THE ECONOMIC BENEFITS OF THE U.S. DEPARTMENT OF ENERGY FOR THE STATE OF TENNESSEE
FISCAL YEAR 1999

Matthew N. Murray, Associate Director
Center for Business and Economic Research
and Project Director

and

Karie Barbour, Graduate Research Assistant

Prepared by the
Center for Business and Economic Research
College of Business Administration
The University of Tennessee
Knoxville, Tennessee

Prepared for
U.S. Department of Energy, Oak Ridge Operations

May 2000

CONTENTS

Section **Page**

EXECUTIVE SUMMARY vi

I. INTRODUCTION 1

II PROFILES OF DOE ACTIVITIES IN TENNESSEE 2

Oak Ridge Operations 2
Oak Ridge National Laboratory 4
Y-12 Plant 4
Oak Ridge Institute for Science and Education 5
Bechtel Jacobs Company LLC 6
Office of Scientific and Technical Information 6
What DOE Facilities Offer Tennessee 6

III. JOB, INCOME, OUTPUT AND SALES TAX BENEFITS OF DOE IN TENNESSEE IN 1999 7

DOE Expenditure Data 7
Overall Benefits 7
Output Benefit 9
Income Benefit 10
Employment Benefits 11
State and Local Tax Revenue 11

IV. ADDITIONAL DOE CONTRIBUTIONS TO TENNESSEE 12

Community Involvement 13
Technology Partnerships 14
Technology Transfer 16
Collaborative R&D 16
Access to ORNL Facilities and Expertise 17
Technical Assistance to Industry 18

CONTENTS (Continued)

Section **Page**

Information Dissemination and Knowledge Transfer 20

V. EDUCATIONAL CONTRIBUTIONS OF DOE AND ITS AFFILIATES 21

Department of Energy Oak Ridge Operations 22
DOE's Office of Scientific and Technical Information 22
Oak Ridge Institute for Science and Education 22
Bechtel Jacobs Company LLC 24
Lockheed Martin Corporation 26
Oak Ridge National Laboratory 26
American Museum of Science and Energy 28
Y-12 Plant 28

VI. NEW DIRECTIONS FOR THE FUTURE 30

Department of Energy Oak Ridge Operations 30
Bechtel Jacobs Company LLC 33
Spallation Neutron Source Research Facilities 34
Direct Economic Impacts 35
The Future of ORNL 36
The National Transportation Research Center 37
Oak Ridge National Laboratory 37
Oak Ridge Associated Universities 38

VII. SUPPORTING REGIONAL INITIATIVES 40

Partnerships with Local Governments 40
Local Economic Summits 40
Other Activities 40

VIII. CONCLUSION 41

APPENDIX 42

Overview of the Economic Impact Model 42

TABLES

Table **Page**

1 Expenditures of DOE and Its Contractors in Tennessee, 1999 8
2 Summary of Economic Benefits of DOE on the State of Tennessee, 1999 9
3 Statewide Economic Benefits of DOE Compared to Anderson County 10
4 Summary of DOE's Income Benefit on the State of Tennessee, 1999 11
5 DOE Employment in Tennessee by Contractor, 1999 11
6 Assumptions Used in the Calculations of the Sales Tax Impact of DOE in Tennessee . 12
7 State and Local Sales Tax Benefit of DOE in Tennessee in 1999 13
8 Community Involvement of DOE and Its Contractors in Tennessee, 1999 15
9 Key ORNL Partnerships that Support Economic Development in Tennessee 17
10 Mechanisms for Accessing ORNL's Resources 18
11 ORNL's User Facilities 19
12 Demonstrated Successes of ORCMT 20
13 Current Activities of the OSTI Adopt-a-School Program 23
14 Educational Activities Supported by ORISE Volunteers in Education Team 24
15 Educational Programs Supported by Lockheed Martin in Tennessee, 1999 27
16 Educational Programs Supported by ORNL 29
17 Selected Projects Undertaken by Reindustrialization 33
18 Regional Community Transition Projects Funded by CROET 34
19 Companies Creating New Jobs Under the Incentive Program Headed by Bechtel Jacobs Development Company, LLC 35

FIGURES

Figure **Page**

1 Map of DOE Facilities in Tennessee 3
2 DOE Expenditures in Tennessee by Major Sector 1999 9
3 Output Benefit of DOE in Tennessee, by Source in 1999 10
4 Employment Benefit of DOE in Tennessee by Spending Category, 1999 12
5 State and Local Tax Revenue Attributed to DOE in Tennessee in 1999 13
6 State Sales Tax Benefit of DOE in Tennessee in 1999 14
7 Educational Makeup of DOE in Tennessee, 1999 22

EXECUTIVE SUMMARY

U.S. Department of Energy (DOE) operations continue to provide a major source of benefits for the State of Tennessee and its residents. DOE's Oak Ridge Operations' sustained operating budget of over $2 billion has a significant impact on the creation of jobs and income in Tennessee, as well as the expansion of state and local tax bases. DOE, its workers and its contractors engage in many other activities that provide important benefits to the state as well. In 1999, the Center for Business and Economic Research (CBER) at The University of Tennessee, Knoxville, prepared two reports detailing the benefits bestowed on Tennessee by DOE's diverse operational activities. The first study focused on *quantitative* benefits arising from DOE's expenditures in the state; the second study emphasized the many *qualitative* benefits created by DOE, including technology transfer and assistance to support educational investments. This consolidated report represents an update of the two reports prepared in 1999. The first section of the report considers quantitative impacts on jobs, incomes and gross state product, while the second section updates DOE's more qualitative benefits that accrue to Tennessee.

Key findings include the following:

- **As a result of DOE expenditures, Tennessee's gross state product was $1.9 billion higher than it would have been in 1999, consistent with gross state product benefits estimated for 1998.**

- **DOE's impact on personal income in the State of Tennessee totaled close to $1.2 billion in 1999, down slightly from $1.3 billion in 1998. The corresponding income multiplier implies that every dollar spent by DOE in the state increases personal income of Tennessee residents by 1.94.**

- **Direct DOE employment totaled 12,269 and an additional 25,484 jobs were supported by DOE expenditures in other sectors of the state economy, yielding total jobs of 37,753 in 1999.**

- **A highly skilled and educated workforce remains a trademark of DOE operations. In 1999, 1,047 employees held Ph.D. degrees, 1,646 held masters degrees, while another 2,859 held some type of bachelors degree.**

- **DOE-funded activities collectively generated over $58.9 million in state and local sales tax revenue in 1999.**

- **Other DOE activities serve to improve quality of life for Tennesseans, while some enhance the productivity of Tennessee business establishments and workers. This includes technology transfer programs, assistance to students and education institutions, and charitable giving.**

I. DIRECT BENEFITS OF DOE

DOE activities yield important benefits for the state economy.

- **Direct employment from DOE and its contractors totaled 12,269 while expenditures on wages and salaries totaled almost $493 million.**

During 1999, DOE and its contractors employed some 12,269 individuals and paid more than $493 million in wages and salaries. As a result of the relatively high wage nature of jobs created by DOE the average annual salary of its employees was approximately $40,240.

- **1999 saw an increase in non-payroll expenditure by DOE to $468 million from a previous 1998 total of $336.5 million.**

DOE significantly increased its acquisition of goods and services from Tennessee businesses in 1999. Non-payroll expenditures totaling more than $467.8 million generated income and supported jobs in a wide array of sectors in Tennessee's economy. Sectors which gained the most from these expenditures included the services and manufacturing sectors, and engineering and management consulting.

- **DOE and its contractors paid nearly $10.6 million in state sales tax, $4.0 million in local sales tax and $1.7 million in payments in lieu of taxes in 1999.**

As a result of DOE and contractor purchases on goods and services in the state, $14.6 million was directly contributed to the tax base of state and local governments. However this number understates the benefits to tax revenues resulting from DOE operations because it excludes other forms of tax payments. Substantial payments-in-lieu-of-taxes and property taxes were also paid by DOE and its contractors in 1999.

II. TOTAL ECONOMIC BENEFITS OF DOE'S DIRECT SPENDING IN TENNESSEE

DOE activities ripple through the state, yielding additional benefits.

- **Tennessee's gross state product increased more than $1.9 billion in 1999 as a result of direct, indirect and multiplier effects of DOE expenditures.**

The total output benefit, measured by changes in gross state product from payroll and non-payroll expenditures of DOE and its contractors, exceeded $1.9 billion in the State of Tennessee in 1999. The output multiplier was 1.75, meaning that for every $1.00 of output produced by DOE in the state, an additional $0.75 of output was produced in other sectors across the state.

- **DOE expenditures led to a total income benefit of $1.2 billion in 1999.**

DOE's impact on income across the State of Tennessee totaled nearly $1.2 billion in 1999. Spending on wages, salaries and pension disbursements by DOE and its contractors increased income by $607 million. Indirect and induced effects of expenditures accounted for an additional $570 in total income benefit.

- **DOE operations supported 37,753 full-time jobs in the state of Tennessee in 1999.**

The new income generated in Tennessee as a result of DOE operations supported a total of 37,753 jobs in the state. The employment multiplier was 3.07, meaning that for every job directly provided by DOE an additional 2.07 jobs were supported in the state. This relatively high jobs multiplier reflects the relatively high earnings of DOE and contractor employees.

- **The state and local sales tax revenue attributed to DOE operations totals more than $58.9 million in 1999.**

In Tennessee, the sales tax is the most prominent source of government revenue and the presence of DOE in the state leads to significant increases in tax revenue. In 1999, the total sales tax attributed to DOE activities was more than $58.9 million with $42.9 million being state revenues and the remaining $16.0 million being local revenues.

III. Qualitative Benefits

Many of the benefits arising from DOE-related activity are not easily quantified. At the same time, these broader activities have an important positive impact on the state. Some activities improve quality of life for Tennesseans, while others improve the productivity of Tennessee firms and workers.

- **DOE's Office of Scientific and Technical Information collects and disseminates world-wide scientific and technical information resulting from the Department's $7.0 billion annual research and development investment.**

- **$720,000 in excess computer equipment was donated to Tennessee schools by DOE and its contractors.**

Table A: Summary of Economic Benefits of DOE in Tennessee, 1999

Impact	Direct	Total
Output	$1,090.3 million	$1,908.1 million
Income	$606.7 million	$1,177.1 million
State Sales Tax Revenue	$10.6 million	$42.9 million
Local Sales Tax Revenue	$4.0 million	$16.0 million
Employment	12,269 full-time jobs	37,753 full-time jobs

- **DOE and its contractors contributed nearly $7.5 million in cash and in-kind gifts in 1999 in support of a wide range of community activities.**

- **More than 15,000 elementary and high school students participated in science and math enrichment programs sponsored by the Oak Ridge National Laboratory.**

- **Adopt-A-School and other volunteer activities by DOE and its affiliates supported several area schools with information on careers, sponsoring workshops, speakers, in-service programs and mentoring/tutoring.**

- **Each year more than 3,000 guest researchers generate 90,000 overnight stays in the Knoxville-Oak Ridge area.**

- **The American Museum of Science and Energy drew more than 125,000 visitors during FY 1999. Of those visitors, more than 2,800 participated in the Public Tour of the Oak Ridge Y-12 Plant and ORNL. Those participants represented all 50 of the United States and 25 foreign countries.**

- **During FY 1999 the Oak Ridge Centers for Manufacturing Technology provided assistance to more than 60 Tennessee manufacturers, supporting nearly 300 jobs.**

IV. New Directions

- **The Community Reuse Organization of East Tennessee (CROET) distributed more than $750,000 in grants to leverage regional economic development and diversification initiatives in 1999, leading to the creation/retention of 265 jobs.**

- **DOE's Reindustrialization Initiative, through CROET, has subleased 882,110 square feet of building to 28 private sector firms creating 243 private sector jobs.**

- **The Bechtel Jacobs Development Company, a division of the Bechtel Jacobs Company, provided assistance to 42 companies in 1999 with $58 million in payroll. This assistance will help the region transition to increased reliance on private sector economic activity.**

- **The Spallation Neutron Source (SNS) and the affiliated Joint Institute for Neutron Sciences (JINS) will support frontier research and create nearly 2,000 jobs for the state. These and other initiatives will keep DOE's Oak Ridge Complex at the forefront of science and technology.**

- **The National Transportation Research Center will open during 2000 and leverage ORNL and UT transportation programs for the benefit of the region.**

- **The Appalachian Wireless Corridor, an initiative of ORAU will merge advanced wireless telecommunications technology with medical delivery to benefit the region.**

THE ECONOMIC BENEFITS OF THE U.S. DEPARTMENT OF ENERGY FOR THE STATE OF TENNESSEE, FISCAL YEAR 1999

I. INTRODUCTION

Operations of the U.S. Department of Energy (DOE) continue to provide significant economic benefits for the State of Tennessee, its residents, and state and local government. DOE facilities were sited in Tennessee in the 1940s. Today they are a primary performer of DOE's science and technology, national security and environmental management programs. DOE's $2 billion operating budget yields significant benefits to the state economy through the creation of jobs and income, increases in state output, and expansions in state and local tax bases. Even though DOE's primary presence in the state is in Anderson and Roane Counties, located in the Knoxville Metropolitan Statistical Area of East Tennessee, the economic benefits accrue statewide as the initial impacts ripple through the economy. Additional benefits accrue to the statewide economy because of the many different programs, including technical assistance, offered by the Department to companies located within the state, as well as community transition assistance due to downsizing of government operations.

In 1999 the Center for Business and Economic Research (CBER) at The University of Tennessee, Knoxville, conducted two in-depth analyses of the economic benefits of DOE payroll and non-payroll spending and selected other activities on the State of Tennessee for fiscal year 1998. This represented the first effort to comprehensively document DOE benefits, despite the fact that DOE

(and its predecessors) has been in the state over 50 years. The first report detailed the more easily quantifiable economic benefits attributed to DOE and its major contractors that arise from their spending in the state. The second report documented DOE's contribution to the state through programs such as technology transfer, educational activities and other community-based programs. The current report represents a consolidated update of these two reports and presents DOE benefits for fiscal year 1999.

The remainder of this report consists of three sections. First, the next section provides a brief history of DOE's presence in the state and a synopsis of DOE-funded operations in Tennessee. The second section updates the quantitative benefits arising from DOE and its contractor activities in Tennessee, emphasizing jobs, income and expansions in state output. (The Appendix summarizes the methodology used to estimate these benefits.) The final section reviews important qualitative benefits which arise from the presence of DOE and its contractors in Tennessee.

II. PROFILES OF DOE ACTIVITIES IN TENNESSEE[1]

The DOE is present in Oak Ridge in two distinct capacities. First, there is the Oak Ridge Operations Office (ORO), which is one of DOE's 10 major field offices. ORO uses several contractors in the management and operation of its facilities. In addition, there is the Office of Scientific and Technical Information (OSTI), which is part of the DOE Headquarters Office of Science but is located in Oak Ridge rather than Washington, D.C.

Oak Ridge Operations

Based in Oak Ridge, Tennessee, the Department of Energy's ORO is rich in history, dating back to World War II when the organization played a major role in the production of materials for the Manhattan Project. Since then, ORO has expanded far beyond that first mission and today is responsible for major DOE programs in science and technology, national security and environmental management, and other activities. ORO's mission and values continue to change to meet the needs of a challenging future. Together these activities represent an important asset for the economy of Tennessee.

The DOE's 35,252-acre Oak Ridge Reservation is located within the City of Oak Ridge in Anderson and Roane counties. There are three major plant complexes on the Oak Ridge Reservation: the Oak Ridge National Laboratory; the Y-12 Plant; and the East Tennessee Technology Park. Also located in the City of Oak Ridge are the Oak Ridge Institute for Science and Education and the American Museum of Science and Energy (see Figure 1). Together, these facilities represent a unique technological and educational resource and a major component of the growing East Tennessee Technology Corridor. ORO is also responsible for the Thomas Jefferson National Accelerator Facility in Newport News, Virginia, and the Weldon Spring Site, located near St. Louis, Missouri. The Weldon Spring facility was a former uranium metal processing facility operated from 1957 to 1966, and is currently undergoing environmental cleanup.

For many years, ORO was responsible for uranium enrichment operations at large gaseous

Figure 1: Map of DOE Facilities in Tennessee

diffusion plants in Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. The Oak Ridge Gaseous Diffusion Plant was shut down in 1985 and became the center for Oak Ridge environmental management activities. After several site name changes, in 1997, this massive facility was renamed as the East Tennessee Technology Park (ETTP). In 1993, operations at the Paducah and Portsmouth facilities were transferred to the United States Enrichment Corporation (USEC). ORO remains responsible for cleanup of legacy wastes created as a result of past operations at these two sites and continues to administer the lease between DOE and USEC under the provisions of the Energy Policy Act of 1992.

Environmental Management is the largest Oak Ridge program, with cleanup programs underway to correct the legacy remaining from over 50 years of energy research and weapons production, as well as an aggressive effort to manage currently-generated wastes. ORO has established a unique initiative to leverage valuable, but unused assets, to accomplish accelerated cleanup and to create private jobs to compensate for the expected loss of jobs as cleanup is completed. This initiative, known as Reindustrialization, has become one of the primary vehicles through which ORO is realizing its vision of transforming the Oak Ridge Complex into an economically viable integrated science, education, technology and industrial complex operated in partnership with the private sector.

ORO's science and technology programs are conducted at the Oak Ridge National Laboratory, the Thomas Jefferson National Accelerator Facility, and the Oak Ridge Institute for Science and Education. Major research and development capabilities include energy production and end-use technologies and conservation technologies; biomedical and environmental sciences and technology; advanced materials synthesis, processing and characterization; neutron-based science and technology; computational science and advanced computing; transportation; and instrumentation and control technologies.

National security activities include manufacturing and reworking nuclear materials components, dismantling nuclear weapons components returned from the national arsenal, serving as the nation's storehouse of special nuclear materials and providing special production support to other programs.

DOE and its Oak Ridge contractors manage a Technology Partnerships program that fosters innovative partnerships and new programs built on the strengths of the Oak Ridge Complex. Alliances are formed with other Federal agencies, the private sector, universities, state and local governments, and international partners. DOE and its contractors use a variety of mechanisms to carry out the program including Memoranda of Cooperation, Cooperative Research and Development Agreements, Technology Licenses, Reimbursable Work Agreements, User Facility Agreements, Personnel Exchanges and an Entrepreneurial Leave Program. These partnerships support changing national priorities and promote a vibrant regional and national economy. Technology Partnerships are another primary vehicle through which ORO is realizing its vision of transforming the Oak Ridge complex into an economically viable integrated science, education, technology and industrial complex operated in partnership with the private sector.

Oak Ridge National Laboratory

ORNL is a multi-program science and technology laboratory managed for DOE by Lockheed Martin Energy Research Corporation. (Effective April 1, 2000, ORNL will be managed by UT-Battelle, LLC, under contract to DOE.) ORNL was established in 1943 to pioneer a method for producing and separating plutonium. Construction and operation of the Graphite Reactor for this mission provided the foundation for the development of later research and production reactors. Wartime capabilities in nuclear science and engineering, materials research and development (R&D), and radiation biology were extended to foster the development of new energy sources, technologies and materials and the advancement of knowledge in the physical, life, engineering, computational and social sciences. Today, ORNL supports DOE missions by conducting basic and applied R&D to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; encourage energy efficiency and advance new energy sources; restore and protect the environment; and contribute to national security.

Y-12 Plant

Lockheed Martin Energy Systems (LMES) manages operations of the Y-12 Plant, which for five decades has been vital to our nation's security

through the manufacture of weapons components. The end of the Cold War brought changes in national security needs. The mission of LMES is as follows:

- Effectively re-manufacture, surveil and assess all uranium, lithium and secondary components in the nuclear stockpile while protecting people and the environment.
- Safely store, process and disposition uranium, lithium and secondary components associated with the nuclear stockpile.
- Perform complementary work that reduces DOE's burden in maintaining Y-12's capability while contributing to regional economic development.

The Y-12 Plant is the home of the Oak Ridge Centers for Manufacturing Technology, a partnership between Y-12 and ORNL, that solves tough manufacturing problems for industry and other Federal agencies. Y-12 is also the home of the National Prototype Center. The National Prototype Center is a place where government agencies and private industry find all the capabilities, skills and resources needed to turn great ideas into innovative, affordable, manufacturable products. The unique designation by the U.S. Congress of the Y-12 Plant as the National Prototype Center represents recognition of the facility's diverse, integrated capabilities.

Oak Ridge Institute for Science and Education

The ORISE has been an integral part of the DOE laboratory system since it was established in 1946 as the Oak Ridge Institute for Nuclear Studies. Today, ORISE and its programs are operated by Oak Ridge Associated Universities (ORAU). ORISE is a nationally recognized institution providing integrated scientific and technical training expertise to the DOE. Its customer base includes the Department, many of its field and operations offices, and most of its major laboratories. ORISE supports the mission of DOE and several other federal agencies by providing technical expertise in the following areas:

- Conducting research and training in workforce health, safety and security.
- Providing worldwide emergency preparedness, response and training.
- Performing radiological hazardous site characterization and cleanup verification.
- Developing and implementing technical training systems.
- Developing and administering science education fellowship and research participation programs.
- Integrating scientific and technical resources to build multidisciplinary programs.
- Creating collaborative research partnerships.

ORAU is a consortium of 86 doctoral-granting colleges and universities. ORAU serves the government, academia and the private sector in important areas of science and technology. A private, not-for-profit corporation, ORAU undertakes national and international programs in education, training, health and the environment. As a consortium, ORAU carries out active programs with and for its members, which include East Tennessee State University, Fisk University, Lincoln Memorial University, Maryville College, Meharry Medical College, Tennessee State University, Tennessee Technological University, the

University of Memphis, the University of Tennessee and Vanderbilt University.

Bechtel Jacobs Company LLC

The Bechtel Jacobs Company LLC is DOE's management and integrating contractor for the environmental management and uranium enrichment facilities programs. The scope of work for this contract also includes reindustrialization. It is Bechtel Jacobs Company's job to safely expedite cleanup, reduce costs, provide transition from a management and operations contract to a management and integration contract, maximize subcontracting, transition the workforce to subcontracts and make an investment in the community. The community investment includes charitable community contributions and jobs creation. The location for these activities are Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio.

Office of Scientific and Technical Information

As one of the major science agencies, the Department of Energy manages a $7 billion annual investment in research and development. The key benefit of this investment is knowledge, which is recorded in technical reports, scientific journals or preprints. DOE's Office of Scientific and Technical Information (OSTI), as part of the DOE Headquarters Office of Science, supports the agency's R&D mission by collecting, preserving and disseminating this information to Departmental researchers as well as ensure its accessibility to the public and academia. Using digital technology, OSTI has developed a set of vast virtual collections of scientific and technical information. Collectively, these systems constitute a virtual library that focuses on energy, science and technology. As a result of OSTI's advances using information technology in putting full-text research information on the Internet, it serves literally hundreds of thousands more people than it did only five years ago. This is the primary responsibility of OSTI—to ensure that the Department and taxpayers receive a return on their research investment in the form of accessible information.

OSTI's mission applies not only to current information but also to a repository of 1.5 million technical reports dating back to the 1940s. In addition, OSTI's mission applies to classified and sensitive information. OSTI provides a secure, active repository of 100,000 classified documents resulting from weapons research.

Also, on behalf of DOE, OSTI represents the United States in two international information exchanges—the International Nuclear Information System, under the auspices of the United Nations' International Atomic Energy Agency, and the Energy Technology Data Exchange, under the auspices of the International Energy Agency.

What DOE Facilities Offer Tennessee

The presence of DOE and its contractors in Tennessee gives rise to many benefits, both quantitative and qualitative. Obviously, the facilities discussed above provide employment and income for residents of the state. The jobs provided are most often high-skilled, high-paying jobs resulting in a high quality workforce comprised of some of the top researchers in their field. The presence of DOE also provides the state with national recognition as a leader in manufacturing, advanced materials, neutron sciences, biological sciences and

transportation technologies. With its R&D capacity and technology sharing programs, DOE plays a significant role in enhancing Tennessee's competitive position in attracting private firms to locate within the state. In addition, DOE is active in bringing federal research grant money to the state and its institutions of higher education. The DOE facilities provide an excellent resource to the University of Tennessee through expanded research capabilities and academic programs. The remainder of this report details the more easily quantifiable economic benefits attributed to the operation of DOE supported facilities in Tennessee and enumerates important qualitative benefits to households, firms and workers.

III. JOB, INCOME, OUTPUT AND SALES TAX BENEFITS OF DOE IN TENNESSEE IN 1999

DOE Expenditure Data

The data used in the analysis consist of detailed expenditure data for the 1999 fiscal year and were provided by the DOE and its major contractors. Field offices of DOE located outside of the state but with expenditures in Tennessee provided ORO with details of those expenditures. Omitted from the data were several smaller contractors, three federal credit unions, a large number of business and general public visitors, and federal and selected contractor retirees. The benefits detailed below therefore are a conservative estimate of the actual benefits attributable to DOE's presence in Tennessee. Steps were taken in the data collection process to prevent double-counting of contracted and subcontracted spending. Expenditures were disaggregated into 34 industries for input into the model (see Table 1). The total direct DOE payroll and non-payroll spending in Tennessee was $962.0 million in 1999, with an additional $113.0 million in pension disbursements to ORNL, Y-12 Plant and Bechtel Jacobs Company retirees residing in Tennessee. Payroll spending was the largest category of expenditure, accounting for $493.7 million or 51.3 percent of the total. The second largest spending category was business services with $130.0 million, or 13.5 percent of the total expenditures. Figure 2 illustrates the breakdown of DOE expenditures (with exception of payments to state and local governments) in Tennessee by major sector for 1999.

The two largest DOE contracts in Tennessee are for Lockheed Martin Energy Research Corporation and Lockheed Martin Energy Systems for the operation of ORNL and the Y-12 Plant, respectively. Together these two contracts account for nearly $691.0 million or 71.8 percent of the total DOE-related expenditures in Tennessee. Other major DOE contractors in Tennessee include Bechtel Jacobs Company LLC and ORAU.

Overall Benefits

As in previous years, expenditures made by DOE in the state of Tennessee had significant impacts on the state's economy in 1999. Payroll and non-payroll expenditures totaled nearly $962.0 million. As this initial wave of spending worked its way through the state's economy, additional indirect and multiplier effects occurred. Total benefits of DOE spending included $1.9 billion in increased output, $1,177.1 million in increased personal income, $58.9 million in sales tax revenues and the creation of 37,753 full-time jobs. A

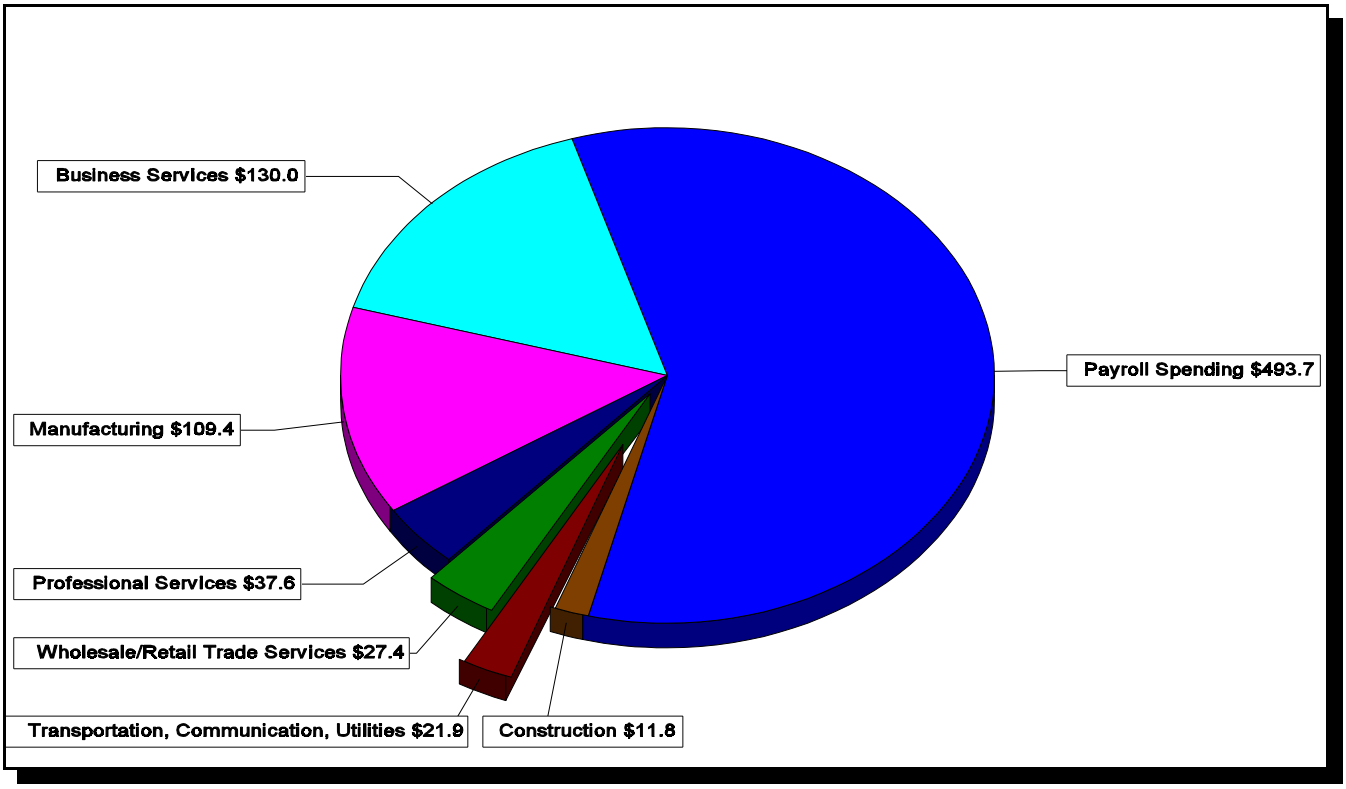
Table 1 : Expenditures of DOE and its Contractors in Tennessee for 1999

SECTOR	DOE-ORO	ORNL	LMES	ORAU	DOE-OSTI	BJC	Albuquerque Operations	Germantown Operations	Chicago Operations	Idaho Operations	Oakland Operations	Ohio Operations	Nevada Operations	Battelle PNNL	Savannah River Operations	FETC*	Total Expenditures In Tennessee
Farm products and agricultural, forestry and fishing	41,000	5,300		42,000													**88,300**
Construction	853,000	2,017,300	120,000	1,275,000		7,500,000											**11,765,300**
Food and kindred products and tobacco products				4,000													**4,000**
Apparel and other textile products		408,200	1,119,400							215,491		508					**1,743,599**
Paper and allied products		126,900	801,500	12,000		5,000						40,372					**985,772**
Printing and publishing		2,000	12,800	66,000	51,000				650								**132,450**
Chemicals, allied, petroleum and coal products		1,038,500	3,401,300	15,000		89,000				11,550		6,935					**4,562,285**
Rubber and misc.plastics products, leather products												750					**750**
Lumber and wood products and furniture and fixtures				4,000		37,000											**41,000**
Stone, clay, and glass products		96,500	42,100														**138,600**
Primary metals industry		9,200	400			15,000											**24,600**
Fabricated metals products		194,700	297,800			1,000				215				84,598	1,077,393		**1,655,706**
Industrial machinery and equipment		5,787,300	4,681,000	428,000		1,648,000			1928						1,318,092		**13,864,320**
Electronic and other electrical equipment		1,795,400	1,604,000	451,000	484,000	171,000				190,533		3625			99,298		**4,798,856**
Other transportation equipment		91,900	130,800							93,263							**315,963**
Instruments and related products		6,652,100	2,245,400	26,000		38,000				397,385			54,000				**9,412,885**
Miscellaneous manufacturing industries		61,154,100	48,155,900	1,000						68,622		43,560					**109,423,182**
Transportation			68,400	2,968,000	56,000	699,000			37,907	21,541	31,767				149,766	18,000	**4,050,381**
Communication	1,007,000	511,200	12,135,200	723,000	211,000	154,000										19,000	**14,760,400**
Electric, gas, and sanitary services	159,000	120,600	1,965,400	696,000	166,000												**3,107,000**
Wholesale trade		7,250,200	8,071,000	62,000		960,000								256,000			**16,599,200**
Retail trade		1,477,200	8,064,300	1,206,000		7,000											**10,754,500**
Depository and non-depository institutions				39,000													**39,000**
Insurance				148,000											100		**148,100**
Real Estate		1,583,000	2,596,500	304,000		9,000											**4,492,500**
Hotels and other lodging places, recreation services				44,000											3,522		**47,522**
Personal and repair services (except auto)				1,861,000								1,870					**1,862,870**
Business services	533,000	13,489,100	88,291,600	8,873,000	4,564,000	4,301,000		2,127,165	1795	32,335	734	4,271,653	13,000	2,716,312	799,282		**130,013,976**
Eating and drinking places		1,300	2,700	32,000		3,000									2,382		**41,382**
Health services		104,800	446,300	109,000	21,000												**681,100**
Legal services				85,000											37,455		**122,455**
Engineering and management services	11,220,000	8,490,100	3,857,300	1,284,000		7,453,000					21,917			53,319	727,533	3,844,000	**36,951,169**
Miscellaneous services	1,427,000	5,108,700	1,267,200			72,795,000				270,443				2,840,993	1,481,961	18,000	**85,209,297**
Households (Payroll Spending)	27,094,472	172,056,277	212,099,994	18,353,278	3,909,682	55,919,286	4,105,592							160,064			**493,698,645**
Total Tennessee Expenditures	42,334,472	289,571,877	401,478,294	39,111,278	9,462,682	151,804,286	4,105,592	2,127,165	42,280	1,301,378	54,418	4,369,273	67,000	6,111,286	5,696,784	3,899,000	**961,537,065**

* Does not include payments to local and state governments or charitable contributions

Any transfer of money or products between specified activities is counted only in the activity of the last receiving agency

Figure 2: DOE Expenditures in Tennessee by Major Sector 1999 (In millions)



complete discussion of the resulting total effects on output, income, employment and tax revenues is presented in the following sections. Table 2 presents a summary of these results. In order to put the impacts of DOE operations into perspective a comparison to relevant statistics for Anderson County is provided in Table 3.

Table 2: Summary of Economic Benefits of DOE on the State of Tennessee, 1999

Output	$ 1,908.1 million
Income	$ 1,177.1 million
State and local tax revenue	$ 58.9 million
Employment	37,753 full-time jobs

Output Benefit

In fiscal year 1999, DOE's output benefit—measured as the increase in gross state product (GSP) resulting from its expenditures within the state—totaled more than $1.9 billion. This total includes all direct, indirect and ripple effects on output brought about by DOE activities and can be broken down by initial spending source as in Figure 3. Non-payroll and visitor spending contribute both directly and indirectly through the multiplier effect to the increase in output while both payroll and retiree spending result in further multiplier effects. The leading source of increased output benefits was non-payroll spending with

Table 3: Statewide Economic Benefits of DOE Compared to Anderson County

Economic Indicator	DOE Operations	Anderson County Economy	Index
Income	$ 1.2 bil.	$ 1.6 bil.	0.75
State sales tax	$ 42.9 mil.	$46.1 mil.	0.87
Local sales tax	$ 16.0 mil.	$14.1 mil.	1.06
Employment	37,753	47,001	0.80

Source: Bureau of Labor Statistics, Tennessee Department of Revenue and CBER estimates.

benefits totaling more than $1 billion. Payroll spending contributed an additional $688 million while retiree and visitor spending provided the remaining benefits to output. As a result of spending and re-spending throughout the state economy, DOE expenditures resulted in an output multiplier of 1.75, meaning that for every dollar spent by DOE a total of $1.75 in total state output is created.

Income Benefit

Total income across the state of Tennessee increased by more than $1,177 million in 1999 as a result of DOE operations within the state. As depicted in Table 4, the total income benefit can be divided between direct and indirect/induced effects and further sub-divided by source of spending. Direct income effects by DOE is represented by spending on wages, salaries and pension disbursements. In 1999, these effects totaled $607 million. Indirect and induced effects on income result from DOE purchases of goods and services in other sectors of the economy. As these expenditures filter through the economy, new jobs are created which provide additional income for Tennessee's residents. In 1999, indirect/induced effects of DOE expenditures totaled over $570.4 million. Of all the spending categories, non-payroll spending had the greatest effect on indirect income created by DOE with an impact of $316.2 million. Indirect/induced effects accruing to payroll, pension and visitor spending supplied the remaining $253.2 million in income benefits. (It should be noted that the visitor spending category for 1999 is not comparable to that from 1998 in that last year's total included benefits from health plans.) The overall personal income multiplier, which is calculated by dividing the total income impact by direct spending on income, was 1.94. In other words, every dollar of income directly created by DOE results in the creation of $1.94 in total state income.

Figure 3: Output Benefit of DOE in Tennessee, by Source in 1999 (In millions)

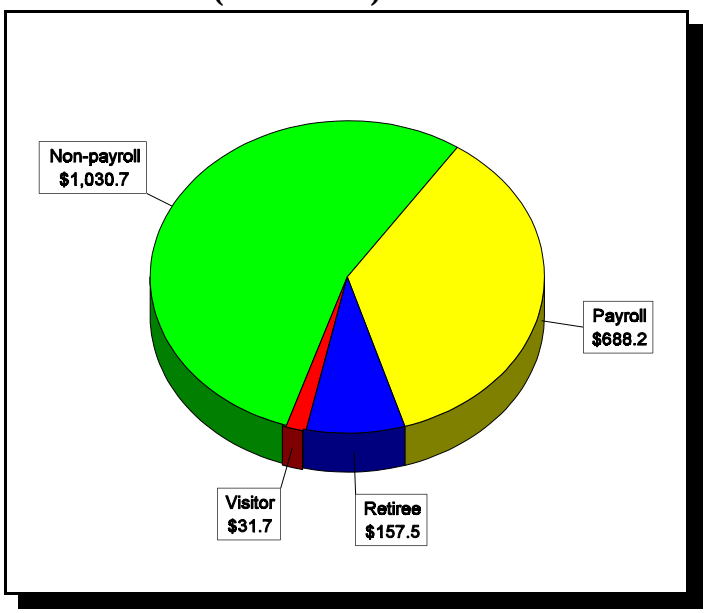


Table 4: Summary of DOE's Income Benefit on the State of Tennessee, 1999 (In millions)

Source	Amount
Direct	
Payroll	$ 493.7
Pension disbursements	113.0
Indirect/Induced	
Payroll	198.7
Non-payroll	316.2
Pension/Retirees	45.5
Visitors	10.0
Total	**$1,177.1**
Personal Income Multiplier	1.94

Employment Benefits

The total number of jobs created by DOE-related activities in FY 1999 was 37,753. Table 5 shows a breakdown of *direct* employment by DOE contractors. In 1999, LMES was the largest employer providing 5,225 jobs while ORNL was the second largest employer providing 4,130 jobs. In addition to the 12,269 jobs directly created by DOE, 25,484 jobs were supported through the purchase of goods and services within the state and through indirect/induced effects of DOE employees spending their salaries within the state. Figure 4 gives employment effects by spending category. Indirect/induced effects from DOE's non-payroll expenditures provided the majority of (13,827 or 36.6 percent) while induced effects from payroll/pension spending supported 30 percent (11,102) of jobs and visitor spending supported another 555 jobs. The sector receiving the largest indirect employment impact in the state economy was the business services sector which received over 5,000 jobs as a result of DOE's operations within the state. The manufacturing sector also received a relatively large portion of the jobs (2,500) compared to the other sectors of the economy. The employment multiplier for FY 1999 is 3.07 which implies that for every job directly provided by DOE an additional 2.07 jobs were supported throughout the state.

State and Local Tax Revenue

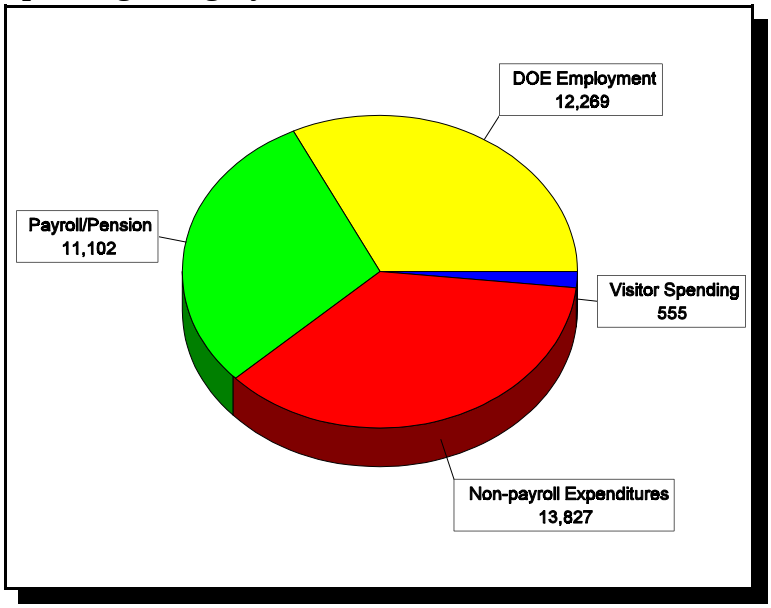
The contribution of DOE on state and local tax revenue arises from several sources. First, there is the direct payment of state and local sales tax by DOE and its contractors, as well as property taxes and payments-in-lieu-of-taxes (PILT). Additional taxes are paid by DOE and its employees, as well as visitors to their facilities. Finally, taxes accruing from the activities of businesses and workers supported through direct, indirect and multiplier-generated income can be attributed to DOE.

The fiscal benefit highlighted here is the state and local sales tax revenue arising from DOE's activities in Tennessee. Since the focus here falls on the sales tax, this means that the actual beneficial impact on state and local tax revenues will be

Table 5: DOE Employment in Tennessee by Contractor, 1999

Division/Contractor	Full-Time Employees
DOE ORO	573
ORNL	4,130
LMES	5,225
ORAU	589
Bechtel Jacobs	1,599
DOE OSTI	89
DOE, Albuquerque	61
Battelle, Pacific Northwest National Laboratory	3
Total	12,269
Average Salary	$40,240

Figure 4: Employment Benefit of DOE in Tennessee by Spending Category, 1999



significantly understated.

In calculating the impacts on sales tax revenue, several assumptions must be employed regarding expenditure patterns, savings and tax rates. A list of the simplifying assumptions used in the analysis is provided in Table 6.

The total estimated benefit of DOE on state and local tax sales tax revenue for 1999 was $58.9 million. As illustrated in Figure 5, $42.9 million in state sales tax revenue was generated while $16.0 million and $1.7 million were generated in local revenue in the form of local sales tax and PILT, respectively.

A more detailed analysis of the sales tax contribution is provided in Table 7 and Figure 6. The total sales tax per job created in 1999 for DOE was $1,136.

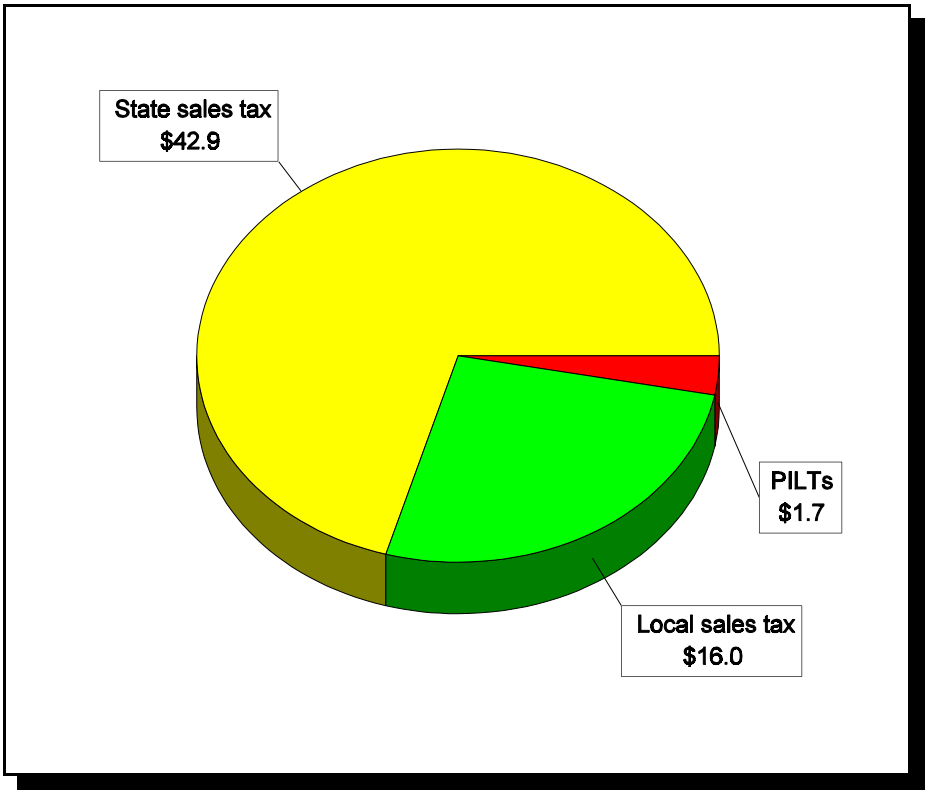
IV. ADDITIONAL DOE CONTRIBUTIONS TO TENNESSEE

In addition to the economic benefits presented in the last section, the DOE also makes significant contributions to the state's economy in other ways as a result of the many different programs it offers. These programs include: community involvement, technology partnerships resulting in establishment of new businesses and technical assistance to Tennessee firms; contributions to Tennessee educational institutions; and reuse of government assets, DOE grants and job creation initiatives to offset the downsizing of government operations in East Tennessee. These DOE-supported programs have been instrumental in reshaping the state's economy by leading to new products and processes,

Table 6: Assumptions Used in the Calculations of the Sales Tax Impact of DOE in Tennessee

- 55 percent of employee income is spent on sales-taxable versus non-taxable goods and services. 45 percent of retiree income and 100 percent of visitor spending is spent on sales-taxable items.
- Adjustments to income are made for leakages of taxes, savings, and out-of-state spending.
- A weighted average local option rate of 2.25 percent was used in the calculation of local impacts.
- Sales tax benefits account for sales tax revenue arising from taxable purchases by business firm.

Figure 5: State and Local Tax Revenue Attributed to DOE in Tennessee in 1999 (million)



and improving overall well-being and competitiveness of the state's industrial base.

This section describes the *qualitative* nature of these programs, which are important contributors to Tennessee's economic growth and development. This updates information provided in a report that was released in August of 1999. In the past year, many of the existing DOE sponsored programs enjoyed significant successes and new programs were created which deserve recognition.

The following areas are addressed:

- Community Involvement
- Technology Partnerships
- Educational Activities
- Reindustrialization
- Supporting Regional Initiatives

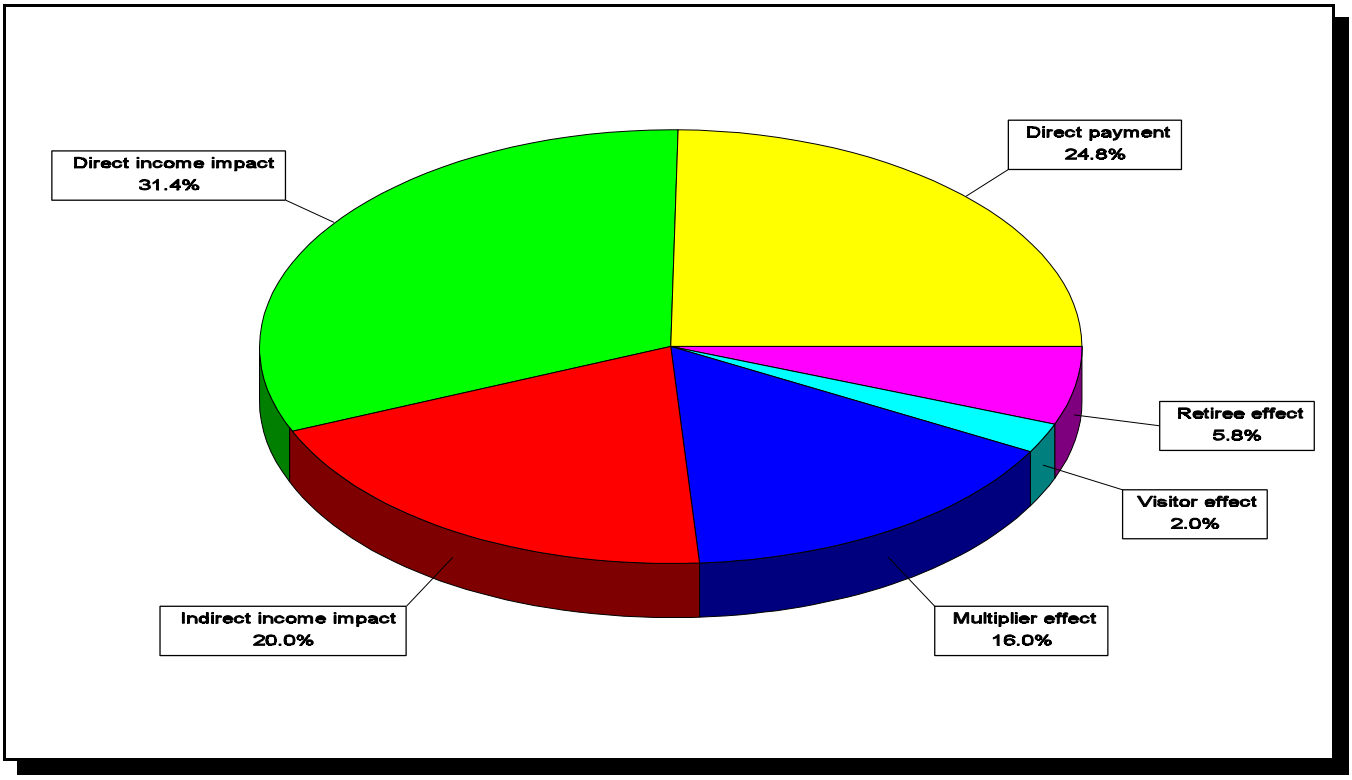
Community Involvement

Significant benefits arise as DOE and its contractors, as well as workers in these same enterprises, contribute to charitable causes within their communities. Table 8 provides a summary of firm-level contributions for 1999. Lockheed Martin alone provided contributions totaling $5.9 million. A total of $7.5 million was generated from all firms that reported information. Additional gifts of time, money and resources have come from individual workers and families,

Table 7: State and Local Sales Tax Benefit of DOE in Tennessee in 1999

	Dollars (In millions)	
Source	**State**	**Local**
Direct payment	$ 10.6	$ 4.0
Sales tax accruing to:		
Payroll spending	13.4	5.1
Non-payroll spending	8.6	3.2
Multiplier income	6.9	2.5
Visitor effect	0.9	0.3
Retirees	2.5	0.9
Total	**$ 42.9**	**$16.0**
Sales tax per job created (actual dollars)	$1,136	$423

Figure 6: State and Local Sales Tax Benefit of DOE in Tennessee in 1999



so the figures presented in Table 8 understate overall benefits by a significant margin.

Technology Partnerships

DOE and its Oak Ridge contractors use a variety of technology partnership mechanisms to transfer DOE technologies to the private sector, universities, state governments and other government agencies. The most common mechanisms include Cooperative Research and Development Agreements (CRADAs), Reimbursable Work Agreements, Licensing Agreements, User Facilities Technical Assistance and Information Dissemination. During 1999 CRADAs were executed that provided $4.5 million in new revenue, Reimbursable Work Agreements added $167 million in revenues and licenses of DOE-developed technologies returned $1.7 million in royalties.

ORCMT delivered two planing hulls and turrets for the U.S. Marine Corps' Advanced Amphibious Assault Vehicle during 1999. In completing that project, ORCMT partnered via subcontract with 12 Tennessee companies, infusing some $200,000 into the state economy.

Table 8: Community Involvement of DOE and Its Contractors in Tennessee, 1999

	DOE-ORO	Lockheed Martin[1]	ORAU	BJC	DOE-OSTI	**Total**
Corporate involvement		$2,623,886				**$2,623,886**
United Way, CFC, etc.	$51,689	714,521	$36,700	$157,652	$10,213	**970,775**
Charitable contributions		1,498,198		1,308,529		**2,806,727**
Donations of equipment		719,500			39,428	**758,928**
Matching educational funds		300,000		11,000		**311,000**
Total	**$51,689**	**$5,856,105**	**$36,700**	**$1,477,181**	**$49,641**	**$7,471,316**

1. Sources of Lockheed Martin funds are: Lockheed Martin Corporation, Lockheed Martin Properties, Lockheed Martin Energy Systems and Lockheed Martin Energy Research.

Technological innovations increase the known range of production techniques, in turn offering new, more efficient ways of producing goods and services, and leading to new types of products. Increased efficiency results from lower production costs arising from new technologies. Certain technological innovations pioneered by DOE and its partners in Tennessee are shared with businesses throughout the state via technology partnerships. Technology partnerships represent an important component of the overall contribution of DOE in Tennessee, spurring economic development and improving the ability of Tennessee firms to compete in the global economy. Through programs such as technology transfer, technical assistance, spin-off technologies and information dissemination, the Department provides invaluable inputs to businesses located throughout the state. The following provides a description of the many technology partnership programs supported by DOE and its contractors.

During FY 1999, ORCMT performed rapid-turnaround emergency repairs (service unavailable elsewhere) for a major Tennessee Valley Authority (TVA) facility, thus solidifying the ORCMT/TVA relationship and helping to keep Tennessee Valley electric rates from rising because of disabled equipment.

Technology Transfer

Technology transfer represents the means by which knowledge and technology developed by DOE is made available to private businesses. These arrangements are important in that they enable businesses to acquire a competitive edge in international markets and enable innovative production methods or lead to unique products, provided the partner agrees to invest in the commercialization of the process or product. ORNL, managed by Lockheed Martin Energy Research Corporation, participates in technology transfer with businesses involving both products and production processes throughout Tennessee.

ORNL transfers knowledge and technology to its customers through many mechanisms: publications, presentations, personnel exchanges, Cooperative Research and Development Agreements (CRADAs) and work-for-others (WFO). One key mechanism is the licensing of intellectual property to the private sector for purpose of commercialization.

New businesses started by entrepreneurs who have left ORNL is another very important component of transferring technology and contributing to local economic development. Since 1960, a total of 90 new companies have been created through this mechanism. The combination of entrepreneurial "spin-offs" and new businesses started with licenses has led to the creation of more than 2,700 direct jobs. ORNL has adopted an entrepreneurial leave program and an outside activity program that enables employees to either leave ORNL to assist in the creation of new businesses or to participate in the creation of new businesses on a part-time basis. Both mechanisms have resulted in the successful nurturing of high technology business that is becoming increasingly important to Tennessee's economy.

Of the 300 companies from 35 states that use ORNL facilities for their R&D, 44 are located in Tennessee. Some key partnerships that support economic development in Tennessee are displayed in Table 9.

Collaborative R&D

ORNL carries out much of its work through collaborative programs that involve scientists and engineers from other national laboratories and research institutions, as well as universities and private industry. The Laboratory has 131 CRADAs involving multiple partners in cost-shared R&D, representing 31 states.

Guest assignments, which range from 2 weeks to 2 years, broaden the Laboratory's base of expertise and support its goals in scientific cooperation and technology transfer. Each year, ORNL hosts more than 3,000 guest researchers;

The Oak Ridge National Environmental Research Park is one of 16 unique "user facilities" available for collaborative research.

Table 9: Key ORNL Partnerships that Support Economic Development in Tennessee

- **The Spallation Neutron Source** (SNS), a newly funded $1.3 billion research facility, will create a significant number of new jobs and additional sales tax revenues. The SNS project is a collaboration with four other DOE national laboratories that will provide the world's best capabilities for neutron research, which will be used by thousands of scientists each year to explore the structure of materials, from plastics to proteins. The work of visiting researchers will be supported by the Joint Institute for Neutron Sciences, a facility to which the State of Tennessee has committed $8 million. It is estimated that on-going operations of the SNS facility will support 1,890 jobs and attract 1,000-2,000 guest scientists per year.

- **Science Alliance**, a partnership between ORNL and the University of Tennessee, is the state's oldest and largest academic Center of Excellence. The Science Alliance sponsors the ORNL-University of Tennessee Distinguished Scientist Program, which provides joint appointments to tenured positions at the University of Tennessee's Knoxville campus and research positions at ORNL. Graduate programs and joint institutes in biological sciences, computational sciences, energy and environment, and neutron sciences represent additional tools for combining the resources of these institutions for research and education.

- **The National Transportation Research Center**, a collaboration between DOE, the University of Tennessee, the Development Corporation of Knox County and ORNL, will be located in a 62,000 square foot facility currently under construction. The center will improve access to regional resources in transportation R&D and should attract new industry partners.

- **The Oak Ridge Centers for Manufacturing Technology** (ORCMT) represent a national resource for manufacturing technology. ORCMT, a joint effort with the Oak Ridge Y-12 Plant (designated as the National Prototype Center), has assisted more than 4,700 businesses nationwide with applied R&D, development, design, prototyping and training.

about one-quarter are from industry. These guest assignments generate an additional 90,000 "bed-nights" annually in the Knoxville-Oak Ridge area.

Access to ORNL Facilities and Expertise

ORNL resources are available to researchers and industry through a number of mechanisms (see Table 10). By making these resources available, ORNL reinforces its role as a leader in restoring the nation's competitive edge. For the State of Tennessee, this access brings national and international visibility as it attracts guest scientists and business leaders from around the world.

Additionally, ORNL is home to 16 major "user facilities," uniquely equipped centers ranging from state-of-the-art particle accelerators to sprawling forests and streams (see Table 11). Access to the facilities is granted on the basis of scientific merit, technical feasibility and the compatibility of the proposed research with the facility's equipment and other priorities. These facilities are open to researchers from universities, industry, and other

Table 10: Mechanisms for Accessing DOE Oak Ridge Facilities

Cooperative Research & Development Agreements (CRADAs): CRADAs allow one or more partners to collaborate on ideas, share costs and pool the results of a particular R&D program to bring a specific technology to the marketplace. ORNL has 131 active CRADAs.

License Agreements: These agreements give industry access to ORNL-developed inventions and technologies. ORNL has executed more than 220 license agreements and commercial sales resulting from these agreements exceed $184 million.

Personnel Exchanges: Through personnel exchanges, ORNL employees can take their expertise to other locations or outside experts and researchers can come to the Lab to enhance technical capabilities and support research in specific areas.

Small Business Innovative Research (SBIR) and Small Business Technology Transfers (STTR): Sponsored by DOE, these programs provide partnership opportunities for qualified small firms. ORNL's Small Business Program Office builds awareness of cooperative research and technical assistance opportunities available to small and medium-sized firms and promotes partnerships under the STTR program.

Work for Others (WFO): WFO is a DOE mechanism that gives federal agencies, commercial companies, and local, state and international governments access to research and technical assistance in solving problems and developing work models or prototypes. ORNL carries out more than $100 million of WFO each year for agencies including NASA, the Department of Defense and the Nuclear Regulatory Commission, just to name a few.

laboratories. Flexible arrangements and an open environment make it possible for thousands of outside experimenters to benefit from ORNL's capabilities each year. Additional benefits arise from the ongoing partnerships with the University of Tennessee and the Tennessee Valley Authority as they allow ORNL to leverage resources in both the energy and research industries.

Technical Assistance to Industry

A second important component of DOE's technological partnerships is technical assistance to industry, which can increase the productivity and competitiveness of the private sector. By providing a large pool of knowledge and expertise, DOE can serve as an important resource for businesses, attracting firms to Tennessee that might otherwise locate elsewhere. A vast array of the technical assistance supported by DOE operations is offered by Lockheed Martin Energy Systems, Inc., via the Y-12 Plant and its National Prototype Center (NPC).

NPC is a place where government agencies and private industry find all the capabilities, skills and resources needed to turn great ideas into innovative, affordable, manufacturable products. As a complement to five decades of prototyping for DOE missions, Oak Ridge has increasingly supported industry and other federal agencies seeking to produce one-of-a-kind products, solve

ORCMT provided technical assistance and new technology to Hale Forge, a Tennessee ornamental blacksmithing company (Bob Hale, owner, shown in photo), that enabled the company to get Professional Golf Association approval and, subsequently, increased sales of their new golf putter.

tough manufacturing problems and modernize industrial processes and systems. More than 100 businesses and federal agencies use the Center's resources every year.

Serving as the gateway to the NPC is the Oak Ridge Centers for Manufacturing Technology (ORCMT). Located at the Y-12 Plant, ORCMT—a joint partnership between ORNL and Y-12—was established by DOE to help maintain national security capabilities while bolstering U.S. economic competitiveness in numerous manufacturing sectors. ORCMT serves as a national resource for manufacturing technology and is a catalyst for applied research, development, design, prototyping, production and training.

Drawing on more than five decades of successful precision manufacturing at the Y-12 Plant and on the advanced R&D resources of ORNL, ORCMT has developed a flexible, multidisciplinary organization that can provide solutions for most manufacturing challenges. Table 12 lists some of the demonstrated successes

Table 11: ORNL's User Facilities

- Advanced Bioprocessing Research Facility Propulsion Technology
- Buildings Technology Center
- Californium User Facility for Neutron Sciences
- Computational Center for Industrial Innovation
- High Flux Isotope Reactor
- High Temperature Materials Laboratory
- Holifield Radioactive Ion Beam Facility
- Metals Processing Laboratory User Center
- Metrology R&D Laboratory
- Mouse Genetics Research Facility
- Oak Ridge Electron Linear Accelerator
- Oak Ridge National Environmental Research Park
- Physical Perspectives Research Laboratory
- Shared Research Equipment Program
- Surface Modification and Characterization Research Center
- Advanced Propulsion Technology Center

Table 12: Demonstrated Successes of ORCMT

- More than 4,700 large and small businesses served throughout all 50 states, Washington, DC, and Puerto Rico.
- Benefits of more than $950 million generated for ORCMT's customers.
- Long-term, proprietary relationships developed that protect technical data and industrial ownership of intellectual property.
- More than 6,000 persons trained through the ORCMT Manufacturing Skills Campus.

of ORCMT. In addition to these successes, ORCMT has provided technical assistance to more than 1,200 companies in Tennessee, with a reported private-sector impact of approximately $385 million and 3,467 jobs saved or created. In FY 1999 alone, ORCMT provided assistance to more than 60 Tennessee manufacturers. The impact of this assistance is reported to be greater than $47 million, with more than 293 jobs saved or supported. A toll-free telephone number (1-800-356-4USA) provides convenient access to ORCMT's technical assistance programs.

Also providing technical assistance to industry and other organizations is ORNL. Through its technical assistance program, ORNL is able to rapidly respond to inquiries from individuals or organizations seeking to further knowledge, solve a specific problem, or improve a process or product. Funding to support technical assistance projects, personnel exchanges and technology maturation projects has been provided by the DOE Office of Science's Laboratory Technology Research Program for more than 6 years. The accessibility of technical assistance was enhanced in 1997 when the DOE Office of Industrial Technology funded the establishment of an e-mail address (assist@ornl.gov), telephone access (865-574-0008) and a website (http://www.ornl.gov/ornlhome/taornl.htm).

Information Dissemination and Knowledge Transfer

A crucial element in technological innovation and a significant part of DOE's technological partnership programs is information dissemination and knowledge transfer. This is the primary purpose of DOE's OSTI. The mission of OSTI is to collect, preserve and disseminate scientific and technical information, the principal product resulting from DOE's $7 billion annual R&D investment. OSTI continues making remarkable progress in the areas of information dissemination and knowledge transfer with the DOE Information Bridge (http://www.osti.gov/bridge)—one of the world's largest digital compilations of energy-related R&D information, now containing over 50,000 full-text technical reports, the DOE Research and Development Project Summaries Web Database (http://www.osti.gov/rdprojects), EnergyFiles (http://www.osti.gov/Energy Files), DOE's Virtual Library of Energy Science and Technology. Each of these products was recognized in 1999 by Vice President Gore's National Partnership for Reinventing Government

with a Hammer Award. New in 1999 were three additional information products: PubSCIENCE; PrePRINT Network; and ETDEWEB.

PubSCIENCE, developed and implemented by DOE/OSTI through negotiations with journal publishers, provides searchable bibliographic records with hypertext linkages to full-text journal articles at publishers' web sites. PubSCIENCE develops and implements the public availability of DOE-generated and DOE-related scientific and technical journal information for use by scientists, academia, and further information availability and the transfer of this information to the private sector. Available since October 1, 1999, PubSCIENCE allows the user to search across abstracts and citations of multiple publishers at no cost. PubSCIENCE is currently used by the Tennessee and other state depository libraries, news sites, government organizations, scientific societies and a variety of electronic publications. PubSCIENCE is electronically referred to by over 200 worldwide web sites.

Planning for a new OSTI initiative, the PrePRINT Network (http: //www. osti. gov/ preprint), commenced in Fiscal Year 1999. The PrePRINT Network serves as a searchable gateway to preprint servers that deal with scientific and technical disciplines of concern to the Department of Energy. The primary beneficiaries of this information would include Tennessee's depository libraries, and library users such as academic and industrial scientists and researchers.

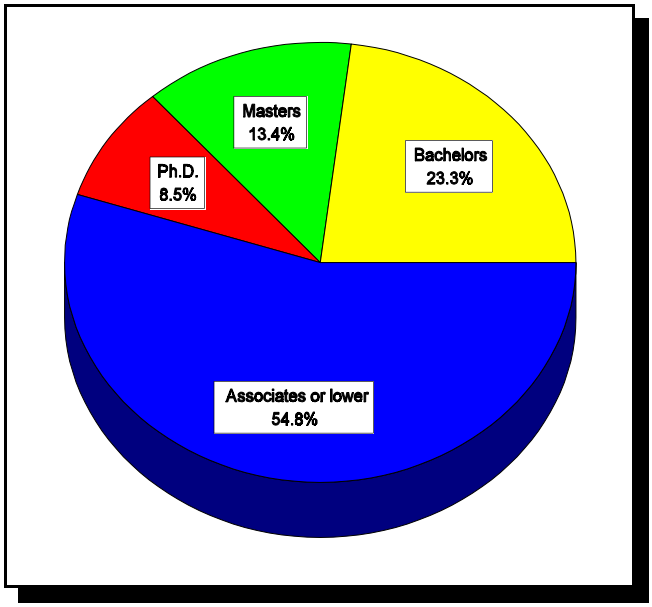
DOE/OSTI continues its strong international information exchange program which allows for the exchange of U.S. scientific and technical information produced and collected by DOE to gain access to similar information produced and collected by International partners. OSTI currently has two large information exchange agreements: the International Atomic Energy Agency's International Nuclear Information System (IAEA/INIS), a collaboration among over 103 countries and 19 international organizations to exchange information on the peaceful uses of atomic energy, and the International Energy Agency's Energy Technology Data Exchange (IEA/ETDE), a consortium of 18 countries that exchanges energy research and technology information in all energy areas. New in 1999 is ETDE World Energy Base or ETDEWEB (http://www.etde.org/ETDEWEB), a new tool for disseminating energy research and technology information collected and exchanged through the ETDE program. Debuting in November 1999, ETDEWEB is an internet version of the most current information (since 1995) in ETDE's database, with links to full-text when available. OSTI built and maintains this new product on behalf of ETDE.

V. EDUCATIONAL CONTRIBUTIONS OF DOE AND ITS AFFILIATES

DOE and its contractors employ a highly-skilled workforce within the state, translating into higher worker earnings. As shown in Figure 7, a significant share of the workers hold a bachelors degree, while others hold more advanced degrees.

DOE's presence in Tennessee also widens the scope of educational opportunities to state residents through various programs and partnerships with schools throughout the region. These investments in human capital can improve the quality of the state's workforce, in turn helping to attract and

Figure 7: Educational Makeup of DOE in Tennessee, 1999



retain businesses and industry in the state. Available evidence shows that both individuals and regional economies benefit appreciably from investments in education. DOE's support for educational programs extends from primary and secondary schools to institutions of higher education at all levels, including research universities. Activities include the Governor's School for Manufacturing, fellowships, science and environmental fairs, and museum tours, just to name a few examples. Several of DOE's partners are active in providing various educational opportunities to students and researchers throughout the region. The following section details the educational support programs provided by DOE and its affiliates.

Department of Energy Oak Ridge Operations

DOE along with ORISE and Pellissippi State Technical Community College (PSTCC) sponsors the annual Tennessee Science Bowl at PSTCC. In 1999, twenty Tennessee high school teams competed in the all day event, with the winner advancing to the DOE National Science Bowl in Washington, D.C. Local DOE employees served as volunteer judges at several local elementary school science fairs, as well as in the Southern Appalachian Science and Engineering Fair held at the University of Tennessee in April, 1999.

DOE's Office of Scientific and Technical Information

Another important mechanism by which DOE and affiliates support education in the region is through their partnerships with local school systems and colleges. For example, the DOE OSTI Adopt-A-School (AAS) Program serves five Anderson County elementary schools: Norwood, Andersonville, Briceville, Dutch Valley and Fairview. The OSTI AAS program goal is to enhance teaching and learning in the fields of science and mathematics. In pursuit of President Clinton's Executive Order encouraging federal offices to provide their surplus computer equipment to schools, OSTI has contributed over $150,000 in computer equipment to schools in Anderson County, Knox County and Claiborne County. In addition, OSTI has contributed $23,000 in supplies, books, science equipment and miscellaneous goods via the Adopt-A-School program. Table 13 outlines current DOE-OSTI AAS activities.

Oak Ridge Institute for Science and Education

On behalf of DOE and other federal agencies, the ORISE administers fellowships, scholarships, internships and other research participation programs that better prepare students to join the workforce as scientists, engineers and technicians.

Table 13: Current Activities of the DOE-OSTI Adopt-a-School Program

Reading at Norwood once a week.
Stocking supply closets at all five elementary schools twice a year.
Raising funds through an annual auction, bake sales and other activities.
Hosting Angel Trees for gifts for children identified by Norwood and Briceville.
Collecting non-perishable food items for needy families identified by Norwood.
Donating surplus computer-related equipment to our adopted schools and other schools who express need.
Judging Norwood's Science Fair.
Providing recognition to Norwood teachers and staff.
Fulfilling special needs requests (medicine, shoes, field trip expenses for students; library books, science equipment for schools).
Participating in the Youth Leadership Development and Community Involvement Program, Clinton High School (2 students at OSTI).

ORISE also administers faculty research programs to give teachers the opportunity to perform innovative research at national laboratories, thereby improving the quality of their classroom teaching experience. Each year over 2,500 individuals benefit from ORISE education programs and over 500 of those are given appointments at ORNL. Their appointments range from several days for a faculty member performing experiments using the advanced facilities at ORNL to several years for a postdoctoral fellowship. East Tennessee is filled with participants who completed their education and then stayed to make the area their permanent home.

Tennessee institutions are particularly well served by the education programs administered by ORISE. Over the past dozen years, an average of 300 students and faculty from within the state participated in research, received fellowships or attended other ORISE education activities annually. Over 130 colleges, high schools and other institutions from Tennessee were serviced by these programs. In 1999, ORISE provided 176 students and faculty members from Tennessee colleges and universities with new appointments in national laboratories.

Perhaps because enhancing education is part of their work life, ORISE employees have taken an active part in contributing to local schools as part of their personal life. Through the ORISE Volunteers in Education Team (VET), employees volunteer their time to enhance local educational efforts, working to assist public schools in the East Tennessee area. The areas in which they offer their talents are detailed in Table 14.

In addition to these on-going activities, last fall VET sponsored an ORAU employees school-supply drive to benefit homeless children served by the Knox Area Rescue Ministries. Recently, VET donated $500 and co-sponsored a classroom in the Oak Ridge community's Freedom School, a national summer program that provides social, cultural and historical awareness activities for African-Americanchildren. VET members facilitate

Table 14: Educational Activities Supported by ORISE Volunteers in Education Team

- **Career Information**
  Provide information and programs related to careers in the sciences, math and technological areas.

- **Chemical Disposal Information**
  Provide information on laboratory safety and safe disposal of laboratory chemicals.

- **Computer Science/Business Applications**
  Provide information and assist in workshops for students and/or teachers on word processing, database management, spreadsheet and graphics software, telecommunications and business applications. Develop programs and provide speakers for the classroom and for meetings of student business professional organizations, especially as the business area relates to science and math-oriented organizations.

- **Inservice Programs for Teachers**
  Provide inservice programs for teachers to give them tools and techniques for enhancing classroom activities related to math, the sciences and technology.

- **Materials Donation**
  Supply materials requested by teachers that would enhance science and math activities. Materials will be limited to individual contributions from personal resources.

- **Mentoring/Tutoring**
  Provide coaching or tutoring assistance to students and teachers in the math and science areas. Provide encouragement by giving feedback or suggesting projects to students and teachers interested in areas of math and science.

- **Science/Math Olympiad and Bowls**
  Assist in demonstrations for Science/Math Olympiad projects and provide coaching for Science and Math Bowls.

speakers for local schools and were instrumental in a transfer of nearly three-quarters of a million dollars of excess computer equipment from ORISE to area classrooms. ORAU employees volunteered their time to load, transport, unload and set up computers, monitors, printers and other items at schools in Loudon County, Monroe County and other surrounding counties.

Bechtel Jacobs Company LLC

The Matching Gifts program that provides for donations to support institutions of higher learning, has been well received by employees. Over $11,000 in Matching Gifts were received by approximately 36 colleges and universities.

Grants to Tennessee colleges and universities include the University of Tennessee, Maryville

College, Roane State Community College and Knoxville College. Bechtel Jacobs Company led a major fundraising event for Knoxville College, a minority institution. Bechtel Jacobs Company also arranged a collaborative relationship between Knoxville College and Junior Achievement, under which students teach the Junior Achievement curriculum to inner city schools as part of the Knoxville College Work Program.

Minority organizations received grants of approximately $100,000. These grants were made to more than 24 organizations such as the Freedom School of Oak Ridge, The Men of Tomorrow Program, NAACP Freedom Fund, Scarboro Community Student Mentoring Program and the Southeastern Consortium for Minorities in Engineering (SECME).

As a corporate sponsor for the SECME Program, Bechtel Jacobs Company LLC participates in the SECME Summer Internship Program. The SECME Internship program is coordinated with the local SECME Coordinator and one of the Executive-level managers at Bechtel Jacobs Company, LLC. Overall this effort placed 35 SECME students in various companies and organizations in Oak Ridge. During the summer of 1999, Bechtel Jacobs Company LLC utilized 13 of the 35 students on environmental management projects at the East Tennessee Technology Park, the Y-12 Plant and the Oak Ridge National Laboratory.

The EnvironMENTAL Fair, which is an educational and community outreach event sponsored by the DOE's Environmental Management Program, had been coordinated by Bechtel Jacobs Company LLC. On behalf of the Environmental Management program of the DOE

Summer SECME Internship Students

ORO, Roane State Community College was tasked to devise, plan and conduct a new environmental learning opportunity for students in the Oak Ridge area. This environmental education/outreach activity replaced the former EnvironMENTAL Fair in Oak Ridge and has two primary objectives: increase the educational value of the event and reduce costs. These objectives have been met by developing a classroom/symposium format to replace the outdoor fair, lengthening the amount of time students spend with each activity, developing and adapting curriculum materials to meet educational objectives and serving smaller student populations at each symposium.

Symposium planners chose eighth grade as the audience because that is when students begin deciding their academic and career tracks. Three separate, but related, activities are designed to explore the science of real-world issues and to introduce students to careers in science. First, Roane State will provide participating teachers with curriculum materials for classroom use in advance of the symposium. Following the symposium, the Roane State Curriculum Director will visit participating classrooms to reinforce what the

students have learned and to introduce career fields. An important part of introducing career fields is counseling students on high school and college requirements for entrance into different fields.

Symposium workshops have been developed around 6 themes, all of which address the science underlying the DOE's Environmental Management mission. Each student will attend 3 workshops during the day, each designed to explore the science within a single theme. Instructors will be professionals who have first-hand working knowledge of the theme being explored. They will offer their students a combination of instruction, demonstration and hands-on exploration that focuses on an environmental issue or medium.

Lockheed Martin Corporation

Lockheed Martin Corporation manages the DOE contracts for the Y-12 Plant and the ORNL and jointly sponsors and contributes to numerous educational activities and initiatives in the State of Tennessee. Table 15 lists the activities and institutions supported by Lockheed Martin Corporation.

For almost a decade, Lockheed Martin and DOE have nurtured the seeds for cultivating technology partnerships with minority educational institutions (MEI). The resulting MEI program uses the unique science and technology resources of the Oak Ridge Complex to initiate, advance, and sustain partnerships with MEIs that lead to cooperative business development alliances. Strategic partnering with MEIs, which blends the Oak Ridge advanced capabilities and MEI expertise, results in collaborative projects for DOE and other customers. The program directly contributes to DOE's vision for an integrated science, technology and education complex. The scope of the MEI program includes historically black colleges and universities, Hispanic-serving institutions and Native American institutions.

Oak Ridge National Laboratory

As the nation's need for a scientifically literate population continues to grow, ORNL will build on its long tradition of service as a national and international science education resource, with emphasis on the southeastern United States. The Laboratory's Office of University and Science Education coordinates more than 40 programs, providing unparalleled opportunities for students and faculty at all educational levels and serving thousands of participants each year. While the emphasis in the K-12 area is in serving the southeastern United States, the overall emphasis is on contributing to the national and international communities. A particular area of interest is ensuring the inclusion of those traditionally under-served in science, mathematics, engineering and technology (SMET). This is accomplished by providing or supporting programs which serve those populations (Freedom School, Spectacles, Project SEED, etc.) as well as ensuring diversity in non-targeted programs through effective recruiting. Strong management support throughout the organization makes this possible. Another critical element to the magnitude of ORNL education programs is that of extensive partnering with academic institutions and with local, regional, national and international organizations. Partnering includes tutoring, mentoring, career fairs, joint conferences and many other activities. A partial listing of programs coordinated by the Office of

Table 15: Educational Programs Supported by Lockheed Martin in Tennessee, 1999

National Initiatives
- Advancing Minorities' Interest in Engineering, 1999 membership investment

Support to Local Colleges and Universities
- Maryville College, support to Community Fund Campaign
- North Carolina A&T State University, sponsorship of Chancellor's Executive Seminar for Careers
- Pellissippi State Foundation, support to purchase of Catholic High School property for use as an East Knoxville facility
- Roane State Community College Foundation, support to establishment of Lockheed Martin Pre-Engineering CAD Lab at Oak Ridge Branch Campus
- Tennessee State University, support to Chair of Excellence in Banking and Financial Services
- University of Tennessee, operating expenses for UT Academy for Teachers of Science and Mathematics

Support to Local School (K-12) Activities
- Anderson County Schools Office of Technology, support for students' attendance at three-week summer program
- Blue Grass Elementary School PTA, funding for Math Superstar Enrichment Program
- Caryville Elementary School, purchase of books for Accelerated Reading Program
- Central High School Renaissance Educational Foundation, equipment for Annenberg Rural Challenge program
- Claxton Elementary School, support to Project APPLY IT for 4th and 5th graders
- Clinton High School DECA Chapter, registration for seven CHS students at National DECA Career Development Conference
- Kingston Elementary School, support to Character Counts curriculum for 4th grade teachers
- Knox County Schools, sponsorship of "Run for Ed" to benefit Knox County Schools
- Maryville City Schools Foundation, Inc., support to purchase of new computers for middle school
- Norwood Elementary School, support to computerized reading program
- Plateau Home School, Inc., sponsorship of two tutors trained in Wilson Reading System
- SECME, Inc., support to programs
- Sweetwater Education Foundation, toward purchase of equipment for two model high-tech classrooms
- Valley View Elementary School, funding for math/science materials

Conference Sponsorships and Related Support
- American Chemical Society, Biochemical Technology Division, support to student travel subsidies to Spring National Meeting
- Institute of Electrical & Electronics Engineers, general conference co-sponsorship of "SoutheastCon 2000" (southeast regional conference)
- Society for Technical Communication, East Tennessee Chapter, support to 23rd Practical Conference on Communication
- Southern Appalachian Science & Engineering Fair, Inc.
- Tennessee Association of Business, sponsorship of "Teacher, Industry and the Environment" workshop
- Twenty-Second Symposium on Biotechnology for Fuels and Chemicals, sponsorship of 22nd Symposium on Biotechnology for Fuels and Chemicals

Scholarship Support
- Altrusa International Inc. of Oak Ridge, support to 1999 Altrusa Re-entry Women's Scholarship Program
- Men of Tomorrow Program sponsorship of 1999 Annual Scholarship Award Banquet

Other Educational Activities
- Community Television of Knoxville, support to media literacy training program for students in Knox County Schools' Talented & Gifted Program
- East Tennessee Discovery Center, sponsorship of 1999 Butterfly Release Program for Knox County first-graders
- Junior Achievement of East Tennessee, Inc., support to classroom programs
- Knox Area Chamber Partnership, Silver Sponsorship of 1999-2000 Leadership Education program
- National Society of Black Engineers-Knoxville Alumni Extension, support to scholarship program
- Stand for Children of Anderson County, support to Oak Ridge Freedom School
- TennCorp Community Services, support to Knoxville Freedom School
- Tennessee Science Olympiad, prizes to two first-place (middle and high school level) winners in Spring 99 event

*Arthur Stewart of ORNL's Environmental Sciences Division (right) explains research involving the snail **Elimia**, to a group of high school students and faculty. **Elimia**, an abundant snail, is an example of a sensitive key species in the study of pollution effects in Oak Ridge Reservation streams.*

University and Science Education is provided in Table 16. A complete listing can be found on the ORNL web page (http://ornl.gov/seer/contents.html).

The core K-12 program is the Ecological and Physical Sciences Study Center which provides hands-on science activities for students and teachers. Through this program, ORNL provides services to a wide variety of users: school groups, summer science camps, teacher training, community groups and the higher education community. In addition, the K-12 programs include research opportunities for students and teachers, research immersion experiences for students and teachers and extensive involvement in technology development and enhancement. On an annual basis, well over 10,000 participants take part in ORNL K-12 programs.

Research participation programs are the core element in the area of higher education. Students and faculty take part in many programs which provide research opportunities including: summer and academic year experiences, thesis and dissertation efforts, and practicums of various types. Post-doctoral students are a most important component to the research programs, enhancing the skills of the students while contributing to the mission of the laboratory.

American Museum of Science and Energy

Operation of DOE's American Museum of Science and Energy (AMSE) in Oak Ridge is part of ORNL's scope of work. Since its opening in 1949, the AMSE has attracted approximately 10 million visitors. The museum currently offers a variety of exhibits on past and current DOE activities in Oak Ridge and an extensive outreach program for teachers and students from school systems throughout East Tennessee. Visitors come from all 50 states and 30 countries, with more than 125,000 visitors during FY 1999.

Y-12 Plant

The Manufacturing Skills Campus at DOE's Oak Ridge Centers for Manufacturing Technology, located at the Y-12 Plant, is a one-of-a-kind on-site retraining program achieving a dual mission of retraining workers to maintain national security core competencies and transferring skills to private-sector customers. The Skills Campus fills manufacturing education and training gaps by complementing existing educational programs and by facilitating partnerships that result in strategic improvements in manufacturing education and training systems.

The Skills Campus has developed partnerships that enable it to serve as a catalyst for improving

Table 16: Educational Programs Supported by ORNL

Higher education programs. Research participation is the core activity, with research opportunities available at all academic levels for students and faculty.

K-12 education programs. Core programs are hands-on activities for students and teachers, many offered through the Ecological and Physical Sciences Study Center, and teacher development programs.

Special events. ORNL sponsors special events designed to meet Laboratory and community needs and interests, including science literacy and public understanding of science. Notable programs include the following:

- The Ecological and Physical Sciences Study Center offers a variety of hands-on study units and serves about 14,000 elementary and secondary students and teachers each year. The Center utilizing support from the Tennessee Space Grant Consortium and other sources offers reduced-fee classes to area schools with a significant enrollment of economically-disadvantaged students.

- ORNL is a partner in the Appalachian Rural Systemic Initiative, providing teacher development programs for the six states involved, and sponsoring a Summer Math/Science Institute in collaboration with the Appalachian Regional Commission.

- As a sponsor of the Southeastern Consortium for Minorities in Engineering and Science and Summer Educational Experiences for the Disadvantaged (SEED), which introduces precollege students to an environment that might enhance their interest in science, mathematics and engineering careers. ORNL provides opportunities for minority and economically-disadvantaged high school students to intern at the Laboratory.

- The Adventures in Supercomputing program introduces students from more than 100 schools in nine states to the excitement of working with powerful computational tools.

- The Energy Research Undergraduate Laboratory Fellowship program and the Institute for Biotechnology, Computing and Environmental Sciences provided academic and summer internship programs for approximately 200 students a year. Over half of those students come from groups traditionally underrepresented in science education.

- Postdoctoral researchers are an important component of the ORNL education effort. More than 250 postdoctoral fellows annually advance their understanding of the research process while making significant contributions to ORNL's R&D activities.

---

manufacturing education and training to support advanced manufacturing needs. These partnerships extend from the K-12 school system to post secondary education and into adult skills training. Courses are designed to complement existing training programs through local colleges and private institutions.

During FY 1999, the Skills Campus extended the breadth of their partnerships and collaborations:

- Presented the Fourth Annual Governor's School for Manufacturing in partnership with The University of Tennessee. This Governor's School featured the first ever "electronic attendance" by students from across the state of Tennessee.
- Collaborated with the Appalachian Regional Commission in presenting the Third Summer Science Honors Academy for high school students.
- Partnered with a local technology center on a train-the-trainer course, resulting in saving 150 jobs and keeping a local company in business.
- Formed a partnership with an area community college for training courses.

VI. NEW DIRECTIONS FOR THE FUTURE

Several existing and future DOE programs hold the prospects for maintaining DOE's technological leadership and economic contributions in the State of Tennessee. DOE anticipates that efforts to mitigate the impacts of downsizing plus new initiatives such as the Spallation Neutron Source, the National Transportation Research Center and New Life Sciences Facilities will provide employment and economic growth/diversification opportunities for the region. In an effort to mitigate the impacts of downsizing, DOE has engaged in several targeted initiatives aimed at assisting surrounding communities in creation of private sector jobs. These initiatives, as well as activities discussed above, can have an important impact on the region's prosperity and economic development. Through September 1999, DOE had committed $53.3 million in community transition grant funds to the Oak Ridge region. The funds were used for a variety of programs including training assistance, loans to businesses, development of new and existing industrial parks and grants to local governments for new economic development projects. The Community Reuse Organization of East Tennessee reported that 1,148 jobs were created or retained during FY 1999 as a result of this funding. One of the primary programs undertaken by DOE to help transition the community is a contract with Bechtel Jacobs Company LLC, which provides a commitment to create private sector jobs.

Department of Energy Oak Ridge Operations

ORO has established a unique initiative to leverage valuable, but unused, assets to accomplish accelerated cleanup, reduce environmental risk and create private sector jobs to compensate for the expected loss of jobs as cleanup is completed. This initiative is known as the Oak Ridge Reindustrialization Program. Through the Reindustrialization Program, DOE has achieved $828 million in cost avoidance and savings. A total of 5,934,158 square feet of plant floor space has been transitioned via innovative contracting and

leasing models, with the added benefit of creating 889 jobs. Much of DOE's effort in this program has been focused on cleaning up formerly used buildings at Heritage Center for reuse by commercial companies that will diversify the local economy. Examples of these projects are provided in Table 17.

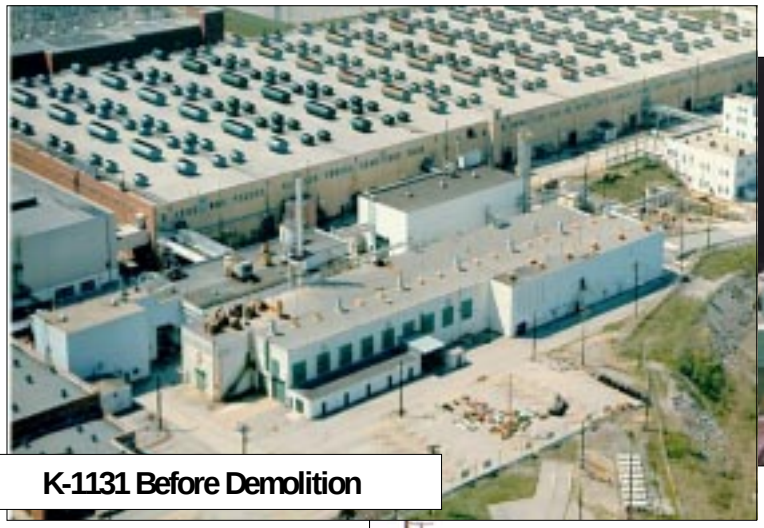
In support of its mission to move the community away from dependence on DOE, the Department aided in the development of the now mature Community Reuse Organization of East Tennessee (CROET). CROET acts as the leasing agent for Reindustrialization properties and has consummated 57 leases with over 31 diverse companies at Heritage Center and Oak Ridge National Laboratory. These leases have created jobs for the local economy and a revenue stream that CROET uses to help offset operating expenses and perform additional cleanup work.

CROET also helps foster economic development in the local community through the application of federal grants. In FY 1999, CROET distributed more than $750,000 in grants that leveraged regional funding toward economic diversification efforts. CROET was awarded the Manager's Diversity award in recognition for outstanding support of DOE's Diversity Programs in conjunction with the awarding of this grant funding which included: funding to a regional community college which is expanding into an economically-challenged area of East Knoxville; internships to students of historically black colleges and universities; grant funding to two woman- or minority-owned small businesses; and awarding at least 10 percent of the small business loans to minority companies. CROET reports that 265 jobs were created or retained as a result of these activities during 1999.

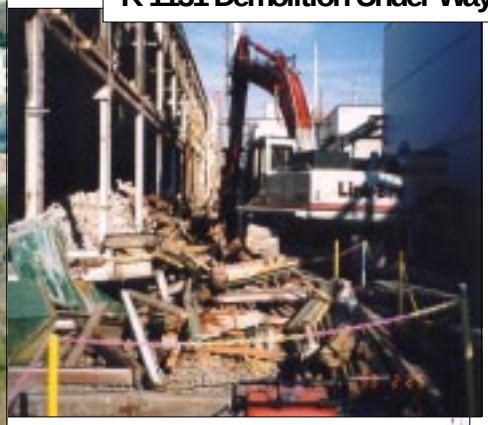
The signing of the 50th lease at East Tennessee Technology Park (ETTP), which encompasses both Heritage and Horizon Centers) took place during 1999. This lease was particularly important as it was signed with The Oak Ridge National Recycling Center, a joint venture of Diversified Environmental Services (a minority, woman-owned business headquartered in Oak Ridge) and 5R of Wisconsin, which is nationally recognized for expertise in de-manufacturing and recycling electronic components. CROET has leveraged the equipment and facilities to sublease 882,110 square feet of buildings to 28 private sector firms creating 243 private sector jobs under the subleasing initiative.

As an alternative to companies in locating at existing facilities at Heritage Center, CROET can offer incoming industries the option of locating at Horizon Center, a greenfield business park adjacent to Heritage Center that is well underway toward completion of Phase I. One of the objectives in the development of this land is to meet specific requirements for preserving a variety of environmental characteristics—wetlands, stands of old-growth hardwood, and wildlife—making it an aesthetically pleasing, state-of-the-art location for business. During 1999 CROET and DOE were successful in attracting the first tenant to Horizon Center, a medical isotope company which is currently constructing a $25 million facility that will house upwards of 240 workers who will produce a revolutionary and highly successful cancer therapy treatment. Community transition projects supported by CROET during 1999 are summarized in Table 18.

The Reindustrialization Program also includes a technology transfer component that is focusing on



K-1131 Before Demolition



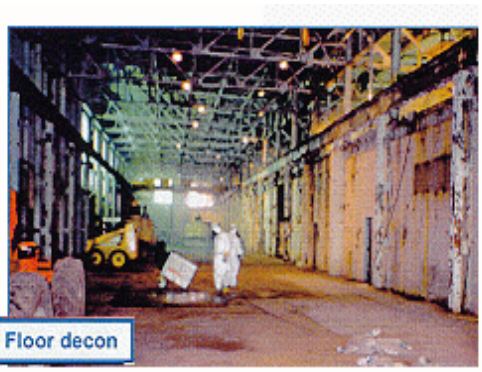
K-1131 Demolition Under Way

KAFaD Group I:

K-1131 Demolition

K-1131 Asphalt Pad after Completion

commercializing technology developed in the gaseous diffusion program. The Inorganic Membrane Technology Laboratory is now successfully providing technologies in the field of inorganic membranes for commercial use in the form of new products that are superior to competitive products in worldwide markets. A manufacturing facility has been leased by a joint venture private sector enterprise. Thus far two inorganic membrane products have been approved for commercial manufacture and have the potential for hundreds of millions of dollars in product sales annually.



Floor decon

Table 17: Selected Projects Undertaken by Reindustrialization

The BNFL Three-Building Decontamination and Decommissioning (D&D) and Recycle Project. This is a six-year, $238-million contract to dismantle, remove and decontaminate the process equipment and support systems materials within three gaseous diffusion plant buildings (K-33, K-31, and K-29) and two switchyards, making them available for commercial reuse. This project is projected to save taxpayers approximately $550 million over more traditional D&D contracting approaches.

The Building K-1200 Clean-up Project. DOE successfully negotiated an 18-month, zero dollar contract with Materials and Energy Corporation (M&EC) to remove existing gas centrifuges, support equipment and structures and decontaminate Building K-1200. Materials and equipment removed will be evaluated for salvageability and reuse by M&EC. M&EC will subsequently hold these buildings under a lease arrangement with CROET and plans are to install and operate a commercial waste treatment facility

The Building K-1420 D&D Project. Building K-1420, a former decontamination and recovery Class 2 nuclear facility, is being decontaminated to industrial criteria via a three-year contract. When finished, the contractor, Decon and Recovery Services, will have an option to lease the facility for commercial reuse. The project is being executed using Surveillance and Maintenance budgets and will produce a savings over $16 million compared to traditional approaches for clean up.

Bechtel Jacobs Company LLC

As part of the Management and Integration (M&I) contract for environmental management, Bechtel Jacobs has committed to spend corporate funds to create $427 million of non-DOE-funded payroll in Anderson, Roane, Knox, Blount and Loudon Counties over the 5-1/2 year contract. Bechtel Jacobs has set specific payroll goals for each year.

A separate division, Bechtel Jacobs Development Company, was set up to meet these commitments. Bechtel Jacobs Development Company has created new payroll through a combination of growing local businesses, attracting businesses to the area and stimulating new businesses. Recognizing that creating jobs is a team effort, Bechtel Jacobs works closely with a wide variety of regional economic development agencies.

More than $13 million of payroll to the Oak Ridge-Knoxville area was paid in 1998 and more than $58 million was paid in 1999 by firms receiving assistance from Bechtel Jacobs Company, according to data released by the company and DOE. During the first reporting period, which ended September 30, 1998, Bechtel Jacobs Company provided assistance to more than 14 companies, in addition to expanding the local non-DOE presence of Bechtel National, Inc., and Jacobs Engineering, and 42 companies for the period ending September 30, 1999.

Under the terms of its DOE contract, Bechtel Jacobs was required to create $11 million of new payroll during 1998 and $43 million in 1999. Bechtel Jacobs Development Company exceeded its goal for 1998 and 1999 with new jobs that helped diversify the regional economy and reduce dependence on the federal budget by providing a variety of incentives. These include direct financial

Table 18: Regional Community Transition Projects Funded by CROET

Reindustrialization and Reuse of the East Tennessee Technology Park and Development of the Horizon Center:
A significant amount of grant funding has assisted in the development of the East Tennessee Technology Park, which includes reindustrialization of the Heritage Center (formerly known as the K-25 site) and the Horizon Center, a 1,000 acre green field high-tech business park.

Manufacturing Skills Campus:
The Skills Campus, a part of the Oak Ridge Centers for Manufacturing Technology at the Oak Ridge Y-12 Plant, has been a valuable training asset. It has offered specialized craft training in the areas of precision machining, electronics and industrial maintenance.

Regional Workforce Development and Economic Diversification Grants:
DOE funds are used to provide grants to stimulate the regional economy. Primary and secondary impacted communities have been assisted through a CROET program which provides grant funding to respond to strengths, opportunities and constraints specific to their workforce development situations.

Gene Research Access Corporation:
Funds have been used to support the creation of a consortium of companies interested in gene research and leverage private sector participation to create new jobs.

National Transportation Research Center (NTRC):
The NTRC is a partnership between the ORNL, the University of Tennessee, the Development Corporation of Knox County and DOE's ORO. During FY 1998, funds were used to purchase equipment for a new research and testing laboratory staffed by the partners.

Technology 2020:
Funds were used to support the efforts of Technology 2020, a public-private partnership designed to build on the significant resource of expertise in information technologies which exists in East Tennessee. More than 150 information technology jobs are expected to be created or retained in the near term.

Tennessee's Resource Valley:
Funds have been used to facilitate the implementation of the 21st Century Jobs Initiative and to provide information on East Tennessee strengths in order to attract new companies to the region.

New Business Development:
New business ventures in the region have been assisted and expanded with particular emphasis on job creation and new regional investment.

support, attractive leases to reindustrialize DOE facilities, in-kind services, custom-designed training programs, access to in-house experts, infrastructure assessments and support services. Some of the companies that created new jobs under the incentive program are highlighted in Table 19.

Spallation Neutron Source Research Facilities

The Spallation Neutron Source (SNS), a newly

Table 19: Companies Creating New Jobs Under the Incentive Program Headed by Bechtel Jacobs Company LLC

- **Dienamic Tooling Systems (DTS),** subleasing 35,200 square feet in the southwest corner of K-1401 at ETTP Heritage Center plus various equipment. A tool and die shop supports the automotive industry, DTS is part of a network of shops known as the Tooling Systems Group. Two other shops are located in Grand Rapids, Michigan and one other shop is located in Comstock Park, Michigan (outside Grand Rapids). Projected employment: year 1: 15 people, year 2: 25 people, and year 3: 35 people.

- **Theragenics Corporation,** proposes to build a medical isotope production facility at the ETTP Horizon Center, the first to be constructed there. An internationally recognized company, Theragenics produces a mature product line that includes palladium "seeds" for treatment of prostate cancer. Leasing and subleasing arrangements include 21 acres of land, an option to sublease an additional 21 acres within 3 to 5 years and a sublease of DOE's Plasma Separation Process (PSP) equipment for 30 years. Theragenics has agreed to provide irradiation expertise and services and PSP technical assistance to Oak Ridge National Laboratory.

- **Interactive Pictures Corporation (IPIX),** continues to be the world leader in interactive imaging for the Internet and expanded its Oak Ridge facility.

Governor Sundquist speaks at the SNS Groundbreaking.

funded $1.3 billion research facility, will have a beneficial impact on the state of Tennessee in two major areas. First, the construction and operation of this large project will give an immediate economic boost to the region. Second, the SNS will play an important role as a flagship facility for ORNL, helping to ensuring the Laboratory's future in Tennessee.

Direct Economic Impacts

The SNS is expected to cost about $1.3 billion to build and to have an operating budget of about $100 million after construction.

During the 7-year construction period, the project should create about 460 primary jobs and 1,750 secondary jobs, for about 2,200 jobs each year. The primary jobs during construction will be labor and high-end craft jobs; the secondary jobs will mainly be in the business community.

Operation of the SNS (after construction) will result in the creation of 250 primary jobs and 1,640 secondary jobs, for about 1,890 total jobs each year. Annual sales tax revenues arising from ongoing activities are expected to be about $9 million per year. The primary jobs after

Congressman Wamp, Congressman Duncan, Governor Sundquist, Vice President Gore, Secretary Richardson, and Senator Frist participate in the SNS Groundbreaking at ORNL.

construction will be of very high quality—mostly professional scientific and technical jobs similar to those at ORNL today. The secondary jobs will be in the business community.

These estimates do not include jobs that may be created as new programs are developed to take advantage of the SNS (for example, in structural biology and other fields).

The SNS will create benefits in other ways:

- *Visitor impacts (users).* When the SNS is in operation, it is expected to draw more than 1,000 visitors to ORNL each year. These visitors will use the capabilities of the SNS for specialized research. They will generate about $1.5 million in additional income, translating into 75 additional secondary jobs and sales tax revenues of $250,000 annually.
- *Joint Institute for Neutron Sciences.* The State of Tennessee is providing funds to construct a facility that will house the Joint Institute for Neutron Sciences, a collaboration established by ORNL and the University of Tennessee (UT), that will serve several purposes:

  - It will generate new faculty positions in neutron science at UT, Vanderbilt and other Tennessee universities.
  - It will serve as an intellectual gathering place for researchers from universities and industry. An industrial affiliates program for industry users and a variety of university affiliations through the Southeastern Universities Research Association and ORAU are planned.
  - It will provide a gateway to other ORNL user programs and guests (probably leading to an increase in the current 4,500 visitors each year) and a means of stimulating industry spin-offs in the local area, much as the High Temperature Materials Laboratory constructed at ORNL in the 1980s attracted Coors Ceramics.

The Future of ORNL

When the SNS begins operating, ORNL and East Tennessee will be home to the world's finest resources for neutron sciences. The SNS will provide significant improvements over existing neutron facilities worldwide for many experiments. The High Flux Isotope Reactor (HFIR) at ORNL, which is now being upgraded to improve its capabilities, will remain the facility of choice for important classes of neutron scattering experiments requiring steady-state beams and for radioisotope production, materials irradiation and neutron activation analysis. The combination of the SNS, the HFIR and the Joint Institute for Neutron

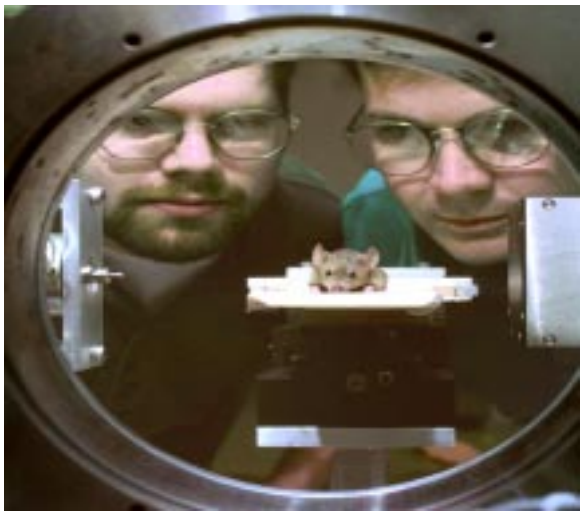
Sciences will place ORNL at the forefront of neutron science and help to ensure the Laboratory's future, thus preserving the economic benefits that result from ORNL's presence in Tennessee.

The National Transportation Research Center

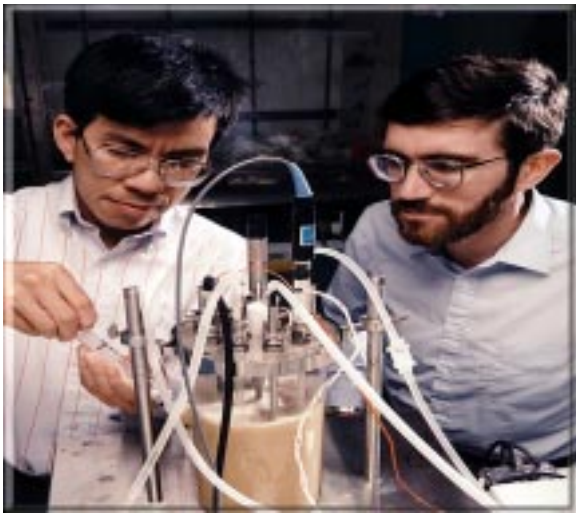
The National Transportation Research Center (NTRC) is a research partnership between ORNL, the University of Tennessee (UT), the Development Corporation of Knox County and DOE. The NTRC will address critical transportation R&D problems of national importance, facilitate collaboration between government and industry, and promote the attraction and retention of transportation-related industry to the East Tennessee region. Created through a Memorandum of Understanding among the DOE, UT and ORNL the purpose of the partnership is to jointly share research staff and resources for mutual benefit and the benefit of R&D sponsors. The combined transportation research activities of ORNL and UT represent nearly $70 million in funding from a variety of sponsors, including DOE. The NTRC will be located in a 85,000 square foot facility that is under construction in a new business park being developed by the Development Corporation of Knox County.

Oak Ridge National Laboratory

The Life Sciences Division (LSD) at ORNL is planning to rapidly expand its research funding over the next five years. Two primary events will make this possible. First, DOE is providing a $13.4 million new animal facility to be sited at the west end of ORNL. This new, state-of-the-art facility will provide the setting for cutting edge molecular biology and genetics research to take place. Because this will replace an antiquated 50-year old facility, more funding can be redirected to research rather than utilities and maintenance. The second event is the newly formed Tennessee Mouse Genome Consortium (TMGC). This is a collaborative research venture with Vanderbilt University Medical Center, University of Tennessee (Knoxville and Memphis), St. Jude Children's Research Hospital, Meharry Medical College and University of Memphis. The TMGC is positioned to bring tens of millions of additional research funding to Tennessee by development of mouse models for human genetic diseases. It is envisioned that ORNL will induce genetic mutations of mice at its new facility and other institutes will co-locate their research at ORNL to screen the mice for potential anatomical, physiological or behavioral abnormalities which are similar or identical to human genetic conditions (e.g., diabetics, obesity,



Kevin Behel (left, a UT graduate student, and Mike Paulus of ORNL's Instrumentation and Controls Division, demonstrate ORNL's MicroCat., which provides three-dimensional images with ten times the resolution of conventional imaging systems.



Nhuan Nghiem and Brian Davison of ORNL with succinic acid fermentation

propensity for cancer, etc.) This rapidly developing program will complement research at many other institutions around the nation and world in the Human Genome Project.

Russ Knapp, Saed Mirzadeh, and Emory Collins of ORNL are developing a new Modular technetium 99-M concentrator for medical applications.

Oak Ridge Associated Universities

The Appalachian region and other rural, less densely populated areas have typically been left behind when new telecommunications services become available. But access to competitively priced communications technologies is vitally important for economic development and quality of life as commerce, education and training, collaboration and information access increasingly require access to the Internet or other networks. Underserved regions run the risk of being unable to compete for their share of economic growth. By extension, these same areas are often underserved with respect to education and health care.

The Appalachian Wireless Corridor (AWC) is a large-scale and high-impact initiative designed to investigate, demonstrate, evaluate and disseminate wireless solutions for the telecommunications needs of the Appalachian region and similar underserved areas. Specifically, the AWC will:

- Cultivate a wide range of wireless technologies, services and applications to leapfrog the Appalachian region into the "Digital Millennium"
- Develop, integrate, deploy, and evaluate advanced wireless communications technologies in public and private sector partnerships
- Focus on public and private sector applications in three critical areas—manufacturing and commerce, health care and education, and training—for the purpose of improving economic welfare, jobs, competitiveness and quality of life
- Transfer regional solutions to national and international markets

Recently, the AWC initiated a university, government and industry partnership—facilitated and managed by ORAU—comprised of lead partners Georgia Tech, the University of Kentucky, the University of Tennessee, Virginia Tech, West Virginia University, ORNL and ORCMT. The consortium's current focus is a series of demonstration projects throughout the Appalachian region that will feature strategic partnerships with end users, local and state governments, colleges and universities, and product and service providers. These demonstration projects can provide broadband network access for:

- An "e-incubator" that serves electronic commerce start-ups and a remote "workport" facility in southwestern Virginia in an area where existing services are limited and prohibitively expensive;
- Distance learning for medical students undergoing clinical training in hospitals throughout Appalachia;
- Health monitoring and caregiver support for long-term care patients in remote areas and immediate monitoring and evaluation for emergency medical services in eastern Tennessee; and
- Manufacturers in northwest Georgia that will enable the incorporation of modern information technology into their processes and the retraining of workers.

An even more basic need of the people in the Appalachian region is health care. Rural, sparsely populated and poor areas are constantly struggling to attract and keep physicians. As a result, medical care is difficult to reach or often not even available. However, ORAU and the University of Tennessee Medical Center at Knoxville (UTMCK) are collaborating on a pilot project to evaluate the efficacy of telemedicine for enhancing medical care to underserved regions in rural areas of the state.

The project, called TeleHomeHealthCare, uses new technology to bring health care to people who live far from adequate medical facilities. To date, units have been placed in the residences of 30 Scott County persons suffering from congestive heart failure or adult onset diabetes. Physicians at UTMCK and epidemiologists at ORAU are collecting and evaluating data to determine how telemedicine improves the health of these chronically ill individuals. If successful, TeleHomeHealthCare will demonstrate a method to provide care from physicians and other health providers into these regions.

The potential for TeleHomeHealthCare goes far beyond the scope of the pilot project. It may someday connect specialists from all over the country or even the world to patients needing their expertise. The applications, therefore, are not limited to rural areas but could impact large medical centers as well. For example, ORAU hopes to use the technology to diagnose and monitor former DOE workers who suffer from chronic beryllium disease. Telemedicine may provide a means to bring the best medical care to these people regardless of their location.

VII. SUPPORTING REGIONAL INITIATIVES

DOE's commitment to being a good neighbor extends beyond business and education. In its ongoing efforts to improve the quality of life for Tennesseans, the Department undertakes various activities aimed at bolstering the regional economy. By working alongside local policymakers and community business leaders, DOE has provided local communities much needed resources to promote economic growth and development. Two of the primary mechanisms used to initiate and support regional economic initiatives are partnerships with local governments and local economic summits. Other activities provide linkages to state government and local organizations.

Partnerships with Local Governments

DOE ORO has demonstrated a commitment to local communities through its Memorandums of Cooperation and Memorandums of Understanding with local governments. These agreements establish a commitment to work with local governments to leverage DOE capabilities and assets in ways that are beneficial to the communities and to DOE. For example, April 1999 witnessed the opening of the Gateway Regional Visitor Center in Knoxville. The center is a cooperative effort of partners, which includes the City of Knoxville, DOE, the National Park Service, the Knoxville Convention & Visitors Bureau, Great Smoky Mountains Natural History Association and Lockheed Martin. DOE donated 42 items, primarily artifacts to the City of Knoxville for the center's exhibit.

Local Economic Summits

DOE ORO and DOE's OSTI have been major contributors in the planning and participation in Economic Summits held in Chattanooga, Knoxville, Oak Ridge and Kingsport. During 1999, the Summit was held in Knoxville. The Summits have led to several new initiatives involving ORO, local governments, universities, private industry and other federal agencies.

Other Activities

As a part of the Manufacturing Means Jobs, and the Manufacturing for the New Millennium initiatives, the State of Tennessee Department of Economic and Community Development (ECD) and ORCMT are now partnering to further extend the services of the Oak Ridge DOE facilities. Site visits by ECD and ORCMT representatives are making manufacturers within the State more aware of the resources available to them from the Y-12 Plant and ORNL.

ORCMT is now a member of a core team established by the Knoxville Area Chamber Partnership (KACP). The core team consists of organizations and governmental bodies which offer services to business to insure their success. This core team also includes the City of Knoxville, the Development Corporation of Knoxville, the Knoxville Utilities Board and the University of Tennessee Center for Industrial Services. Within this core team, visitation teams exist that will perform site visits to businesses in order to gain a better understanding of their activities and to share insights about incentives or programs that could be used to encourage their continued growth.

VIII. CONCLUSION

The State of Tennessee has benefitted from the presence of DOE for more than 50 years. The benefits garnered by the state are both quantitative and qualitative. Quantitative benefits include increases in personal income, employment and tax revenue. For FY 1999, the presence of DOE led to the generation of nearly $1.9 billion output, more than $1,177.1 million in personal income, $54.9 million in state and local sales tax revenue, and 37,753 full-time equivalent jobs. While these benefits are significant, additional contributions of DOE include a vast array of other activities which support the economic development of Tennessee and the nation.

Through technology partnerships, educational opportunities, community assistance programs and regional initiatives, DOE contributes to the overall productivity and competitiveness of business and industry in Tennessee, and improves the quality of the state's workforce. Many of these programs are aimed specifically at creating new jobs by attracting businesses to Tennessee, helping to build on Tennessee's economic advantages. While it is not possible to accurately quantify the total benefits in terms of income, jobs or tax revenue, it is evident that these programs significantly enhance the prosperity of the Tennessee regional economy.

APPENDIX

OVERVIEW OF THE ECONOMIC IMPACT MODEL

A major goal of this study is to quantify the benefits of on-going operations of DOE in Tennessee. The economic benefits garnered by the state are best measured in terms of the number of jobs created, the amount of personal income that accrues to residents and expansions in output. The key fiscal benefit is the additional sales tax revenue generated as a result of the increase in economic activity attributable to DOE.

These economic impact measures can be further broken down into *direct, indirect*, and *multiplier* (or *ripple*) effects. *Direct* effects are those attributable specifically to DOE itself. For example, the workers employed by DOE and its contractors represent the direct employment benefit of these facilities. Similarly, its expenditures on wages and salaries account for its direct income effect. An important strength of DOE activities in Tennessee is that the primary market for its services is the national economy, rather than a local economy. As with a manufacturing or financial firm that services a national market, this leads to an injection of *additional* purchasing power and creation of *additional* jobs and income. If DOE were simply competing with other in-state firms, there might be little or no net benefit for the state's economy. Direct fiscal effects also arise through a full range of taxes on businesses such as property and sales taxes from investments in real and personal property and spending on sales taxable items. In addition, there are other payments-in-lieu-of-taxes (PILT) and fees paid by DOE and its contractors which also contribute to the facility's direct fiscal benefit.

Indirect effects arise from DOE's acquisition of raw materials, services, supplies, and other operating services which help to support jobs in regional businesses, as well as expenditures by visitors to the facilities supported by DOE. For example, many of the business services utilized by DOE are purchased from firms within Tennessee. The overall effects of DOE increase as the share of raw materials and other inputs acquired within the region increases. Note that only the *value added* via the local production process, not the total *retail sale*, gives rise to additional economic benefits for Tennessee. Only the portion of the expenditure actually retained by an in-state vendor can be used in the calculation of the firm's indirect income benefit to the *state* economy. For example, if new computers are purchased from a supplier in Middle Tennessee but were actually manufactured outside the state, only the mark-up of the machines above cost would be counted as new income in the state. It is for this reason that retail sales, in isolation, represent a poor measure of economic benefits. Of course, state and local governments reap the benefits of sales tax on these sales, but this is accounted for separately. Thus, the size of a firm's indirect impact on regional jobs and incomes depends primarily on the dollar value of regionally purchased goods and services *and* whether these same goods and services are produced within the region or imported into the community.

The indirect effects arising from visitors to DOE facilities is somewhat unique in that most private sector firms would not be expected to attract many visitors. However, since some of the

facilities supported by DOE provide excellent research opportunities for visiting scientists and the public at large is interested in its science and energy research, the visitor effect has both a substantial quantitative and qualitative benefit. The quantitative impact of visitors to DOE facilities are derived from their expenditures on lodging, food, entertainment, and other expenditures incurred in the state during their visit. DOE provided the data on the number of guest scientists using ORNL facilities during the year and visitors to the American Museum of Science and Energy. Estimates of expenditures per day were based on recent surveys conducted by the Knoxville Convention and Visitor's Bureau.

Finally, *multiplier* (or *ripple*) effects are created as the additional income generated by the direct and indirect effects is spent and re-spent within the local economy. Note again that it is the additional purchasing power from *outside* the community—the ability to export the product or service—that gives rise to the direct and indirect effects; and, hence, the ripple or multiplier effects as well. For example, part of the wages received by a firm's employees will be spent on retail sales. If the employee goes shopping in Nashville, a portion of the sales receipt will be used to pay local employees of the retail establishments. These employees will in turn spend a portion of their income in the state on groceries, housing, etc., thus adding to the amount of state-wide personal income attributable to the firm's activities. However, during each of these subsequent rounds of spending, a large portion of the income generated leaks out of Tennessee's economy through taxes, savings, and spending outside the state, thereby diminishing the increment to total state income attributable to these firms.

Total economic impacts attributable to increased business activity are computed as the sum of the direct, indirect, and multiplier effects. The TILI model was developed by the Center for Business and Economic Research at the University of Tennessee to calculate economic impacts of firm activity using the RIMS II multipliers specific to Tennessee (available from U.S. Department of Commerce). Using the expenditure data provided by DOE and its contractors, the model allows calculation of the output, income, employment, and sales tax revenue impacts accruing in the State of Tennessee.

ENDNOTES

1. Profiles provided by DOE and its contractors.