries in 1995.

Second, the direct output requirements of every industry affected as a result of requirements for nuclear technologies are estimated. These direct requirements show, proportionately, how much an industry must purchase from every other industry to produce one unit of output.

Direct requirements, however, give rise to subsequent rounds of indirect requirements. For example, steel mills require electricity to produce steel. But an electric utility requires turbines from a factory to produce electricity. The factory requires steel from steel mills to produce turbines, and the steel mill requires more electricity, and so on.

The latter are the indirect requirements. The sum of the direct plus the indirect requirements represents the total output requirements from an industry necessary to produce one unit of output. Economic input-output (I-O) techniques allow the estimation of the direct, as well as the indirect, production requirements, and these total requirements are represented by the "inverse" equations in the model. The ratio of the total requirements to the direct requirements is called the input-output multiplier.
Thus, in the third step in the model the direct industry output requirements are converted into total output requirements from every industry by means of the input-output inverse equations. These equations show not only the direct requirements, but also the second, third, fourth, nth round indirect industry and service sector requirements resulting from nuclear technologies expenditures.

Next, the total output requirements from each industry are used to compute sales volumes, profits and value added for each industry. Then, using data on manhours, labor requirements and productivity, employment requirements within each industry are estimated. This allows estimation of the total number of jobs created within each industry.

The next step requires the conversion of total employment requirements by industry into job requirements for specific occupations and skills. To accomplish this, MISI utilizes data on the occupational composition of the labor force within each industry, and estimates job requirements for 475 specific occupations encompassing the entire U.S. labor force. This permits estimation of the impact of nuclear technologies applications on jobs for specific occupations and on skills, education and training requirements.

Using the modeling approach outlined above, MISI estimated the effects on employment, personal income, and corporate sales and profits, and estimates were then developed for detailed industries and occupations. The total federal, state and local government tax revenues produced by the utilization of nuclear technologies were estimated using average 1995 federal, state and local government tax rates for each industry and within each state.

The MISI statistical estimates reflect the direct and indirect effects of the industries and persons involved in the production, processing, transportation, utilization, etc., of nuclear technologies throughout the economy. For example, if the department of nuclear medicine in a major hospital is closed or scaled back, the MISI estimates show the likely direct and indirect economic and employment effects of this reduction in output throughout the economy of the region, state and nation.

The next step in the analysis (not carried out in this study) entails assessing the economic impact on specific cities--Metropolitan Statistical Areas (MSAs). The MISI approach permits disaggregation to the level of most U.S. MSAs and, if desired, to the county level. Empirically, the basis of the sub—state estimates is the Regional Input-Output Modeling System (RIMS II) developed by the U.S. Commerce Department's Bureau of Economic Analysis.

The MISI model and data base permit economic impacts to be estimated for any region composed of one or more counties and for any industry in the national I-O table. MISI can estimate the impacts of project and program expenditures by industry on regional output (gross receipts or sales), earnings (the sum of wages and salaries, proprietors' income, and other labor income, less employer contributions to private pension and welfare funds), and employment. The use of this methodology has been validated in independent studies over the past two decades.

For the MSAs, there may be further interest in estimating the impact on requirements for specific occupations. This can be accomplished using the MISI occupation-by-industry matrix, the coefficients of which show the percent distribution of occupational employment among all industries. The 500-by-475 matrix was developed from the Current Population Survey and was modified to conform to the available data.

MISI maintains extensive proprietary and nonproprietary databases on the U.S. economy, the state economies, on the Metropolitan Statistical Areas within the states, and on counties in the states. The major public sources of the nonproprietary data include:

- The Bureau of Economic Analysis of the U.S. Commerce Department
- The Bureau of the Census of the U.S. Commerce Department
- The Bureau of Labor Statistics of the U.S. Labor Department
- The Energy Information Administration of the U.S. Energy Department

In addition:

- MISI has proprietary economic forecasting databases for the U.S. and for most states, developed and utilized over the past decade.
- MISI staff has developed extensive technology- program- environmental- and state-specific economic and statistical databases.

Thus, the direct and indirect effects of nuclear technologies on the national and state economies can be disaggregated into the impact on:

- Jobs (475 occupations and skills)
- Industry sales (500 4-digit SIC industries)
- Corporate profits
- Federal, state and local government tax revenues
- Employment and unemployment (by industry and occupation)
- Net growth or displacement of new businesses
- Major economic, technological, social and environmental parameters and externalities

MISI derives these estimates using quantitative models and databases it has online and which have been used by MISI in many other analogous disaggregate regional, economic, technological and environmental studies. These models and data are unique and proprietary and give MISI estimation capabilities in this area unequaled by any other firm. These models include:

- The U.S. Commerce Department's national input-output model.
- A modified version of the Commerce Department's regional econometric forecasting model.

- A modified version of the Regional Input-Output Modeling System (RIMS) supplemented with the Census Bureau/BLS industry-occupation matrix—adapted to state economies by MISI.
- A modified version of the Energy Externalities Simulation (EES) model developed by MISI.

Use of these proprietary models and the associated databases permitted MISI to develop the nuclear technologies estimates.

Interpretation of the Estimates

The estimates developed here of the economic and employment impacts of nuclear technologies are subject to statistical imprecision and, especially with respect to individual states or occupations, could easily vary by 10 or 15 percent. However, the salient point is that, if anything, these estimates actually understate the importance of nuclear technologies to the economy and labor market.

In most studies the estimates developed here would present a relatively accurate description of the effects. Thus, within a particular industry or manufacturing process, if one input becomes scarce or relatively expensive, other inputs or production methods are substituted. Depending on the economic and technological elasticities, very often even small changes in availability or prices can lead to widespread substitution and utilization of other inputs and alternative methods.

Obviously, in many cases this will also hold true for nuclear technologies. However, in many applications throughout the economy there are no cost-effective substitutes for nuclear technologies methods and processes; very often there are no substitutes whatsoever. For example, the usual case in industry is that an increase in price of 2 or 3 percent in one input triggers economic and technological substitution and the use of alternatives.

However, in the case of nuclear technologies, the alternatives are not just slightly more expensive, inconvenient or time consuming. Rather, the non-nuclear technologies alternatives are often more expensive and time consuming by factors of 10, 50, 100 or more. For example, in the automotive and machine tool industries, the alternatives are more than 10 times more expensive and, at least in the latter industry, are less precise than nuclear technologies methods. In the chemical industry nuclear technologies techniques can be 100 times more precise than the alternatives.

Thus, a realistic estimate of the impact of the loss or reduction of nuclear technologies on the economy would require a comprehensive analysis taking all of these losses into account. Such an analysis is outside the scope of the current study and indeed would be an extremely challenging task. Two things are certain, though:

- Such an analysis would provide estimates of the economic and job impacts of nuclear technologies much larger than those detailed here —probably several times larger.

- Second, even these data would underestimate the economic benefits of nuclear technologies.

The reason for the second point above is that in many cases there simply are no substitutes for nuclear technologies:

- Many important medical diagnostic and treatment procedures would be impossible without nuclear technologies—and the economic consequences here would involve the premature loss of millions of lives.

- Radioactive materials are not used in U.S. space probes because they are cheap or convenient; rather, there are no substitutes for them.

- In the exploration for oil and gas there are very often no substitutes for radioisotope tracer methods.

- Without nuclear technologies, there would be no way to date historical and archaeological artifacts accurately.

- Without nuclear technologies entire areas of research and development in chemistry, metallurgy, genetics, biotechnology, and many other fields of science and engineering would not exist.

- More basically, many of the economic and technological advances of recent years taken for granted and involving safety, convenience, sophistication, efficiency and cost effectiveness would not—could not—exist without nuclear technologies.

In sum, as discussed in the report, we estimate that the beneficial economic impacts of nuclear technologies in 1995 totalled $421 billion in industry sales and 4.4 million jobs. In reality, the beneficial impacts of nuclear technologies are considerably larger than these estimates indicate.

Appendix C

Benefits by the Numbers

A State-by-State Accounting of the Economic Impact of Nuclear Technologies

The highly integrated economy of the United States distributes benefits from the application of nuclear technologies to every one of the 50 states. While some clearly derive more gains than others, no state can dismiss the substantial advantages these materials produce in a competitive marketplace.

On the following pages, benefits of using nuclear technologies are shown for each state through the amount of annual ***sales*** tied to the technologies, the number of ***jobs*** generated and the annual ***tax revenues*** paid by companies and other institutions.

- The first section of the appendix lists states in which at least one nuclear power plant currently operates.
- The second section presents these figures for states in which no nuclear plants currently produce electricity.

Overall corresponding figures for the United States are also shown. All figures are for 1995.

In selected cases, the number of jobs generated in a state by nuclear technologies is also shown as a percentage of the total job base in that state. For states in which a substantial portion of electrical power generation is derived from nuclear energy, that figure is shown.

Finally, most people are familiar with news reports about the incentives some states have made to attract a particular company to its jurisdiction, or to keep one from leaving. For instance, Virginia failed in its effort to attract a new Disney theme park, despite the offer of a generous incentives package, while St. Louis made a successful bid to attract a National Football League franchise. Under the heading "Perspectives on Economic Development," examples are given for several states which make it possible to compare the lengths to which states have gone to attract and retain business, on the one hand, with the substantial advantages nuclear-related industries and technologies generated for those states in 1995 on the other.

Section 1

Alabama

	Alabama 1995	United States 1995
Sales related to nuclear technologies (million $)	4,844	420,900
Jobs	42,735	4,395,000
Tax revenues (million $)	894	78,700
Electricity produced by nuclear energy (%)	21	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993, Alabama (at the cost of $300 million in incentives) won the bidding war among the states for a Mercedes-Benz factory that is currently generating, in total, about 3,000 jobs in the state. This represents a cost to the state of $170,000 per on-site job created.

In contrast, in 1995 nuclear technologies generated almost 43,000 jobs in Alabama.

Arizona

	Arizona 1995	United States 1995
Sales related to nuclear technologies (million $)	3,539	420,900
Jobs	26,144	4,395,000
Percentage of total jobs within state	1	
Tax revenues (million $)	658	78,700
Electricity produced by nuclear energy (%)	39	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

During 1993 and 1994 Hughes Aircraft, in response to a generous package of tax incentives, relocated substantial operations from California to Arizona, resulting in the loss of about 12,000 jobs in California and the creation of an equivalent number in Arizona.

In contrast, in 1995 nuclear technologies created 250,000 jobs in California and 26,000 jobs in Arizona.

Arkansas

	Arkansas 1995	United States 1995
Sales related to nuclear technologies (million $)	1,855	420,900
Jobs	13,314	4,395,000
Tax revenues (million $)	346	78,700
Electricity produced by nuclear energy (%)	30	20

California

	California 1995	United States 1995
Sales related to nuclear technologies (million $)	26,536	420,900
Jobs	250,117	4,395,000
Tax revenues (million $)	5,157	78,700
Electricity produced by nuclear energy (%)	25	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993 McDonnell Douglas relocated operations generating about 3,000 jobs from California to Missouri.

In contrast, in 1995 nuclear technologies generated 78,000 jobs in Missouri and 250,000 jobs in California.

During 1993 and 1994 Hughes Aircraft, in response to a generous package of tax incentives, relocated substantial operations from California to Arizona, resulting in the loss of about 12,000 jobs in the former state and the creation of an equivalent number in the latter.

In contrast, in 1995 nuclear technologies created 250,000 jobs in California and 26,000 jobs in Arizona.

California, and especially southern California, has since World War II been disproportionately affected by the defense and aerospace industries. During the early 1990s, due at least in part to reductions in federal defense and aerospace spending, California suffered from one of the most severe recessions in the state's recent history. Economic growth declined, the real estate and construction industries collapsed, and for virtually the first time in history, the state experienced significant out-migration of businesses and population. Between 1991 and 1995, the state lost, on average, about 40,000 total jobs per year due to the downturns in defense spending and the aerospace industry. These job losses were well recognized and publicized, and were often taken as a precursor of austere times for the California economy.

However, at the same time it was not appreciated that nuclear technologies were generating in California, on an annual basis, 250,000 jobs—more than six times as many as were lost in any single year in the defense and aerospace related industries.

Connecticut

	Connecticut 1995	United States 1995
Sales related to nuclear technologies (million $)	12,248	420,900
Jobs	113,662	4,395,000
Percentage of total jobs within state	7	
Tax revenues (million $)	2,730	78,700
Electricity produced by nuclear energy (%)	70	20

Florida

	Florida 1995	United States 1995
Sales related to nuclear technologies (million $)	5,212	420,900
Jobs	38,313	4,395,000
Tax revenues (million $)	973	78,700
Electricity produced by nuclear energy (%)	20	20

Georgia

	Georgia 1995	United States 1995
Sales related to nuclear technologies (million $)	9,672	420,900
Jobs	94,285	4,395,000
Tax revenues (million $)	1,758	78,700
Electricity produced by nuclear energy (%)	30	20

Illinois

	Illinois 1995	United States 1995
Sales related to nuclear technologies (million $)	15,558	420,900
Jobs	124,528	4,395,000
Percentage of total jobs within state	3	
Tax revenues (million $)	2,861	78,700
Electricity produced by nuclear energy (%)	54	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In the early 1990s, Illinois undertook the "largest job-retention effort in the state's history" (at a cost of $250 million) to prevent Sears, Roebuck & Co. from moving out of state, and thus preserved about 8,000 jobs for Illinois.

In contrast, in 1995 nuclear technologies generated 125,000 jobs in Illinois.

Iowa

	Iowa 1995	United States 1995
Sales related to nuclear technologies (million $)	4,132	420,900
Jobs	64,055	4,395,000
Tax revenues (million $)	745	78,700
Electricity produced by nuclear energy (%)	11	20

Kansas

	Kansas 1995	United States 1995
Sales related to nuclear technologies (million $)	1,534	420,900
Jobs	12,466	4,395,000
Tax revenues (million $)	284	78,700
Electricity produced by nuclear energy (%)	26	20

Louisiana

	Louisiana 1995	United States 1995
Sales related to nuclear technologies (million $)	2,666	420,900
Jobs	21,428	4,395,000
Tax revenues (million $)	513	78,700
Electricity produced by nuclear energy (%)	24	20

Maine

	Maine 1995	United States 1995
Sales related to nuclear technologies (million $)	2,143	420,900
Jobs	29,863	4,395,000
Tax revenues (million $)	384	78,700
Electricity produced by nuclear energy (%)	7	20

Maryland

	Maryland 1995	United States 1995
Sales related to nuclear technologies (million $)	6,963	420,900
Jobs	77,480	4,395,000
Percentage of total jobs within state	3	
Tax revenues (million $)	1,458	78,700
Electricity produced by nuclear energy (%)	29	20

Massachusetts

	Massachusetts 1995	United States 1995
Sales related to nuclear technologies (million $)	11,110	420,900
Jobs	110,010	4,395,000
Percentage of total jobs within state	4	
Tax revenues (million $)	2,306	78,700
Electricity produced by nuclear energy (%)	17	20

Michigan

	Michigan 1995	United States 1995
Sales related to nuclear technologies (million $)	4,799	420,900
Jobs	37,880	4,395,000
Tax revenues (million $)	892	78,700
Electricity produced by nuclear energy (%)	26	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1996, Blue Water Fibre received $80 million in inducements from Michigan for a paper-recycling mill that employs 34 workers—thus costing the state $2.4 million per on-site job created.

In 1993 and 1994 Ypsilanti, Mich., took General Motors to court in a futile attempt to prevent the relocation of the Willow Run Assembly Plant to Arlington, Texas, which eventually cost the state of Michigan about 9,000 total jobs.

In contrast, in 1995, nuclear technologies generated 38,000 jobs in Michigan and 220,000 jobs in Texas.

Minnesota

	Minnesota 1995	United States 1995
Sales related to nuclear technologies (million $)	12,961	420,900
Jobs	132,,149	4,395,000
Percentage of total jobs within state	6	
Tax revenues (million $)	2,413	78,700
Electricity produced by nuclear energy (%)	31	20

Mississippi

	Mississippi 1995	United States 1995
Sales related to nuclear technologies (million $)	1,837	420,900
Jobs	16,161	4,395,000
Percentage of total jobs within state	1	
Tax revenues (million $)	339	78,700
Electricity produced by nuclear energy (%)	30	20

Missouri

	Missouri 1995	United States 1995
Sales related to nuclear technologies (million $)	7,240	420,900
Jobs	78,000	4,395,000
Tax revenues (million $)	1,300	78,700
Electricity produced by nuclear energy (%)	13	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993 McDonnell Douglas relocated operations generating about 3,000 jobs from California to Missouri.

In contrast, in 1995 nuclear technologies generated 78,000 jobs in Missouri and 250,000 jobs in California.

Nebraska

	Nebraska 1995	United States 1995
Sales related to nuclear technologies (million $)	1,775	420,900
Jobs	14,594	4,395,000
Tax revenues (million $)	328	78,700
Electricity produced by nuclear energy (%)	30	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In the late 1980s Nebraska gave ConAgra $10 million in incentives to build a new laboratory in the state that currently generates about 800 jobs.

In contrast, in 1995 nuclear technologies created 15,000 jobs in Nebraska.

New Hampshire

	New Hampshire 1995	United States 1995
Sales related to nuclear technologies (million $)	924	420,900
Jobs	4,970	4,395,000
Percentage of total jobs within state	9	
Tax revenues (million $)	202	78,700
Electricity produced by nuclear energy (%)	60	20

New Jersey

	New Jersey 1995	United States 1995
Sales related to nuclear technologies (million $)	14,667	420,900
Jobs	126,686	4,395,000
Tax revenues (million $)	3,057	78,700
Electricity produced by nuclear energy (%)	62	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1992, New Jersey offered $50 million to First Chicago Corp. in a successful effort to induce it to move to the state from New York, thus creating about 2,500 jobs in New Jersey.

In contrast, in 1995 nuclear technologies created 127,000 jobs in New Jersey and 148,000 jobs in New York.

New York

	New York 1995	United States 1995
Sales related to nuclear technologies (million $)	18,501	420,900
Jobs	147,841	4,395,000
Tax revenues (million $)	4,010	78,700
Electricity produced by nuclear energy (%)	26	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1992 and 1993, New York state and city granted $362 million in tax incentives and other concessions to four corporations and five commodities exchanges to prevent them from moving to Connecticut or New Jersey—despite a "non-aggression pact" the three states signed in 1991 to prevent such competition. For example:

- In 1993, CBS Inc. received $50 million in tax incentives in return for a pledge to keep its headquarters in New York for 15 years. About 6,000 total jobs were preserved for New York by this agreement.

- In 1993, Prudential Securities received $106 million in tax incentives and low-cost energy rates in return for a pledge to keep its employees in New York for 20 years. This agreement preserved a total of about 8,000 jobs for New York.

In contrast, in 1995 nuclear technologies created 148,000 jobs in New York.

North Carolina

	North Carolina 1995	United States 1995
Sales related to nuclear technologies (million $)	12,432	420,900
Jobs	128,846	4,395,000
Tax revenues (million $)	2,251	78,700
Electricity produced by nuclear energy (%)	37	20

Ohio

	Ohio 1995	United States 1995
Sales related to nuclear technologies (million $)	6,462	420,900
Jobs	68,960	4,395,000
Tax revenues (million $)	1,222	78,700
Electricity produced by nuclear energy (%)	12	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993 the state of Kentucky outbid Ohio and Pennsylvania for a Canadian steel mill that would create 800 total jobs—at a cost to Kentucky of $14 million in foregone tax revenues.

In contrast, in 1995 nuclear technologies generated 18,000 jobs in Kentucky, 70,000 jobs in Ohio, and 630,000 jobs in Pennsylvania.

Pennsylvania

	Pennsylvania 1995	United States 1995
Sales related to nuclear technologies (million $)	62,901	420,900
Jobs	629,616	4,395,000
Percentage of total jobs within state	11	
Tax revenues (million $)	11,231	78,700
Electricity produced by nuclear energy (%)	39	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993 the state of Kentucky outbid Ohio and Pennsylvania for a Canadian steel mill that would create 800 total jobs—at a cost to Kentucky of $14 million in foregone tax revenues.

In contrast, in 1995 nuclear technologies generated 630,000 jobs in Pennsylvania, 18,000 jobs in Kentucky, and 70,000 jobs in Ohio.

South Carolina

	South Carolina 1995	United States 1995
Sales related to nuclear technologies (million $)	19,382	420,900
Jobs	240,990	4,395,000
Percentage of total jobs within state	13	
Tax revenues (million $)	3,493	78,700
Electricity produced by nuclear energy (%)	63	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1992, South Carolina granted the German automobile manufacturer BMW $150 million in tax breaks and other incentives to build an automobile assembly plant near Spartanburg which, by 1995, was generating about 3,000 total jobs in the state.

In contrast, in 1995 nuclear technologies generated 240,000 jobs in South Carolina.

Tennessee

	Tennessee 1995	United States 1995
Sales related to nuclear technologies (million $)	29,173	420,900
Jobs	325,766	4,395,000
Percentage of total jobs within state	13	
Tax revenues (million $)	5,194	78,700
Electricity produced by nuclear energy (%)	19	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In the mid-1980s, Tennessee outbid other states for the location of General Motors' much sought after Saturn automobile factory. This manufacturing plant generates about 6,000 jobs in the state, and cost Tennessee more than $100 million in various types of financial incentives.

In contrast, in 1995 nuclear technologies generated 325,000 jobs in Tennessee.

In 1992, Kentucky—at a cost of $39 million in incentives—outbid Tennessee for an International Paper Co. label manufacturing plant that currently generates about 800 jobs.

In contrast, in 1995 nuclear technologies created 18,000 jobs in Kentucky and 325,000 jobs in Tennessee.

Texas

	Texas 1995	United States 1995
Sales related to nuclear technologies (million $)	21,834	420,900
Jobs	220,456	4,395,000
Tax revenues (million $)	3,919	78,700
Electricity produced by nuclear energy (%)	14	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1993 Congress voted to terminate work on the Superconducting Super Collider (SSC), which was being constructed near Waxahachie, Texas. The decision was made due to continuing cost overruns in the project and to Congress' mood of fiscal restraint. It was also made despite the fact that $2.7 billion had been committed for the $11 billion project, which was already 20 percent complete. The Texas state government and congressional delegation lobbied intensely to save the project—largely out of concern for the economic development and jobs it would mean for Texas—and worried that the SSC's demise was a major blow to the Texas economy. When terminated, the SSC was generating about 5,000 jobs in Texas, and when fully operational it would have generated about 14,000 total jobs.

However, it was not realized that nuclear technologies were already generating 220,000 jobs in Texas—nearly 16 times the number of jobs that even a fully operational SSC would have created.

Vermont

	Vermont 1995	United States 1995
Sales related to nuclear technologies (million $)	1,299	420,900
Jobs	11,793	4,395,000
Percentage of total jobs within state	4	
Tax revenues (million $)	248	78,700
Electricity produced by nuclear energy (%)	80	20

Virginia

	Virginia 1995	United States 1995
Sales related to nuclear technologies (million $)	28,246	420,900
Jobs	379,137	4,395,000
Percentage of total jobs within state	12	
Tax revenues (million $)	5,042	78,700
Electricity produced by nuclear energy (%)	48	20

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1995 Virginia offered $165 million in incentives to the Disney Co. to build a Disney America theme park that would have generated a total of about 12,000 jobs.

In contrast, in 1995 nuclear technologies generated 379,000 jobs in Virginia.

Washington

	Washington 1995	United States 1995
Sales related to nuclear technologies (million $)	18,421	420,900
Jobs	243,381	4,395,000
Tax revenues (million $)	3,277	78,700
Electricity produced by nuclear energy (%)	7	20

Wisconsin

	Wisconsin 1995	United States 1995
Sales related to nuclear technologies (million $)	3,818	420,900
Jobs	32,573	4,395,000
Tax revenues (million $)	706	78,700
Electricity produced by nuclear energy (%)	22	20

Section 2

Alaska

	Alaska 1995	United States 1995
Sales related to nuclear technologies (million $)	307	420,900
Jobs	3,599	4,395,000
Tax revenues (million $)	71	78,700

Colorado

	Colorado 1995	United States 1995
Sales related to nuclear technologies (million $)	3,169	420,900
Jobs	37,853	4,395,000
Tax revenues (million $)	569	78,700

Delaware

	Delaware 1995	United States 1995
Sales related to nuclear technologies (million $)	795	420,900
Jobs	8,092	4,395,000
Tax revenues (million $)	145	78,700

Hawaii

	Hawaii 1995	United States 1995
Sales related to nuclear technologies (million $)	1,556	420,900
Jobs	23,931	4,395,000
Tax revenues (million $)	288	78,700

Idaho

	Idaho 1995	United States 1995
Sales related to nuclear technologies (million $)	335	420,900
Jobs	4,041	4,395,000
Tax revenues (million $)	61	78,700

Indiana

	Indiana 1995	United States 1995
Sales related to nuclear technologies (million $)	3,692	420,900
Jobs	41,119	4,395,000
Tax revenues (million $)	664	78,700

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1986, Fuji-Isuzu agreed to locate a new plant in Indiana, at a cost to the state of $50,000 per on-site job created.

Kentucky

	Kentucky 1995	United States 1995
Sales related to nuclear technologies (million $)	1,641	420,900
Jobs	18,257	4,395,000
Tax revenues (million $)	299	78,700

PERSPECTIVES ON ECONOMIC DEVELOPMENT

In 1992, Kentucky—at a cost of $39 million in incentives—outbid Tennessee for an International Paper Co. label manufacturing plant that currently generates about 800 jobs.

In contrast, in 1995 nuclear technologies created 18,000 jobs in Kentucky and 325,000 jobs in Tennessee.

In 1993 the state of Kentucky outbid Ohio and Pennsylvania for a Canadian steel mill that would create 800 total jobs—at a cost to Kentucky of $14 million in foregone tax revenues.

In contrast, in 1995 nuclear technologies generated 18,000 jobs in Kentucky, 70,000 jobs in Ohio, and 630,000 jobs in Pennsylvania.

Montana

	Montana 1995	United States 1995
Sales related to nuclear technologies (million $)	351	420,900
Jobs	4,570	4,395,000
Tax revenues (million $)	66	78,700

Nevada

	Nevada 1995	United States 1995
Sales related to nuclear technologies (million $)	945	420,900
Jobs	10,502	4,395,000
Tax revenues (million $)	197	78,700

New Mexico

	New Mexico 1995	United States 1995
Sales related to nuclear technologies (million $)	546	420,900
Jobs	5,823	4,395,000
Tax revenues (million $)	103	78,700

North Dakota

	North Dakota 1995	United States 1995
Sales related to nuclear technologies (million $)	112	420,900
Jobs	997	4,395,000
Tax revenues (million $)	22	78,700

Oklahoma

	Oklahoma 1995	United States 1995
Sales related to nuclear technologies (million $)	6,413	420,900
Jobs	72,030	4,395,000
Percentage of total jobs within state	5	
Tax revenues (million $)	1,141	78,700

Oregon

	Oregon 1995	United States 1995
Sales related to nuclear technologies (million $)	20,761	420,900
Jobs	241,381	4,395,000
Tax revenues (million $)	3,834	78,700

Rhode Island

	Rhode Island 1995	United States 1995
Sales related to nuclear technologies (million $)	291	420,900
Jobs	3,245	4,395,000
Tax revenues (million $)	54	78,700

South Dakota

	South Dakota 1995	United States 1995
Sales related to nuclear technologies (million $)	327	420,900
Jobs	3,607	4,395,000
Tax revenues (million $)	60	78,700

Utah

	Utah 1995	United States 1995
Sales related to nuclear technologies (million $)	3,233	420,900
Jobs	41,110	4,395,000
Percentage of total jobs within state	5	
Tax revenues (million $)	598	78,700

West Virginia

	West Virginia 1995	United States 1995
Sales related to nuclear technologies (million $)	973	420,900
Jobs	11,255	4,395,000
Tax revenues (million $)	178	78,700

Wyoming

	Wyoming 1995	United States 1995
Sales related to nuclear technologies (million $)	335	420,900
Jobs	4,255	4,395,000
Tax revenues (million $)	65	78,700

APPENDIX D

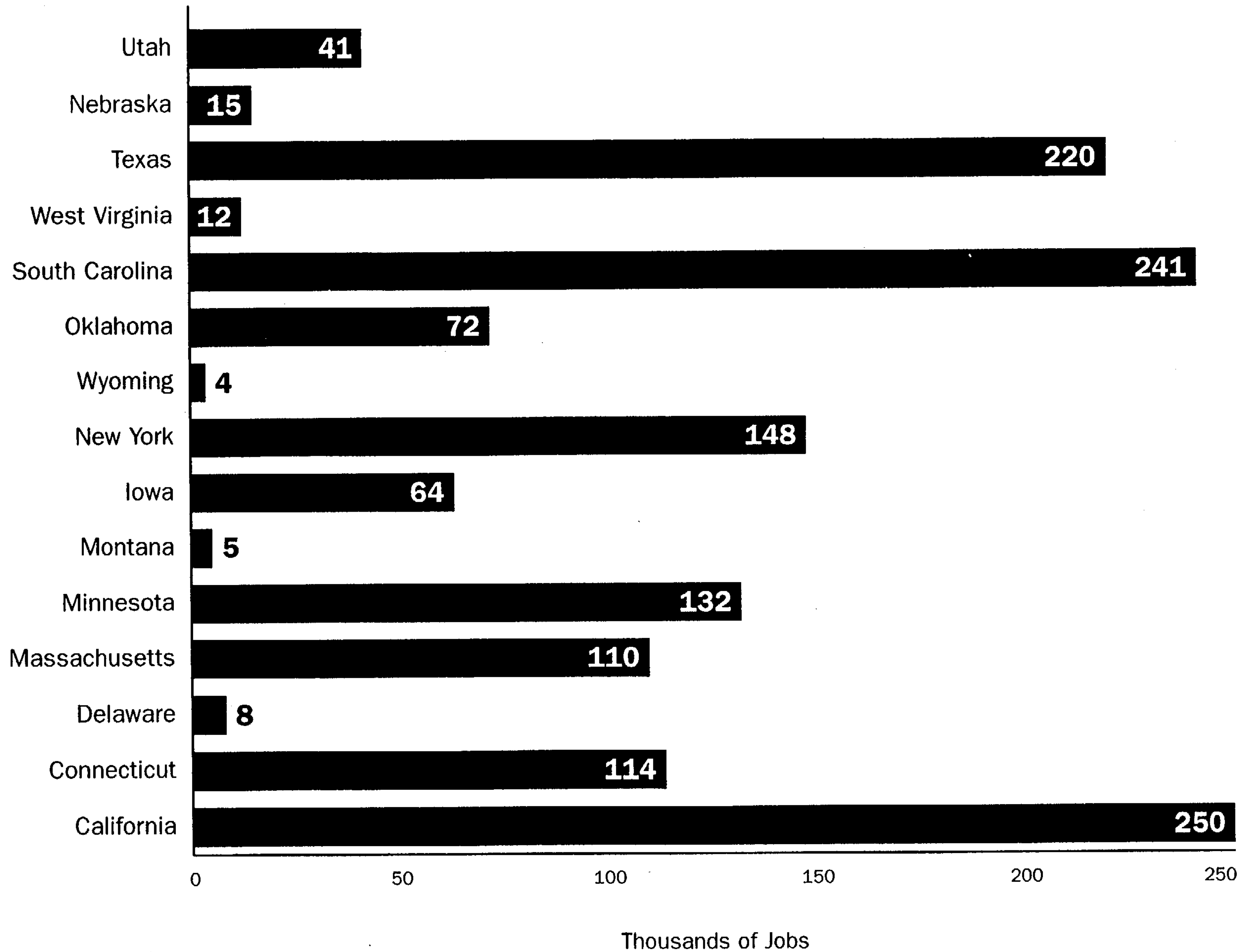
Sales and Jobs Created in the U.S. in 1995 Within Selected Industries by Nuclear Energy and Radioisotope Technologies

Industry Title	Sales (million $)			Jobs		
	Energy	Radioisotopes	Total	Energy	Radioisotopes	Total
Livestock & livestock products	$53	$1,753	$1,806	366	15,221	15,587
Iron ore mining	23	981	1,004	103	5,532	5,635
Maintenance & repair construction	4,742	5,062	9,804	36,199	48,633	84,831
Lumber & wood products, exc. containers	233	2,531	2,764	1,989	27,211	29,200
Paper & allied products	243	4,825	5,067	1,029	25,795	26,825
Chemicals & slected chemical products	756	9,491	10,247	2,673	42,277	44,950
Rubber & miscellaneous plastics products	303	6,802	7,105	2,343	66,213	68,555
Primary iron & steel manufacturing	495	7,118	7,614	2,390	43,239	45,630
Heating, fabricated metal products	289	1,534	1,823	2,562	17,119	19,682
Engines & turbines	623	1,028	1,651	2,761	5,747	8,508
General industrial machinery	180	1,840	2,020	1,299	16,727	18,026
Electrical transmission equipment	255	3,322	3,577	2,179	35,754	37,933
Transportation & warehousing	3,615	10,915	14,530	34,536	131,300	165,836
Electric, gas, & sanitary services	40,756	13,620	54,376	118,586	49,918	168,505
Wholesale & retail trade	1,428	11,705	13,133	23,910	246,888	270,798
Finance & insurance	1,437	5,695	7,131	14,096	70,384	84,480
Hotels & personal services	204	2,373	2,577	4,290	62,758	67,048
Business services	1,903	15,819	17,722	24,181	253,116	277,297
Health, educational & nonprofit	147	47,456	47,603	2,657	1,081,805	1,084,462
Total all industries*	$90,151	$330,739	$420,890	442,406	3,953,461	4,395,866

*Total includes industries not listed separately.

Source: Management Information Services, Inc., 1996

Appendix D
Jobs Created Within Selected States in 1995



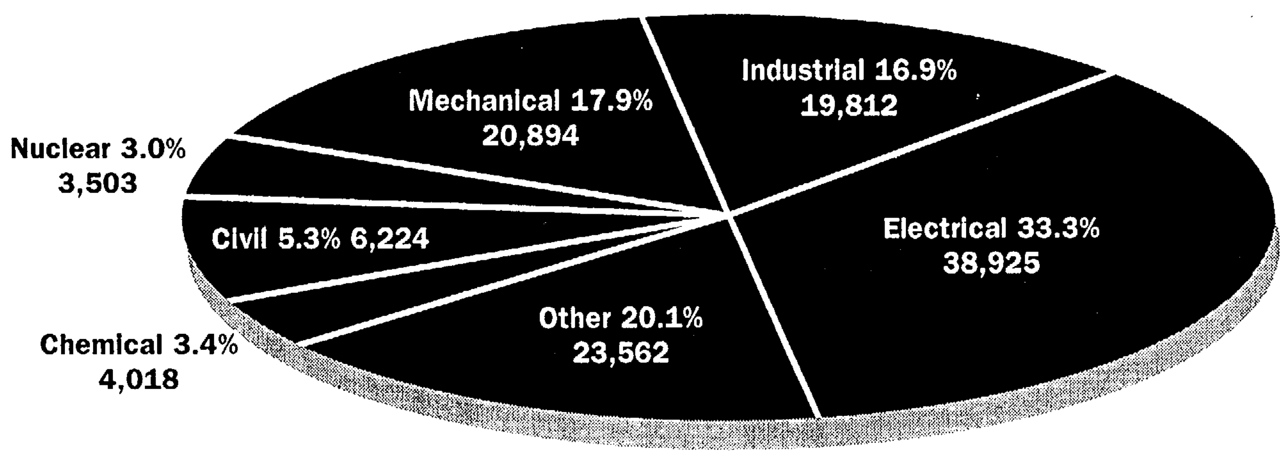
APPENDIX D

Jobs Generated Nationwide Within Selected Occupations in 1995 by Nuclear Energy and Radioisotope Technologies

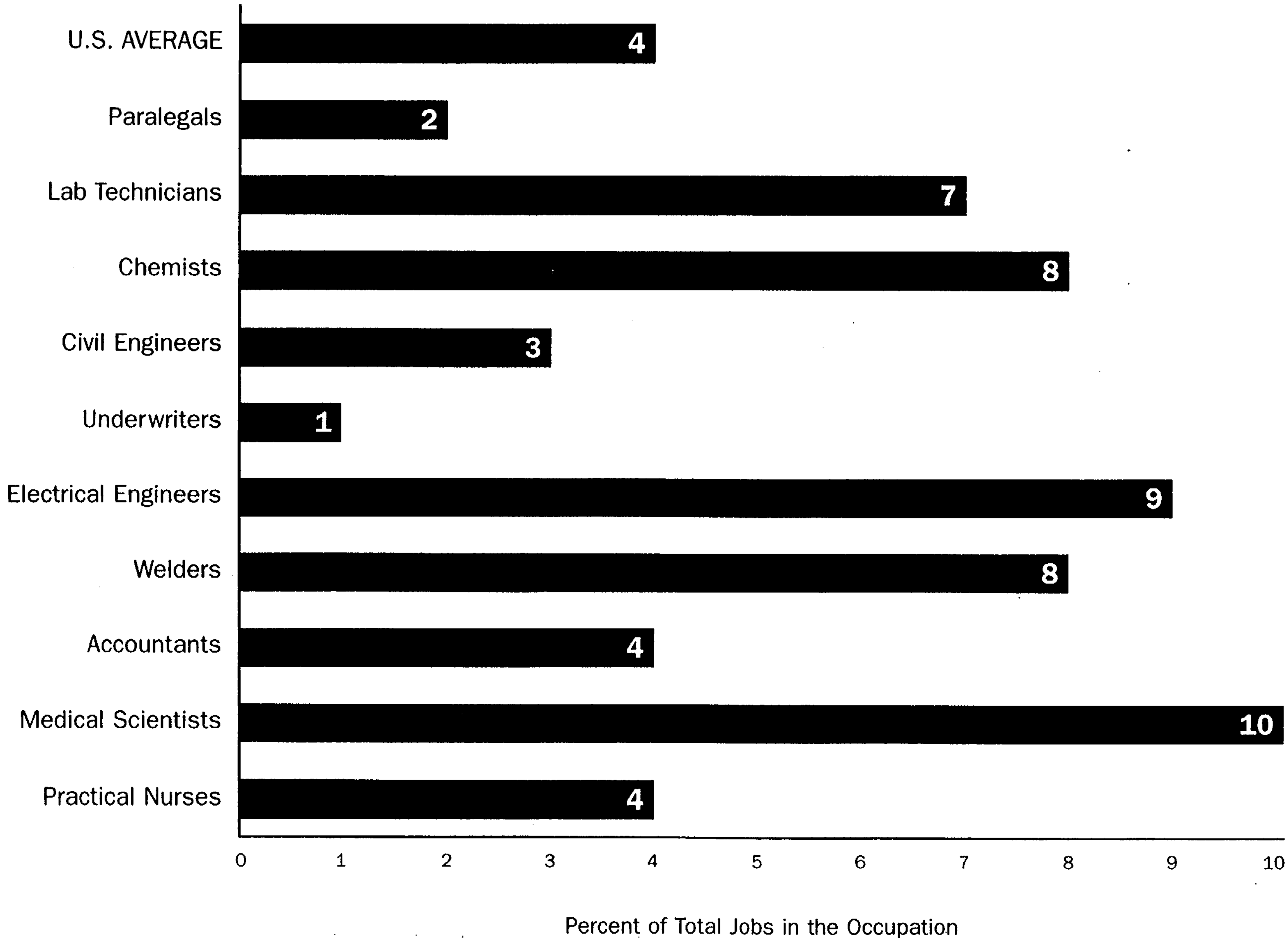
Occupation	Jobs	Occupation	Jobs
Financial managers	14,156	Heavy equipment mechanics	13,127
Purchasing managers	7,607	Industrial machinery repairers	43,916
Managers, medicine & health	6,234	Data processing equipment repairers	2,412
Accountants & auditors	41,020	Heating & air conditioning mechanics	7,824
Management analysts	3,655	Mechanical control repairers	3,729
Personnel & training specialists	14,073	Millwrights	3,924
Inspectors, except construction	7,257	Brickmasons & stonemasons	2,824
Architects	2,914	Glaziers	968
Electrical engineers	38,925	Structural metal workers	1,136
Industrial engineers	19,812	Supervisors, extractive occupations	11,993
Surveyors & mapping	835	Explosives workers	1,633
Chemists	6,595	Mining machine operators	5,454
Geologists & geodesists	6,921	Tool & die makers	14,412
Veterinarians	1,756	Precision grinders	995
Pharmacists	4,542	Sheet metal workers	7,338
Economists	3,291	Upholsterers	1,897
Technical writers	3,407	Optical goods workers	2,375
Photographers	3,827	Inspectors & testers	10,956
Clinical laboratory technicians	17,971	Water & sewage plant operators	3,456
Drafting occupations	26,095	Drilling machine operators	5,817
Chemical technicians	7,394	Forging machine operators	679
Computer systems analysts	16,374	Metal plating machine operators	9,484
Tool programmers	95	Sawing machine operators	4,917
Legal assistants	3,957	Photoengravers & lithographers	1,649
Sales representatives	45,647	Textile sewing machine operators	16,978
Supervisors, financial records	3,816	Packaging/filling machine operators	17,999
Receptionists	29,568	Separating machine operators	3,760
Personnel clerks	4,388	Crushing/grinding machine operators	2,166
File clerks	11,441	Photo process machine operators	2,939
		Welders & cutters	25,145
Dispatchers	6,991		
Weighers & checkers	3,759	Solderers & brazers	9,888
General office clerks	26,137	Graders & sorters	2,598
Proofreaders	599	Truck drivers, heavy	76,556
Statistical clerks	5,302	Parking lot attendants	1,207
Supervisors, guards	1,181	Operating engineers	7,086
Kitchen workers	3,976	Machine feeders & offbearers	7,237
Janitors & cleaners	90,003	Vehicle & equipment cleaners	7,229
Transportation attendants	2,616		
		Total, all occupations*	4,380,497

*Includes jobs not listed here.

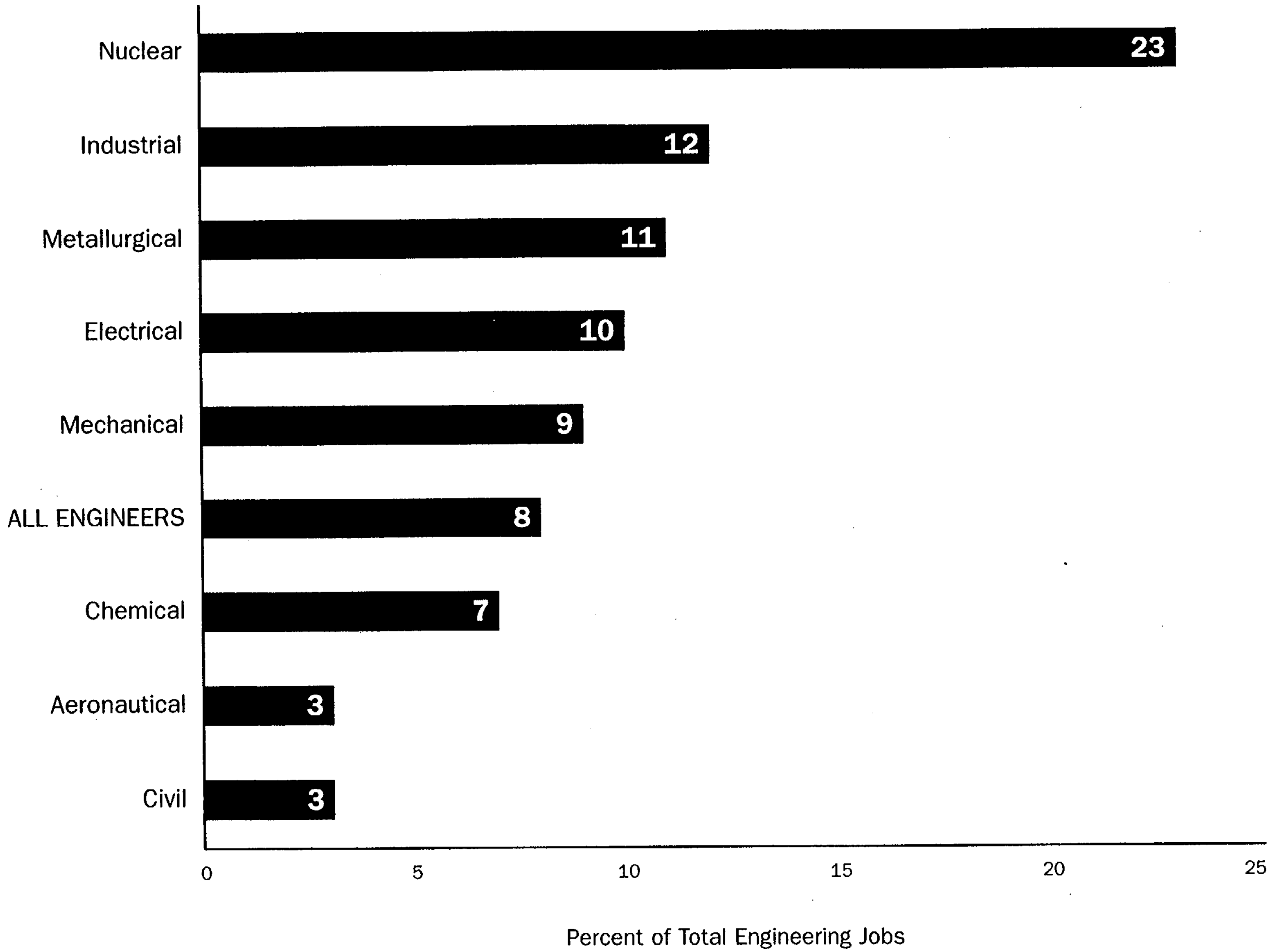
Appendix D
Engineering Jobs Generated by Nuclear Technologies in 1995



Appendix D
Percent of Jobs Within Selected Occupations Created in 1995 by Nuclear Technologies



Appendix D
Percent of Total Engineering Jobs Created in 1995 by Nuclear Technologies



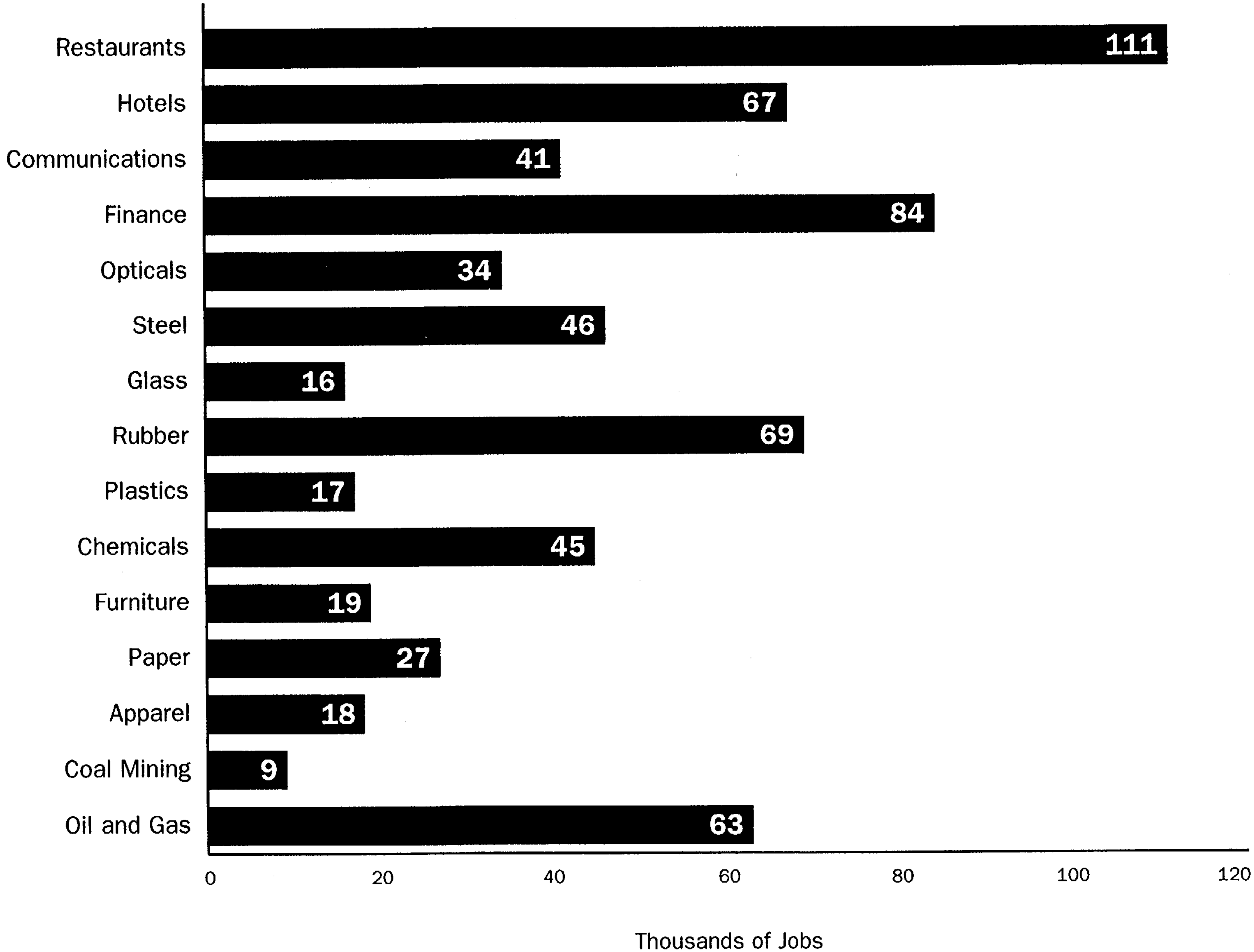
APPENDIX D

Total Jobs, Sales and Tax Revenues Created Within Each State in 1995 by the Use of Nuclear Technologies

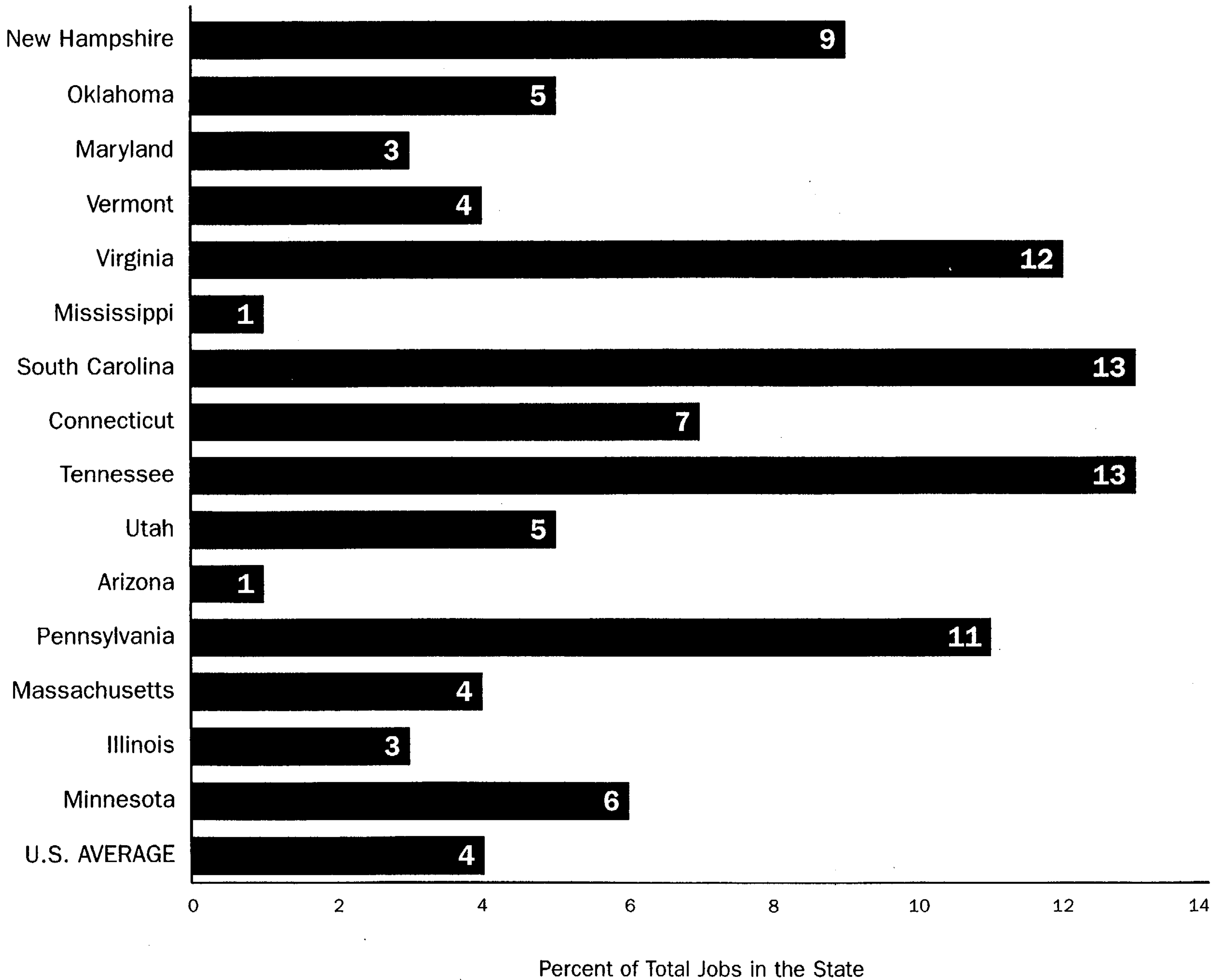
State	Sales (million $)	Jobs (number)	Tax Revenues (million $)
Alabama	$4,844	42,735	$894
Alaska	307	3,599	71
Arizona	3,539	26,144	658
Arkansas	1,855	13,314	346
California	26,536	250,117	5,157
Colorado	3,169	37,853	569
Connecticut	12,248	113,662	2,730
Delaware	795	8,092	145
District of Columbia	428	2,002	97
Florida	5,212	38,313	973
Georgia	9,672	94,285	1,758
Hawaii	1,556	23,931	288
Idaho	335	4,041	61
Illinois	15,558	124,528	2,861
Indiana	3,692	41,119	664
Iowa	4,132	64,055	745
Kansas	1,534	12,466	284
Kentucky	1,641	18,257	299
Louisiana	2,666	21,428	513
Maine	2,143	29,863	384
Maryland	6,963	77,480	1,458
Massachusetts	11,110	110,010	2,306
Michigan	4,799	37,880	892
Minnesota	12,961	132,149	2,413
Mississippi	1,837	16,161	339
Missouri	7,240	78,000	1,300
Montana	351	4,570	66
Nebraska	1,775	14,594	328
Nevada	945	10,502	192
New Hampshire	924	4,970	202
New Jersey	14,667	126,686	3,057
New Mexico	546	5,823	103
New York	18,501	147,841	4,010
North Carolina	12,432	128,846	2,251
North Dakota	112	997	22
Ohio	6,46	68,960	1,222
Oklahoma	6,413	72,030	1,141
Oregon	20,761	241,381	3,834
Pennsylvania	62,901	629,616	11,231
Rhode Island	291	3,245	54
South Carolina	19,382	240,990	3,493
South Dakota	327	3,607	60
Tennessee	29,173	235,766	5,194
Texas	21,834	220,456	3,919
Utah	3,233	41,110	598
Vermont	1,299	11,793	248
Virginia	28,246	379,137	5,042
Washington	18,421	243,381	3,277
West Virginia	973	11,255	178
Wisconsin	3,818	32,573	706
Wyoming	335	4,255	65
TOTAL	$420,890	4,395,867	$78,700

SOURCE: Management Information Services, Inc., 1996.

Appendix D
Jobs Created Within Selected Industries



Appendix D
Percent of Total State Jobs Created Within Selected States in 1995



Appendix D

Total Jobs, Sales, and Tax Revenues Created Within Each Compact Region in 1995 by the Use of Nuclear Technologies

Compact and State	Sales (million $)	Jobs (number)	Tax Revenues (million $)
APPALACHIAN	$71,632	726,443	$13,012
Delaware	795	8,092	145
Maryland	6,963	77,480	1,458
Pennsylvania	62,901	629,616	11,231
West Virginia	973	11,255	178
CENTRAL INTERSTATE	$14,242	133,831	$2,612
Arkansas	1,855	13,314	346
Kansas	1,534	12,466	284
Louisiana	2,666	21,428	513
Nebraska	1,775	14,594	328
Oklahoma	6,413	72,030	1,141
CENTRAL MIDWEST	$17,199	142,785	$3,160
Illinois	15,558	124,528	2,861
Kentucky	1,641	18,257	299
MIDWEST	$38,305	416,855	$7,049
Indiana	3,692	41,119	664
Iowa	4,132	64,055	745
Minnesota	12,961	132,149	2,413
Missouri	7,240	78,000	1,300
Ohio	6,462	68,960	1,222
Wisconsin	3,818	32,573	706
NORTHWEST	$44,963	562,013	$8,193
Alaska	307	3,599	71
Hawaii	1,556	23,931	288
Idaho	335	4,041	61
Montana	351	4,570	66
Oregon	20,761	241,381	3,834
Utah	3,233	41,110	598
Washington	18,421	243,381	3,277

Appendix D

Total Jobs, Sales, and Tax Revenues Created Within Each Compact Region in 1995 by the Use of Nuclear Technologies

(Continued)

ROCKY MOUNTAIN	$4,995	58,433	$935
Colorado	3,169	37,853	569
Nevada	945	10,502	197
New Mexico	546	5,823	103
Wyoming	335	4,255	65
NORTHEAST	$26,915	240,348	5,787
Connecticut	12,248	113,662	2,730
New Jersey	14,667	126,686	3,057
SOUTHEAST	$110,797	1,266,233	$19,944
Alabama	4,844	42,735	894
Florida	5,212	38,313	973
Georgia	9,672	94,285	1,758
Mississippi	1,837	16,161	339
North Carolina	12,432	128,846	2,251
South Carolina	19,382	240,990	3,493
Tennessee	29,173	325,766	5,194
Virginia	28,246	379,137	5,042
SOUTHWESTERN	$30,514	280,864	$5,897
Arizona	3,539	26,144	658
California	26,536	250,117	5,157
North Dakota	112	997	22
South Dakota	327	3,607	60
NON-COMPACT	$61,328	568,061	$12,112
District of Columbia	428	2,002	97
Maine	2,143	29,863	384
Massachusetts	11,110	110,010	2,306
Michigan	4,799	37,880	892
New Hampshire	924	4,970	202
New York	18,501	147,841	4,010
Rhode Island	291	3,245	54
Texas	21,834	220,456	3,919
Vermont	1,299	11,793	248
TOTAL	$420,890	4,395,867	$78,700

SOURCE: Management Information Services, Inc., 1996