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EMPLOYMENT IN NUCLEAR ENERGY ACTIVITIES, 1977

A HIGHLIGHTS REPORT

Published May 1979

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**U.S. DEPARTMENT OF ENERGY
Assistant Secretary for
Intergovernmental and Institutional Relations
Office of Education, Business, and Labor Affairs
Labor Affairs and Manpower Assessment Division**

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Foreword

This report presents highlights from the 1977 Survey of Employment in Nuclear Energy Activities. This was the fifteenth survey in a series initiated in 1960 under the direction of the Atomic Energy Commission. The surveys were continued under the Energy Research and Development Administration, which replaced the Commission, and are being directed now by the Department of Energy, which absorbed the Energy Research and Development Administration.

The surveying, as in prior years, was performed by the Bureau of Labor Statistics, U.S. Department of Labor. We wish to express our appreciation to them and to the many organizations and individuals who contributed to the survey.

Lawrence G. Stewart, Director
Office of Education, Business,
and Labor Affairs

February 1979

ACKNOWLEDGEMENTS

This report was prepared by June S. Chewning, Manpower Analyst in the Division of Labor Affairs and Manpower Assessment, under the direction of Norman Seltzer, Chief, Manpower Assessment Program.

The survey was conducted by the Bureau of Labor Statistics under the general supervision of Brian MacDonald, OES Survey Coordinator, and Neal Rosenthal, Acting Chief, Division of Occupational Outlook.

INTRODUCTION

In spite of the uncertainties in the nuclear energy field, employment in nuclear activities increased by nearly 15 percent between July 1975 and July 1977, according to the latest Bureau of Labor Statistics survey conducted for the Department of Energy. The survey covers employment in 21 industrial sectors comprised of Government-owned facilities operated by 57 private contractors, and 874 privately-owned establishments, including 21 not-for-profit institutions. Not included in the survey are employees of Federal, state, and local governments; uranium mining; construction, except for reactors; medical institutions; or educational institutions not performing work connected with the Department of Energy.

The surveys were conducted annually from 1960 through 1971, and biennially since 1971. This *Highlights Report* is based on the basic results of the 1977 survey and shows some significant trends. A report based on more thorough analysis will be issued later.

HIGHLIGHTS

Nearly 227,000 persons were employed in the nuclear energy field in July 1977. Fifty-seven percent were in private establishments, including one percent in not-for-profit organizations, and 43 percent were in Government-owned contractor-operated facilities.

Technicians and engineers, who each made up 18 percent of employment, were the largest occupational groups. Skilled craftworkers followed next with 17 percent, scientists comprised seven percent, and managers and other professional employees together made up 12 percent.

See Appendix, Table I, for detail.

**Employment in
Nuclear Energy Activities, 1977
(Total-227,000)**

EMPLOYMENT SECTOR

OCCUPATION GROUP

¹Includes not-for-profit organizations

²DOE's Government-owned contractor-operated facilities

Source: Bureau of Labor Statistics & Department of Energy

Of the 55,800 scientists and engineers, 22,900, or 41 percent, were in research and development.

Only 16 percent of the scientists and engineers employed in private establishments were in research and development, compared to 74 percent of those employed in Government-owned facilities, where research and development was concentrated.

See Appendix, Table I, for detail.

**Employment of Engineers and Scientists in Nuclear
Energy Activities, Research and Development, and
Non-Research and Development, by Type of
Employer, 1977**

All Scientists and
Engineers 55,800

GOCO* Scientists and
Engineers 24,300

Private Establishments**
Scientists and Engineers
31,500

*DOE's Government-owned contractor-operated facilities

**Includes not-for-profit organizations

Source: Bureau of Labor Statistics & Department of Energy

Among the 10 Federal regions, Region 4, made up of the southeastern states, with 21 percent of the nuclear work force, contained the highest concentration of workers. The sparsely populated Region 8 had the fewest workers.

The two states which employed the most nuclear workers were California, with 14 percent, overwhelmingly in the private sector, and Tennessee, with 10 percent, primarily in Government-owned contractor-operated facilities.

See Appendix, Table II, for detail.

Employment in Nuclear Energy Activities, By Federal Regions, 1977

Region	Total**	Engineers	Scientists	Technicians
All*	227,000	40,800	15,000	41,600
1	13,800	3,500	700	3,200
2	19,000	4,700	1,200	3,800
3	27,100	6,200	1,000	5,600
4	47,100	6,000	2,500	7,600
5	32,300	5,300	2,000	5,800
6	20,000	2,800	2,300	4,400
7	7,500	1,000	400	700
8	4,800	300	400	500
9	36,600	7,600	3,100	7,100
10	18,900	3,400	1,300	2,900

*Detail may not add to totals because of rounding

**Includes employment in other occupations not shown separately

Source: Bureau of Labor Statistics & Department of Energy

The largest industrial sector was the design and engineering of nuclear facilities, which employed 16 percent, followed closely by firms engaged in the design and manufacture of reactors and reactor components, which employed 15 percent. The weapons development and production sector employed 13 percent.

The industrial sectors which experienced the greatest numerical growth since 1975 were also those associated directly with the production of electrical power. These included, in addition to the two fuel cycle sectors mentioned above, the following sectors: reactor operation and maintenance, processing and enrichment of reactor fuel, reprocessing and disposal of irradiated material, and production of special materials for use in reactors.

All other sectors which are connected with the nuclear fuel cycle increased, including those associated with health and safety, which saw the largest percentage increase. Employment in both environmental research and health physics firms increased by more than 100 percent over 1975.

The greatest decreases were in those sectors engaged primarily in reactor research, weapons, and nuclear energy research.

See Appendix, Tables III and IV, for detail.

Employment in Nuclear Energy Activities, By Industrial Sector, 1977

Source: Bureau of Labor Statistics & Department of Energy

Note: All employment in an installation is reported under the sector which corresponds to the major activity of that installation.

Engineers were engaged primarily in the design of nuclear facilities, where 31 percent were employed. The next largest group of engineers were in reactor design and manufacture.

Almost one-third of the scientists were in the research and development in nuclear energy sector. The second largest group of scientists were in weapons development and manufacturing.

Twenty-two percent of the technicians were employed in the design of nuclear facilities sector, with the second largest group employed in weapons.

See Appendix, Tables III and IV, for detail.

Employment in Nuclear Energy Activities, By Industrial Sector, 1977

(Engineers, Scientists, and Technicians)

Note: All employment in an installation is reported under the sector which corresponds to the major activity of that installation.
Source: Bureau of Labor Statistics & Department of Energy

Of the 931 establishments engaged in nuclear activities, 55 which employed more than 1,000 persons each, accounted for 66 percent of total employment. Nine establishments, eight of them Government-owned facilities, employed more than 5,000 each. Private establishments predominated in all other size categories. Well over half of the establishments (534) employed less than 50 employees each, and accounted for less than four percent of all workers.

Distribution of Nuclear Establishments and Employment by Size of Establishment, 1977

<u>Size of Establishment (Employees)</u>	<u>Number of Establishments</u>	<u>Percent Distribution</u>	<u>Employment</u>	<u>Percent Distribution</u>
Total	931	100%	227,000	100%
1-9 employees	234	25	1,100	*
10-49 "	300	32	7,100	3
50-99 "	125	13	8,800	4
100-499 "	182	20	38,900	17
500-999 "	35	4	23,300	10
1000-4999 "	46	5	94,400	42
5000+ "	9	1	53,400	24

*Less than 1/2 of one percent

Source: Bureau of Labor Statistics and Department of Energy

While private employment has shown constant increase since 1971, employment in the Government-owned contractor-operated (GOCO) facilities declined in 1973, then started increasing. By 1977 GOCO employment had surpassed the 1971 level. Whereas private establishments represented only 39 percent of nuclear employment in 1971, they represented 57 percent in 1977.

Trends in Total Nuclear Employment and Employment in Government-Owned Contractor-Operated (GOCO) Facilities, 1971-1977

Source: Bureau of Labor Statistics & Department of Energy

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APPENDIX

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Table I

Occupational Distribution of Nuclear Employment, 1977
(Total and R&D by Type of Establishment)

Occupations	All Sectors		Non-Profit		Private		GOCO*	
	Total Employment	R&D Employment	Total Employment	R&D Employment	Total Employment	R&D Employment	Total Employment	R&D Employment
Total	226,954	49,850	2,701	1,979	125,658	7,682	98,595	40,189
Managers	13,602	3,006	150	100	8,552	857	4,900	2,049
Chemical engineers	2,401	1,147	6	6	822	195	1,573	946
Civil engineers	3,829	381	9	4	3,345	144	475	233
Electric and electronic engineers	7,799	3,107	96	89	4,326	522	3,377	2,496
Mechanical engineers	11,544	4,187	110	74	7,349	899	4,085	3,214
Nuclear and reactor engineers	5,647	1,517	40	39	4,097	236	1,510	1,242
Metallurgical engineers	1,153	561	10	9	679	131	464	421
Other engineers	8,473	1,974	104	83	5,637	421	2,732	1,470
Mathematicians	1,906	1,169	19	15	431	127	1,456	1,027
Chemists	3,579	2,294	88	87	985	303	2,506	1,904
Geologists and geophysicists	511	177	2	2	207	18	302	157
Physicists	4,198	3,588	174	166	812	404	3,212	3,018
Metallurgists	664	406	10	10	290	52	364	344
Other physical scientists	810	506	32	1	258	111	520	394
Biological scientists	1,566	1,237	372	371	423	115	771	751
Medical scientists	283	187	21	20	120	39	142	128
Health scientists	1,000	141	13	4	407	29	580	108
Other life scientists	453	312	111	110	113	13	229	189
Other professional workers	13,455	2,240	69	11	5,942	471	7,444	1,758
Draftsmen	9,636	1,290	72	66	7,714	216	1,850	1,008
Electrical and electronics technicians	6,642	2,792	131	117	2,894	315	3,617	2,360
Other engineering technicians	8,298	2,549	352	304	4,722	408	3,224	1,837
Physical science technicians	2,708	1,095	45	15	649	140	2,014	940
Life science technicians	753	336	56	47	328	120	369	169
Health physics technicians and radiation monitors	2,391	350	9	5	1,435	19	947	326
Senior nuclear reactor operators	920	66	3	1	824	17	93	48
Nuclear reactor operators	1,674	86	9	0	922	60	743	26
Auxiliary reactor operators	1,498	65	2	0	1,297	62	199	3
Other technicians	7,127	2,640	22	19	4,023	238	3,082	2,383
Welders with nuclear certification	5,438	43	5	0	4,666	37	767	6
Other skilled craft workers	32,157	2,939	113	76	17,435	267	14,609	2,596
Clerical workers	21,519	4,518	344	98	10,297	376	10,878	4,044
All other workers	43,320	2,944	102	30	23,657	320	19,561	2,594

* Government-owned contractor-operated

Table II

Employment in Nuclear Energy Activities by Federal Region and Occupational Group, 1977

Regions	Occupational Groups										
	Managers	Engineers	Mathema- ticians	Physical Scientists	Life Scientists	Other Professional Workers	Technicians	Skilled Craft Workers	Clerical Workers	All Other Workers	Total All Groups
All regions	13,602	40,846	1,906	9,762	3,302	13,455	41,647	37,595	21,519	43,320	226,954
Region 1 . . .	841	3,509	33	424	223	461	3,164	1,609	1,152	2,352	13,768
Region 2 . . .	1,032	4,713	88	762	393	734	3,756	2,427	1,891	3,171	18,967
Region 3 . . .	1,870	6,238	204	554	226	1,197	5,648	4,580	2,190	4,380	27,087
Region 4 . . .	2,021	5,989	440	1,357	750	3,130	7,584	10,694	3,932	11,157	47,054
Region 5 . . .	1,934	5,303	170	1,335	502	1,555	5,843	6,336	2,531	6,783	32,292
Region 6 . . .	1,242	2,805	357	1,742	240	1,084	4,430	2,172	2,658	3,244	19,974
Region 7 . . .	251	991	21	337	17	765	689	1,033	509	2,932	7,545
Region 8 . . .	441	324	9	348	30	272	501	1,002	524	1,368	4,819
Region 9 . . .	2,478	7,552	476	2,123	536	2,538	7,128	5,638	3,771	4,341	36,581
Region 10 . .	1,492	3,422	108	780	385	1,719	2,904	2,104	2,361	3,592	18,867

Source: Bureau of Labor Statistics and Department of Energy

Table III

Employment by Nuclear Industrial Sector, 1977
Type of Establishment, Total and Research and Development

<u>Industrial Sector</u>	<u>All Employment</u>	<u>R&D</u>	<u>Private</u>	<u>R&D</u>	<u>GOCO**</u>	<u>R&D</u>
All sectors	226,954	49,850	129,359*	8,601*	98,595	40,189
Uranium milling	1,926	12	1,926	12	0	0
Processing and enrichment of reactor fuel	13,729	389	553	6	13,176	383
Production of special materials for use in reactors	3,799	65	3,791	57	8	8
Reactors and reactor component design and manufacture	34,084	5,211	28,549	1,529	5,535	3,682
Fuel fabrication	2,739	85	2,739	85	0	0
Transportation of nuclear materials	845	72	845	72	0	0
Chemical processing and disposal of irradiated materials	9,528	868	843	9	8,685	859
Design and engineering of nuclear facilities	36,893	618	36,128*	378*	765	240
Reactor operations and maintenance	17,270	421	15,095*	77*	2,175	344
Radioisotopes	2,250	301	2,250	301*	0	0
Design and manufacturing of instruments, gauges, and control devices	8,056	851	7,867	846	189	5
Accelerators	5,771	4,107	639	55	5,132	4,052
Environment and ecological research and evaluation	1,485	338	1,307*	326*	178	12
Biology and medical research	1,355	849	1,170*	741*	185	108
Reactor research, development and evaluation	5,378	3,534	1,918	1,057	3,460	2,477
Commercial laboratory services	1,325	70	1,323*	70*	2	0
Health physics and industrial safety	461	43	461	43	0	0
Weapons development and production	30,263	15,917	106	32	30,157	15,885
Research and development in nuclear energy	20,690	13,147	2,261*	2,021*	18,429	11,126
Industrial radiography	979	2	979	2	0	0
Miscellaneous	28,128	2,950	17,609*	1,942*	10,519	1,008

*Includes not-for-profit

**Government-owned contractor-operated

Source: Bureau of Labor Statistics and Department of Energy

Table IV

Trends in Employment by Nuclear Industrial Sector, 1975-1977

<u>Sectors</u>	<u>1975 Employment</u>	<u>1977 Employment</u>	<u>Numerical Change</u>	<u>Percentage Change*</u>
All	197,500	227,000	29,500	+ 15
Design and engineering of nuclear facilities	34,200	36,900	+ 2,700	+ 8
Reactor and reactor component design and manufacturing	27,100	34,100	+ 7,000	+ 26
Weapons development and production	31,700	30,300	- 1,400	- 4
Research and development in nuclear energy	22,000	20,700	- 1,300	- 6
Reactor operation and maintenance	12,700	17,300	+ 4,600	+ 36
Processing and enrichment of reactor fuel	11,400	13,700	+ 2,300	+ 21
Chemical reprocessing and disposal of irradiated materials	8,600	9,500	+ 900	+ 11
Design and manufacturing of instruments, gauges, and control devices	8,300	8,100	- 200	- 2
Accelerators	6,700	5,800	- 900	- 13
Reactor research and evaluation	7,300	5,400	- 1,900	- 27
Production of special materials for use in reactors	2,400	3,800	+ 1,400	+ 59
Fuel fabrication	3,700	2,700	- 1,000	- 26
Radioisotopes	2,500	2,300	- 200	- 9
Uranium milling	1,700	1,900	+ 200	+ 13
Environmental and ecological research and evaluation	600	1,500	+ 900	+ 134
Commercial laboratory services	1,350	1,300	- 50	- 2
Biology and medical research	2,000	1,400	- 600	- 33
Industrial radiography	1,900	1,000	- 900	- 49
Transportation of nuclear materials	700	800	+ 100	+ 13
Health physics and industrial safety	200	500	+ 300	+ 165
Miscellaneous	10,500	28,100	+ 17,600	+ 168

*Percentages are based on non-rounded numbers.

NOTE: All employment in an installation is reported in the sector which best describes the major activity of the installation.

Source: Bureau of Labor Statistics and Department of Energy

U.S. Department of Labor

Form Approved
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(This request for information relates to:)

General Instructions

Telephone (include Area Code) _____

Employment

23

5. Occupational Employment in Nuclear or Nuclear Energy-Related Activities (As of the payroll including July 12, 1977)

In the occupations listed below, classify each employee working in nuclear or nuclear-energy related activities in the occupation in which he spent most of his time. Do not classify an employee in more than one occupation. Employees reported in column (1) who spend 50% or more of their time in research and development activities also should be reported in column (2). *Definitions are provided on page 4.*

Occupation	As of July 12, 1977			Occupation	As of July 12, 1977		
	Occupation Code	Total	R&D*		Occupation Code	Total	R&D*
	(1)	(2)			(1)	(2)	
MANAGERS (see definition)	10000			TOTAL TECHNICIANS (see definition)			
TOTAL ENGINEERS (see definition)				Draftsmen	32003		
Chemical Engineers	21003			Electrical and Electronics Technicians	32004		
Civil Engineers	21004			All Other Engineering Technicians	32900		
Electrical and Electronics Engineers	21005			Physical Science Technicians	33001		
Mechanical Engineers	21008			Life Science Technicians	33002		
Nuclear and Reactor Engineers (see definition)	21015			Health Physics Technicians and Radiation Monitors	33003		
Metallurgical Engineers	21016			Senior Nuclear Reactor Operators (see definition)	34049		
All Other Engineers	21900			Nuclear Reactor Operators (see definition)	34050		
TOTAL MATHEMATICIANS (see definition)	22100			Auxiliary Reactor Operators (see definition)	34051		
TOTAL PHYSICAL AND EARTH SCIENTISTS (see definition)				All Other Technicians	39000		
Chemists	22201			WELDERS WITH NUCLEAR CERTIFICATION (see definition)	58015		
Geologists and Geophysicists	22202			ALL OTHER SKILLED CRAFT WORKERS (see definition)	59001		
Physicists	22205			CLERICAL WORKERS (see definition)	60000		
Metallurgists	22206			ALL OTHER WORKERS who spend more than 50% of their time in nuclear related activities (service workers, sales workers, laborers, operatives, and all other workers not classified above). (see definition)	88999		
All other Physical Scientists	22299						
TOTAL LIFE SCIENTISTS (see definition)							
Biological Scientists (see definition)	22303						
Medical Scientists (see definition)	22305						
Health Physicists (see definition)	22307						
All Other Life Scientists	22399						
ALL OTHER PROFESSIONAL WORKERS (see definition)	29000						

SUMMATION INSTRUCTIONS: The sum of all employment in nuclear or nuclear energy-related activities, by occupation, entered in column (1) above must equal the entry in item 4.2.

***RESEARCH AND DEVELOPMENT**

Include in this function employees who spend the greatest proportion of their time performing, managing, or administering basic and applied research in engineering, mathematics, physical, life (including medicine), and other sciences; and in the design and development of prototypes and processes. For purposes of this study, research and development *includes* the following types of activities: (a) Pursuit of planned research of new knowledge, whether or not the research has reference to a specific application. (b) Application of existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses. (c) Application of existing knowledge to problems involved in the improvement of an existing product or process.

6. Personnel Supply

- a. Is your establishment currently having difficulty in hiring personnel to fill vacancies for any occupations listed in item 5? Yes ☐ (611) No ☐ (612)
- b. If yes, please list all such occupations by the codes found in item 5.

Remarks

7. Source of Funds for Payroll Support

Indicate below the percentage of Engineers, Mathematicians, and Physical and Life Scientists shown in item 5 whose work is supported by Federal Government funds, own organization funds, and other funds. Exclude all additional employees listed in item 5 from these calculations.

Source of Funds

	7.1		7.2		7.3		7.4
	Percent		Percent		Percent		Percent
Federal Government		Own Organization		Other		Total	100%

NOTE: For this survey the production of standard items (e.g., shelf or vendor items) for the Federal Government is *not* considered work performed for the Federal Government.

8. Employment in Nuclear or Nuclear Energy-Related Activities by Industrial Segments

Distribute total employment in the Nuclear or Nuclear Energy-Related Activities (item 4.2) as of July 12, 1977, as follows:

Column 1 List each industrial segment (see definition A) in descending order of the number or proportion of employees in each segment as of July 12, 1977. The principal segment of the establishment should appear on line 8.1.

Column 2 List the segment number for each activity shown in column 1. (See definition A.)

Columns 3 & 4 Distribute the total employment reported in item 4.2 by segment in column 3, if available. If employment data are not available, show a percentage distribution by segment in column 4 of the total employment reported in item 4.2. There should be an entry in *either* columns 3 or 4 for every segment shown in columns 1 and 2. The total of column 4, if used in lieu of column 3, should equal 100%.

	Industrial Segment Name (1)	Industrial Segment No. (2)	Distribution of Employees Engaged in Nuclear or Nuclear Energy-Related Activities	
			Number of Employees (3)	Percent of Total (4)
8.1	*			
8.2				
8.3				
8.4			Total = Item 4.2	100%

*Principal nuclear or nuclear energy-related activity

Definitions for the Survey of Occupational Employment in Nuclear or Nuclear Energy-Related Activities

A. Industrial Segments. Nuclear or nuclear energy-related activities are comprised of the following industrial segments:

Code Description

- Uranium Milling:** Reduction of uranium ores to concentrates (*exclude* mining).
- Processing and Enrichment of Reactor Fuel Materials:** Refining of reactor fuel concentrates and conversion of refined fuel concentrates and recovered U-235/U-238 to uranium hexafluoride, enrichment of these fuel materials in the isotope U-235, followed by conversion to oxides, carbides or other fuel compositions.
- Production of Special Materials for Use in Reactors:** Preparation and treatment of core structural and cladding materials such as zirconium, control rod materials such as hafnium and boron, and moderators such as heavy water and graphite.
- Reactor and Reactor Component Design and Manufacturing:** The design and/or manufacture of nuclear reactors and reactors components, including control rods and drives for power, test, and research purposes and missile and space applications. Includes the assembly, testing, and disassembly of reactors and the testing of materials for reactor usage.
- Fuel Fabrication:** Production of fuel forms (pellets, coated particles, etc.), and encapsulation of fuel forms in fuel assemblies.
- Transportation of Nuclear Materials:** Packaging and interfacility transportation of special nuclear materials, fabricated fuel assemblies, irradiated fuels assemblies, and other radioactive materials.
- Chemical Reprocessing and Disposal of Irradiated Materials:** Separation and recovery of fertile and fissile fuel materials, and of by-product materials includes purification, concentration and packaging of fuel and by-product materials, storage and solidification of high-level wastes, collection, packaging, and disposal of low-level wastes.
- Design and Engineering of Nuclear Facilities:** Design and engineering of all nuclear facilities with the exception of those included in segments 4 (reactor and reactor components), 5 (fuel fabrication), 11 (nuclear instruments, gauges and control devices), and 12 (accelerators).
- Nuclear Reactor Operation and Maintenance:** Operation and maintenance of nuclear power production, test, and research reactors. Includes operation and maintenance of auxiliary systems for supply and treatment of power, air, water, etc.
- Radioisotopes:** Manufacture, processing, and packaging of radioisotopes, including radiochemicals, radiopharmaceuticals, and other radioactive labeled compounds. Includes irradiation of medical supplies, food, and agricultural products, and of commercial materials. Excludes in-plant processing incidental to another activity.
- Design and Manufacture of Nuclear Instruments, Gauges, and Control Devices:** Design and manufacture of hot cell and laboratory instruments and monitoring and control devices, radiographic and teletherapy equipment, activation analysis systems, etc.
- Accelerators:** The design, engineering, manufacturing and/or construction, operation/maintenance, and research and development conducted for all classes of accelerators.
- Environmental and Ecological Research and Evaluation:** Activities to preserve, improve, or restore the natural environmental and ecological balance. Types of activities covered are: thermal effects and effects of irradiation on plants, animals, and marine life.
- Biology and Medical Research:** Research on the interaction of radiation with biological systems; use of radiation and radioisotopes in diagnosis and treatment of illnesses; study of effects of low-level radiation and ingestion of toxic and radioactive materials on biological systems.
- Reactor Research, Development and Evaluation:** Activities relating to research, development, and demonstration of new fission reactor systems, components, fuels, moderators, etc. Includes development, conduct, evaluation and analysis of reactor safety tests.
- Commercial Laboratory Services:** Provides laboratory service activities for other establishments. Examples of services are: activation analysis, film badge service, mass spectrometry, radiography, physical testing, etc.
- Health Physics and Industrial Safety:** Establishes, evaluates, and monitors working conditions for compliance with industrial safety and radiation exposure standards.
- Weapons Development and Production:** Develops, designs, tests, and fabricates nuclear weapons.
- Research and Development in Nuclear Energy:** Investigations directed toward the development of new or fuller scientific knowledge of the subject studies. It also covers systematic application of scientific knowledge directed toward the creation of new or substantially improved processes, procedures, techniques, etc. It excludes research and development reported under segments 12, 13, 14, and 15 which are to be reported separately.
- Industrial Radiography:** Commercial radiographic services. Exclude in-plant radiography where its use is incidental to another activity.
- Miscellaneous:** Activities not classified in any of the above segments such as: consultant services, laundry services, leasing services, etc.

Definitions for the Survey of Occupational Employment in Nuclear or Nuclear Energy-Related Activities—Continued

B. Occupational Definitions

Employees in the specialized occupations covered by this survey should be counted on a "Working As" basis, as of the date of the report (July 12, 1977), regardless of field of degree or whether they hold a college degree. For example, an employee trained as an Engineer but working as a Mathematician as of the date of the report should be reported as a Mathematician. Similarly, an employee trained as a Life Science Technician but working as a Health Physics Technician as of the date of the report should be reported as a Health Physics Technician. Include all employees in research and development, production, management, technical service, sales, and other positions which require them to use the indicated level of knowledge in their work.

Managers (Occ. Code 10000): Include persons concerned with policy making, planning, organizing, staffing, directing, and/or controlling activities that are common to many types of organizations, usually through subordinate supervisors who directly supervise the activities of the company or establishment work force and/or professional or technical management.

Engineers (Occ. Code 21000): Count all persons actually engaged in engineering work at a level which requires knowledge of engineering equivalent at least to that acquired through completion of a 4-year college course, regardless of whether they hold a college degree. *Exclude* persons trained in engineering, but currently employed in positions not requiring the use of such training.

Nuclear and Reactor Engineers (Occ. Code 21015): Count all engineers who are concerned with the release, control, and use of all types of energy from nuclear sources, including the design and development of fission or fusion reactors for the controlled release of nuclear energy, and the applications of radiation. *Exclude* Nuclear Reactor Operators.

Mathematicians (Occ. Code 22100): Count only those persons whose positions require a knowledge of mathematics equivalent at least to that acquired through a 4-year college course with a major in mathematics and who spend the greatest proportion of their time in development or application of mathematical techniques, regardless of whether they hold a college degree. Include Actuaries, Statisticians, and Computer Programmers *only* if they specialize in mathematical techniques. *Exclude* Accountants.

Physical and Earth Scientists (Occ. Code 22200): Count all Chemists, Physicists, Metallurgists, Geologists, Geophysicists, and other Physical and Earth Scientists who are actually engaged in scientific work at a level which requires a knowledge of the physical sciences equivalent to that acquired through completion of a 4-year college course with a major in one of the physical science fields, regardless of whether they hold a college degree. *Exclude* persons trained in the physical sciences but currently employed in positions not requiring the use of such training.

Life Scientists (Occ. Code 22300): Count all Health Physicists, Medical Scientists, Agricultural Scientists, Biological Scientists, and other Life Scientists who are actually engaged in scientific work at a level which requires a knowledge of the life sciences equivalent to that acquired through completion of a 4-year college course with a major in one of the life science fields, regardless of whether they hold a college degree. *Exclude* persons trained in the life sciences but currently employed in positions not requiring the use of such training. *Exclude* Psychologists. See definitions for Health Physicists and Biological Scientists.

Biological Scientists (Occ. Code 22303): Count all persons who meet the general requirements for "Life Scientists" and who spend the greatest proportion of their time in scientific work dealing with life processes other than those classified in the agricultural and medical sciences. *Include* Pathologists, Microbiologists, Pharmacologists, Bacteriologists, Toxicologists, Botanists, Zoologists, etc.

Medical Scientists (Occ. Code 22305): Count only those Physicians, Dentists, Public Health Specialists, Pharmacists, and members of other scientific professions who meet the general requirements for "Life Scientists" and who are concerned with the understanding of human diseases and improvements of human health, and spend the greatest proportion of their time in clinical or laboratory investigation or other research, production, technical writing, and related activities. *Exclude* from this category all practitioners—that is, those Medical Scientists who spend the greatest proportion of their time providing care to patients, dispensing drugs or services, or in diagnosis, etc. Persons working as Pathologists, Microbiologists, Pharmacologists, etc., should be *excluded* from the figures for Medical Scientists and *included* in the figures for Biological Scientists.

Health Physicists (Occ. Code 22307): Count all persons who meet the general requirements for "Life Scientists or Engineers" and who are concerned with programs to protect plant and laboratory personnel from radiation hazards; develop inspection standards, radiation exposure limits, and decontamination procedures; conduct tests to insure that radiation is not in excess of permissible limits; and design or modify such health physics equipment as detectors and counters to improve radiation protection.

All Other Professional Workers (Occ. Code 29000): Include all other workers concerned with such fields as law, education, labor and business relations requiring a substantial educational preparation, usually at the university level.

Technicians (Occ. Code 30000): Count all persons actually engaged in technical work at a level which requires knowledge of engineering, mathematical, and physical or life sciences, comparable to that acquired either through study at technical institutes, junior colleges, or other formal post-high school training *less extensive than a 4-year college course* or through equivalent on-the-job training or experience. Some typical job titles are Draftsman, Surveyor, Laboratory Assistant, Physical Science Aid, and Electronic Technician. All persons in positions which require the indicated level of knowledge should be counted, regardless of job title or department in which employed. **Computer Programmers** who meet the above definition of Technicians should be reported under "All Other Technicians" Occupation Code 39000. *Exclude* those persons whose positions require knowledge of training consistent with the foregoing definitions of Engineers, Mathematicians, or Scientists, and report them in the appropriate occupational category on the questionnaire. Also, *exclude* all craftsmen such as Machinists and Electricians.

Nuclear Reactor Operators (Occ. Codes 34049, 34050, 34051): Count all persons who spend the greatest proportion of their time in (a) the actual manipulation of the controls of a nuclear reactor, or (b) directing others in the manipulation of such controls. Under Nuclear Regulatory Commissions (NRC) licensing regulations, the former are referred to as "operators" and the latter as "senior operators". Count as "auxiliary operators," those persons who are not licensed operators but work under the supervision of either nuclear or senior operators while preparing to fulfill NRC requirement to become licensed operator. A nuclear reactor is an apparatus, other than a nuclear weapon, designed or used to sustain nuclear fission and self-supporting chain reaction (e.g., power reactors, test reactors, production reactors, research reactors, critical assemblies). *Exclude* persons who spend the greatest proportion of their time as Nuclear Reactor Engineers or in performing other functions of a professional, scientific or engineering nature.

Welders With Nuclear Certification (Occ. Code 58015): Count all persons certified under NRC requirements who join surface, or otherwise make or repair structures or parts, using gas or electric welding, soldering, or brazing equipment with or without filler material; fusing to join or shape lead products or parts, using a gas torch; cutting or perforating metal, using gas or electric welding equipment.

All Other Skilled Crafts and Kindred Workers (Instrument Repairer; Painter, Maintenance; Patternmaker, Metal Die Setter; Die Sinker; Etc.) (Occ. Code 59001): Include all other skilled crafts and kindred workers in production, maintenance, construction, repair, powerplant, and material handling occupations that predominately require a thorough and comprehensive knowledge of processes involved in the work, the exercise of considerable independent judgment, usually a high degree of manual dexterity, and in some instances, extensive responsibility for valuable product or equipment. Workers in these occupations usually become qualified by serving apprenticeships or completing extensive training periods. *Occupations should be counted as skilled if the specific vocational preparation required to perform them involves training or other preparation of more than two years.*

Clerical Workers (Occ. Code 60000): Include office and plant clerical personnel. *Office clerical work* involves preparing, transcribing, transferring, systematizing, and preserving communications and records; collating accounts and distributing information. Typical examples are: Secretaries; Stenographers; Typists; File Clerks; Office Machine Operators; Bookkeepers; Cashiers; Messengers; Telephone Operators; etc. *Plant clerical work* involves planning, coordinating, or expediting of production and the flow of work; or the clerical aspects of receiving, storing, issuing, or shipping of materials merchandise, supplies, or equipment.

All Other Workers (Occ. Code 88999): Include service and sales workers, operatives, laborers, and all other workers not classified above.