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An Interim Report to the
Office of Science and Technology Policy

From the
Committee on the Education and Employment
of Women in Science and Engineering

Commission on Human Resources
National Research Council

NATIONAL
ACADEMY OF
SCIENCES

Washington, D.C. 1980

NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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PREFACE

The Committee on the Education and Employment of Women in Science and Engineering was appointed by the Commission on Human Resources in December 1974. Its charge was to examine the social and institutional constraints that limit the participation of women in science and engineering and to serve as a focus for efforts to improve their utilization.

Since September 1977, the Committee's studies have been supported by the Office of Science and Technology Policy, Executive Office of the President. The Committee's first report to the OSTP entitled Climbing the Academic Ladder: Doctoral Women Scientists in Academe was published in April 1979. Included in the report were recommendations for improved utilization of women in faculty, postdoctoral, and advisory appointments.

This second, briefer report concerns the status of women scientists and engineers in private industry and the federal government. In particular, it examines the extent to which their employment situation has improved since the advent of affirmative action mandates. The report consists primarily of analyses of the available data on doctoral women. A more intensive study, examining industry hiring of women scientists at all degree levels and recommendations concerning their recruitment is now being planned.

Since its inception, the Committee has been chaired by Dr. Lilli S. Hornig, Executive Director, Higher Education Resource Services, Wellesley College.

ACKNOWLEDGMENTS

The Committee wishes to thank Gilbert S. Omenn, Associate Director for Human Resources and Social and Economic Services, Office of Science and Technology Policy, who has been the responsible liaison officer and has generously contributed to the work of the Committee.

Nancy C. Ahern, of the Commission on Human Resources served as Staff Officer for the study. Harrison Shull, Chairman, and William C. Kelly, Executive Director of the Commission, provided valuable guidance and support. Milda H. Vaivada, formerly administrative assistant to the Committee, was helpful in the early stages of the project. Michele R. Renfroe had responsibility for preparation of the final manuscript.

Staff of the U.S. Office of Personnel Management who assisted in providing data and helpful suggestions include Robert Penn, Workforce Analysis and Statistics Division, and Ruth Cullen, Office of Affirmative Employment Programs.

To these and all others who aided in the preparation of this report, the Committee expresses its sincere thanks.

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INTRODUCTION

The majority of doctoral scientists traditionally have been employed in colleges and universities, although with considerable variation by field. Since academic opportunities have shrunk in the last few years and are expected to decline more steeply in the next decade, a predictably strong interest in industrial and government employment has emerged. The extent to which these sectors will absorb a growing share of the Ph.D. population is not clear, however.

This issue is particularly relevant to employment prospects for women scientists. In the past decade the number of women who annually earn doctorates in the sciences has tripled, while overall Ph.D. production peaked in 1973 and has declined slowly since then. In addition, significantly greater proportions of women scientists than of men have relied historically on the academic job market, although they have characteristically been employed in untenured positions and in the lowest ranks.[1]

The rapid increase in the pool of highly trained women scientists has coincided with not only a decline in faculty openings, as noted above, but also with two other important developments: the emergence of affirmative action regulations and a change in social attitudes about the role of women. The combination of these events might be expected to result in an increased number of women in industry and government and improved opportunities for career advancement.

This leads to an important set of questions. To what extent are women scientists in fact moving into these areas? Which industries or federal agencies are hiring increasing proportions of women scientists? Do job functions differ by sex? Are women being promoted to management positions as frequently as men with the same training? Are salary differences narrowing?

About the report

This report to the Office of Science and Technology Policy presents data on the status of women scientists and engineers in private industry (Part 1) and the federal government (Part 2). In particular, it examines the extent to which their employment situation has improved in the 1970's. The Committee's findings with respect to women scientists in industry

[1] Committee on the Education and Employment of Women in Science and Engineering, Commission on Human Resources, National Research Council, *Climbing the Academic Ladder: Doctoral Women Scientists in Academe* (Washington, D.C.) National Academy of Sciences, 1979).

constitute an interim report to be followed by a more intensive study of recruitment and hiring patterns.

The scientists under discussion are those trained in the natural sciences, social sciences, and engineering. The report primarily concerns Ph.D.s in these fields although some analyses of bachelor's and master's degree recipients appear in Part 2. Individuals with professional degrees in medicine, law, etc., are not included.

Men and women will be compared in terms of employers, starting salaries, job functions, promotions, and other variables. Changes over the 1970's in male/female differences may indicate the impact of affirmative action programs and shifting social attitudes. Because of this focus, much of the discussion will be directed to employment patterns of recent Ph.D.s, for whom relative improvement would be expected to occur first.

The sources of data for the report are described in the box on the opposite page.

Primary Data Sources and Their Scope

Source	Scope of the Data
Survey of Doctorate Recipients, National Research Council	
A survey conducted biennially since 1973 that includes a sample of about 65,000 scientists and engineers who earned Ph.D.s during the period 1934-1976. The sample is carefully stratified by sex, field, and other variables and the survey responses weighted so as to estimate population figures. The questionnaire used for the 1977 survey is shown in Appendix A.	Estimates from the survey are subject to possible error due to sampling variability. Sampling errors, which provide a measure of precision or confidence, have been computed for most statistics in the report. A fuller treatment of the subject is provided in Appendix B.
Survey of Earned Doctorates, National Research Council	
A virtually 100 percent survey of individuals receiving doctorates from U.S. institutions. Through the cooperation of graduate deans, information is collected at the time of receipt of the Ph.D. on educational background and future plans.	The survey does not include persons with professional degrees in medicine or law. Information on employment plans at the time of receiving the Ph.D. is 95 percent complete.
Central Personnel Data File, Office of Personnel Management	
A computerized file of employment data on all federal personnel. By special request, a tape extract was obtained, containing 1974 and 1978 information on the population of science and engineering degree recipients employed by federal agencies. A more detailed description of the population is provided in Appendix C.	The data do not include persons employed by the various intelligence and security agencies and persons in ungraded positions. The analyses are limited to 1974 and 1978 comparisons, since 1974 was the first year that information on level and field of education was routinely collected. Most items of information reported here were 100 percent complete.

SUMMARY OF FINDINGS

WOMEN IN INDUSTRY

- A quarter of all male scientists and engineers in the Ph.D. work force but only seven percent of such women held positions in industry in 1977. This differential is partly due to the fact that relatively few of the women Ph.D.s are in engineering and physics -- fields which together account for about 40 percent of the doctorate-level jobs in industry. (page 8)

- For several fields, the percentage of women among industrial scientists was less than half their percentage in the Ph.D. work force. (page 9)

- Women represented approximately six percent of the net increase in industrial R&D personnel between 1973 and 1977. The electronics industry recorded the largest proportional increase in number of women -- 11 percent. (page 10)

- Male doctorate-holders were twice as likely as comparable women to be in managerial positions in 1977. (page 11)

- Sex differences in salaries for new Ph.D.s have been greatly reduced. Otherwise, the pay differential remains substantial: men typically earned $7,500 more than women among older Ph.D.s and $4,000 more in the mid-career group, based on 1977 salaries. For the mid-career scientists and engineers the salary differentials were noticeably larger in the 1977 than in 1973. (page 15)

- Similar proportions of men and women in industry had received their doctorates from prestigious academic departments (page 18), but in several fields the men were more likely to have engaged in postdoctoral study prior to employment. (page 20)

- The sex differences in hiring rates and salaries are most marked in the life sciences where the pool of doctoral women is relatively large. (page 22)

- The available data do not identify causes of the differences in employment, work activities, and salaries for men and women Ph.D.s in industry. (page 23)

WOMEN IN THE FEDERAL GOVERNMENT

- Between 1974 and 1978 the number of women scientists and engineers in the federal government grew from just under 8,000 to nearly 12,000 or 50 percent, while total federal employment of such personnel increased from 134,700 to 156,200 or 16 percent. (page 27)

- Women now account for one in 13 of the federally employed scientists and engineers at all degree levels and one in 20 of the Ph.D. personnel. (page 27)

- Approximately 21 percent of the women scientists and engineers were in GS 13 and above in 1978 compared with 45 percent of the men. (page 28)

- The proportion of women scientists and engineers in GS 15-18 showed an increase from 2.4 percent in 1974 to 2.9 percent in 1978. (page 28)

- In general, women scientists and engineers were promoted to a higher grade and to management positions at a faster rate than their male counterparts between 1974 and 1978. Forty percent of the women who were GS 12's in 1974 had been promoted to a higher grade by 1978 compared with 28 percent of the men. Despite these adjustments, women scientists and engineers still hold only about 500 of the 17,600 federal managerial jobs. (page 31)

- Salary differences for men and women scientists and engineers remained substantial, despite the fact that women's earnings climbed somewhat more rapidly than did men's over this period. In the mid-career group -- those age 40-44 -- the differential in pay amounted to $4,300 as of 1978. (page 34)

- Among the new accessions, women scientists were typically hired at a lower grade and a lower salary than comparable males. This was found at all degree levels and number of years since the degree was earned. (page 36)

- Sex differences in starting salaries for new Ph.D.s in government are slight, but for those six years or more past the doctorate, the differential grows to at least $2,400. (page 36)

- Sex differences in starting salaries and grade levels for recent bachelor's and master's degree holders remain large, with men earning almost 20 percent more than women. (page 37)

PART 1

DOCTORAL WOMEN SCIENTISTS AND ENGINEERS IN INDUSTRY

Federal laws prohibiting sex discrimination in employment first appeared in Title VII of the Civil Rights Act of 1964. It was not until 1971, however, that government contractors were required to develop written affirmative action plans containing goals and timetables. In 1972, Title VII was amended to cover all private employers of 15 or more persons -- regardless of whether or not they receive federal funds -- in addition to public institutions. The threat of losing government contracts due to failure to comply is a real one. To date, the Labor Department has debarred 21 firms from federal contracts for this reason.

To what extent have these pressures affected the rate of hiring and advancement of women scientists and engineers? If special efforts are being made towards more equitable employment, one would expect to find: (i) an increasing proportion of the pool of qualified women among new hires, (ii) a narrowing of salary differences, and (iii) growing numbers of women in management positions.

In this section of the report, we will examine recent trends in the employment of women doctorates in private industry -- their employers, work activities, salaries, and other characteristics. The mileposts for measuring progress will be 1973 and 1977 since these are the earliest and most recent years for which reliable longitudinal data are available.

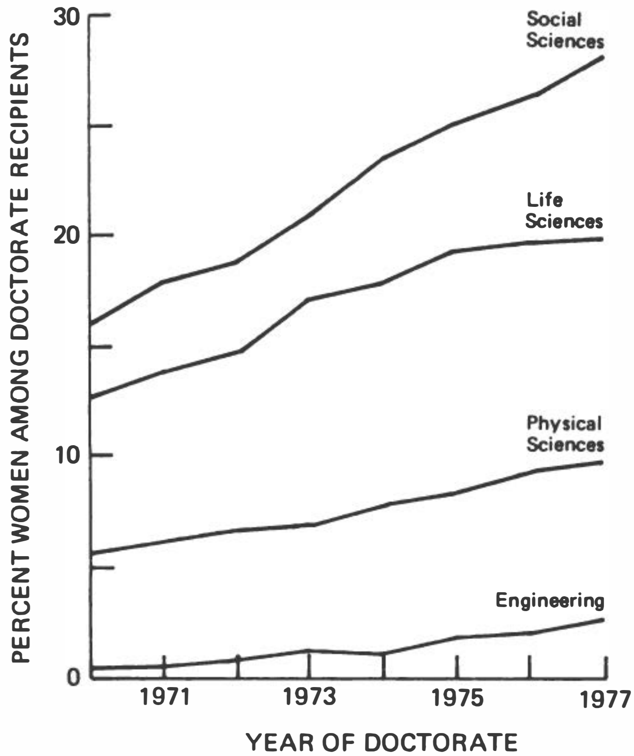
The data are derived from the National Research Council's 1973 and 1977 surveys of doctorate recipients (see box on page 3). Included are Ph.D. scientists and engineers in the labor force who earned doctorates in the period since 1934.

Business and industry employment figures shown here exclude individuals who are self-employed.

Supply of Women Ph.D.s

The proportion of women among new science and engineering Ph.D.s has risen sharply in recent years to a 1977 level of 10 percent in physical sciences, 20 percent in biosciences, and nearly 30 percent in social sciences (Figure 1.1).

FIGURE 1.1 Percent of doctoral degrees in science and engineering awarded to women, 1970-1977.



SOURCE: Survey of Earned Doctorates, National Research Council

Employment Trends

A quarter of all male scientists and engineers with the Ph.D. but only seven percent of such women held positions in industry in 1977 (Table 1.1). The pattern is similar among the most recent Ph.D. graduates, and although the proportion of women going into industry has increased since 1973, it is still under 10 percent. This differential is largely due to the fact that relatively few of the women Ph.D.s are in engineering and physics -- fields which together account for about 40 percent of the doctorate-level jobs in industry.

TABLE 1.1 Doctoral scientists and engineers by employment sector and sex

	1973 Employment		1977 Employment	
	Men	Women	Men	Women
All Ph.D.s				
Number	185,800	14,700	236,800	24,200
% Business/industry	24	5	26	7
Academe	57	72	55	68
U.S. government	9	6	8	5
Other employers	10	17	11	20
New Ph.D.s*				
Number	26,400	3,000	22,500	4,400
% Business/industry	22	5	25	9
Academe	56	73	52	64
U.S. government	9	3	8	3
Other employers	13	19	15	24

*Earned doctorate 1-2 years prior to employment survey.

SOURCE: Survey of Doctorate Recipients, National Research Council

Utilization by Field

All companies that have federal contracts are required to submit annual reports to the Department of Labor on their affirmative action programs. Such reports as a rule include the percent of women employees compared with their proportion in the available pool. An industry-wide analysis of this sort is shown in Table 1.2.

Among doctorate-level personnel, the rate of industrial employment of women scientists is less than half their rate in the Ph.D. work force. The discrepancy between percent of women employed in industry and the percent availability is largest in the life sciences, with the greatest discrepancy occurring in medical sciences. It is interesting to note, however, that in physics and engineering, which are major feeder fields for industry, the percent women matches their representation in the doctoral pool.

TABLE 1.2 Percent doctoral women employed in industry and percent available, 1977

Field	Total Ph.D.s in industry	No. women industry	% Women industry	% Women in Ph.D. labor force
All fields	61,500	1,700	3%	10%
Engineering, math & physical sciences	49,100	900	2	4
Mathematics	1,100	50	4	7
Computer sciences	2,900	100	3	7
Physics	3,900	80	2	2
Chemistry	17,100	500	3	6
Earth sciences	2,800	70	2	4
Engineering	21,300	100	1	1
Life sciences	8,500	400	5	13
Agricultural sciences	2,600	20	1	2
Medical sciences	2,400	100	4	13
Biological sciences	3,500	280	8	16
Behavioral & social sciences	3,900	400	9	18
Psychology	1,800	200	11	23
Social sciences	2,100	200	8	14

SOURCE: Survey of Doctorate Recipients, National Research Council

Profile by Industry

Overall, industrial R&D personnel who hold science and engineering doctorates increased by an estimated 8,900 in four years from 37,200 in 1973 to 46,100 in 1979. Women represented six percent of the net increase. Of the manufacturing companies, the electrical equipment industry recorded the largest proportion of women among net R&D growth -- 11 percent -- although it sustained one of the lowest rates of growth of R&D personnel over this period (Table 1.3).[1]

The most striking under-representation of women scientists and engineers in R&D appears in the fastest-growing industrial sector, "other nonmanufacturing" companies, which grew at an annual rate of 14 percent in number of Ph.D.s employed in R&D, but in which only 3.6 percent of the additional personnel were women. This sector includes companies engaged in such activities as agriculture, mining, finance, and wholesale and retail trade -- fields in which few women scientists are found (with the possible exception of retail trade).

[1]The "electrical equipment" industry includes companies whose gross revenues are chiefly from electrical and communications products, such as AT&T, General Electric, and Westinghouse, etc. Industry groups are defined by the Standard Industrial Classification of the Office of Management and Budget.

TABLE 1.3 Four-year growth in R & D personnel[1] who hold science and engineering doctorates by industry group, including increase in numbers of women

Industry Group[2]	Doctoral R & D Personnel			4-Year Growth		
	1973	1977	Average Annual Growth (1973-77)	Total	No. of Women	Women as % of Increase
Total employed	37,209	46,088	5.5%	8,879	531	6.0%
Classifiable companies	34,974	43,410	5.6	8,436	525	6.2
Manufacturing	32,253	39,603	5.3	7,350	461	6.3
Chemicals	7,751	9,353	4.8	1,602	98	6.1
Electrical equipment	6,085	6,858	3.0	773	86	11.1
Pharmaceuticals	3,206	4,297	7.6	1,091	77	7.1
Petroleum and refining	3,343	3,900	3.9	557	35	6.3
Instruments	2,259	3,118	8.4	859	40	4.7
Other Manufacturing	9,609	12,077	5.9	2,468	125	5.1
Services	1,682	2,066	5.3	384	39	10.2
Other non-manufacturing	1,039	1,741	13.8	702	25	3.6
Non-classifiable companies	2,235	2,678	5.0	443	6	1.3

[1]Includes individuals whose primary work activity is management or performance of research and development.

[2]Standard Industrial Classification.

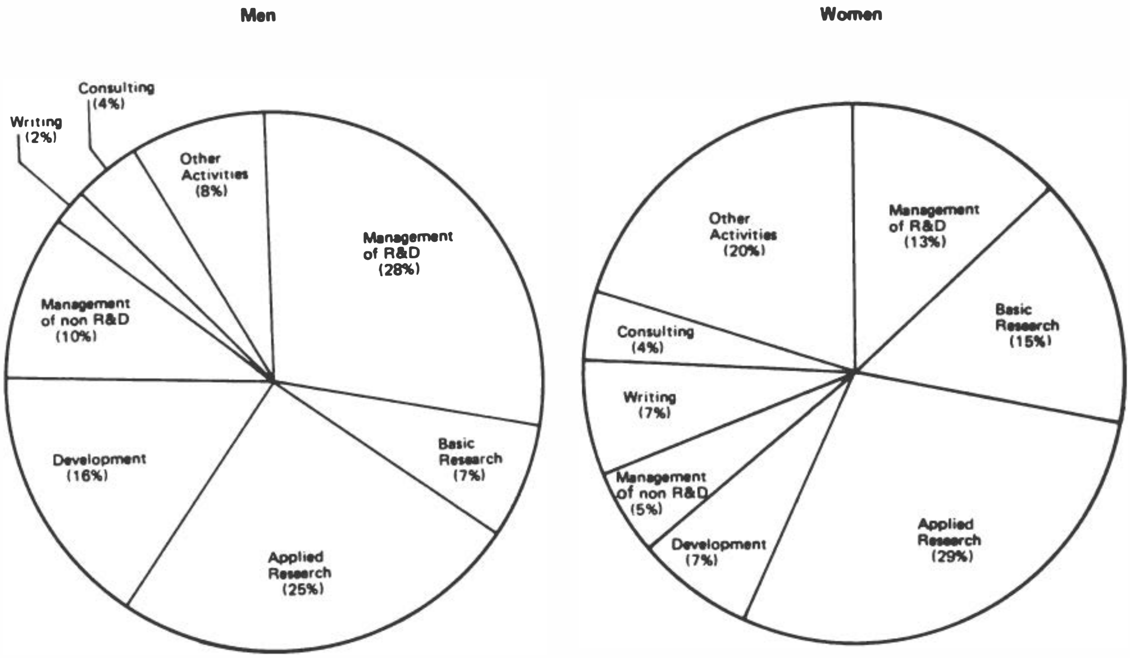
SOURCE: Survey of Doctorate Recipients, National Research Council

Women Managers

Before examining salary differentials between men and women, it is important to consider possible differences in types of positions held. The available data on doctoral scientists and engineers in industry do not indicate the level or kinds of responsibility involved or experience required. Nor do many positions in industry lend themselves to classification into well-defined categories such as occur in academic and government jobs. The information at hand allows us to categorize jobs by industry group, primary work activity, and salary.

Some major differences in work activities for men and women are evident from Figure 1.2. Men are twice as likely as their female colleagues to be in managerial positions -- a difference which we will discuss later with reference to their comparative salaries. Within R&D activities, basic research employs relatively more women scientists and development relatively more men.

FIGURE 1.2 Primary work activities of doctoral scientists and engineers in industry, 1977.



SOURCE: Survey of Doctorate Recipients, National Research Council

The 18 percent of women scientists and engineers in management (R&D and other) in 1977 is actually lower than the comparable statistic of 20 percent for 1973, although the difference is not statistically significant. For both men and women, the proportion who were managers dropped between 1973 and 1977, but the 2-to-1 ratio remained constant (Table 1.4).

TABLE 1.4 Percent of doctoral scientists and engineers in industry whose primary work activity is management, 1973 and 1977

	Men	Women
% Managers		
1973	40.3	20.0
1977	37.2	18.1

SOURCE: Survey of Doctorate Recipients, National Research Council

Examining work activities by field (Table 1.5), we find that the principal job functions for men and women are most dissimilar in the life sciences. About 40 percent of the male scientists, but only 15 percent of the females, are engaged in management of R&D.[2] In both the life and social sciences -- fields with relatively large proportions of women Ph.D.s -- men are also about twice as likely to be employed as consultants.

TABLE 1.5 Primary work activities of doctoral scientists and engineers in industry by field and sex, 1977

Primary work activity	All fields		Engineering, math., and physical sciences		Life sciences		Behavioral and social sciences	
	Men	Women	Men	Women	Men	Women	Men	Women
Total	59,844	1,692	48,198	910	8,126	413	3,520	369
Total reporting activity	59,038	1,657	47,705	893	7,954	411	3,379	353
Management of R&D	27.7%	13.5%*	26.6%	14.4%*	39.3%	14.8%*	16.0%	9.3%
Basic research	6.7	14.8 *	6.8	14.9 *	7.1	18.2 *	3.9	10.5*
Applied research	25.5	29.3	26.6	36.2 *	18.0	24.1	28.3	17.8
Development	16.3	7.0 *	19.0	11.4 *	5.9	3.4	2.2	0.0
Management, other	9.5	4.6 *	9.2	4.5 *	9.4	4.4	14.4	5.4*
Consulting	4.2	3.9 *	3.4	3.0	5.4	2.2	12.1	7.9
Sales/marketing	2.6	1.9	2.3	0.6 *	4.1	2.2	3.2	4.8
Prof. services to individuals	1.5	6.0 *	0.7	1.6 *	2.8	7.3 *	9.2	15.6
Technical writing	1.5	7.1 *	1.0	4.3 *	2.7	10.9 *	4.5	9.9
Production/inspection	2.0	4.0 *	2.0	2.8	2.7	6.6 *	0.4	4.0*
Other	2.5	7.9 *	2.3	6.4 *	2.6	5.8	5.7	14.7*

*Sex difference is statistically significant at the .05 level.

SOURCE: Survey of Doctorate Recipients, National Research Council.

Most marked is the difference between men and women primarily engaged in technical writing and in "other" nonclassified work activities. About 15 percent of all industrially employed women scientists and engineers are in these two categories, and they are more than three times as likely as men to hold such positions. The undefined work category presumably includes such functions as staff work and other internal support services, e.g. libraries, which are often not viewed as central to a company's business.

[2] The estimated percents in management of R&D and their corresponding sampling errors are: men, 39.3 ± 1.5 percent; women, 14.8 ± 3.4 percent.

What about promotions to management positions between 1973 and 1977? Is there evidence that women scientists and engineers moved into managerial slots at a greater rate than did male Ph.D. personnel over this period? Table 1.6 shows that about one in six of the women on R&D staffs (non-management) in 1973 was promoted to management positions by 1977 as compared with slightly more than one in five of their male counterparts. However, the difference is not statistically significant. In addition, it should be noted that the data are not segregated by age, which may be a factor in rate of promotion.

TABLE 1.6 Promotions of doctoral R&D personnel to management of R&D, 1973 to 1977, by sex

	1973 Number on R&D staff (non-management)	1977 Estimated % in management of R&D[a]
Men	21,636	20.4 (±1.0)
Women	412	17.6 (±3.7)

[a]Based on those responding to both the 1973 and 1977 surveys.

NOTE: Estimated sampling errors are given in parentheses.

SOURCE: Survey of Doctorate Recipients, National Research Council

Salaries[3]

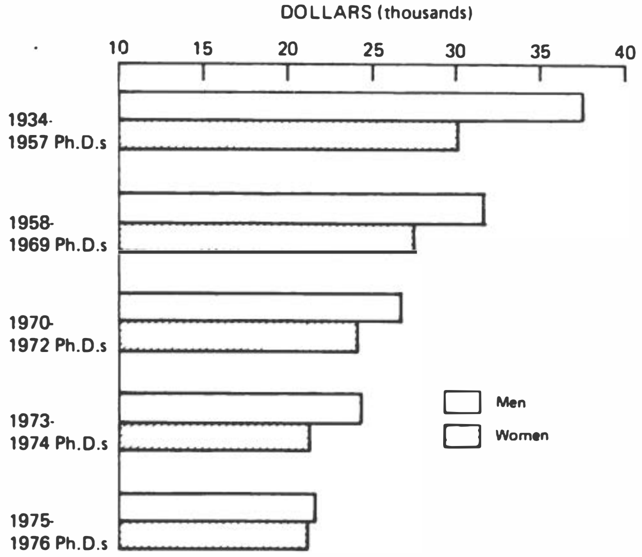
Median industry salaries for men and women scientists and engineers differed by nearly 20 percent as of 1977. Undoubtedly, some part of the observed salary differential is attributable to the relatively higher numbers of women among recent Ph.D.s.

For this reason, salaries will be analyzed separately for the older Ph.D.s -- those who earned degrees in the period 1934-1957; the mid-career group, 1958-1969 Ph.D.s; and three groups of recent doctorates -- those who earned degrees in 1970-1972, 1973-1974, and 1975-1976.[4] We will also examine salary differences when controlled by number of full-time equivalent years of experience.

[3]Annual salaries were reported for February 1973 and February 1977. About 95 percent of the survey respondents provided salary information. Medians were computed for full-time employed persons only. Self-employed individuals are excluded.

[4]It is recognized that these groupings only partially control for salary differences due to cohort. However, because of the small numbers of women in industry, a finer break-out by year of doctorate would not afford reliable estimates of median salaries.

FIGURE 1.3 Median salaries of doctoral scientists and engineers in industry by cohort and sex, 1977.



As shown in Figure 1.3, the pay differential for men and women has been greatly reduced for the most recent Ph.D.s, based on 1977 data. Otherwise, the salary disadvantage for women scientists and engineers in industry remains substantial. Men typically earned $7,500 more than women among older Ph.D.s and $4,000 more in the mid-career group. For mid-career scientists and engineers, the salary gap was markedly wider in 1977 than in 1973 (Table 1.7).

TABLE 1.7 Median annual salaries of doctoral scientists and engineers in industry* by field, cohort and sex, 1973 and 1977

		1934 - 1957 Ph.D.s			1958 - 1969 Ph. D.s			1970 - 1972 Ph.D.s		
		Men	Women	Diff.	Men	Women	Diff.	Men	Women	Diff.
All fields	1973	$28,100	$22,300	20.6%	$22,800	$20,500	10.1%	$18,700	$16,300	12.8%
	1977	37,700	30,000	20.4	31,400	27,500	12.4	26,800	24,000	10.4
Engineering, math., physical sciences	1973	27,700	22,100	20.2	22,700	20,400	10.1	18,700	16,400	12.3
	1977	37,400	*	—	31,300	27,200	13.1	26,800	23,500	12.3
Life sciences	1973	28,900	*	—	23,100	19,700	14.7	17,700	14,800	16.4
	1977	37,800	*	--	32,000	26,900	15.9	25,600	22,300	12.9
Behavioral & social sciences	1973	*	*	--	27,700	*	--	20,200	17,500	13.4
	1977	*	*	--	*	*	--	29,800	30,400	+ 2.0

*Data unreliable; estimated sampling errors are greater than ± $2,000.

NOTE: Only those full-time employed are included.

SOURCE: Survey of Doctorate Recipients, National Research Council

In all fields, the salary patterns demonstrate a growing differential with length of experience (Table 1.8). Among industrially employed physical scientists and engineers with 0-2 years experience, women earned about $700 or three percent less than their male colleagues. However, for those with the full-time equivalent of 15 years experience or more, the differential in pay increased to nearly 20 percent or a dollar difference of about $6,000. The salary gap is widest for life scientists. This may stem partly from the considerable under-representation of women managers in the life sciences, as noted on page 12. Due to the sex differences in work activities in all fields, not only the life sciences, we will next compare earnings within primary job functions, and examine any remaining discrepancies.

TABLE 1.8 Median salaries of doctoral scientists and engineers in industry by field, full-time equivalent years of experience, and sex, 1977

Field and no. of years experience	Men	Women	Diff.
All fields+			
2 years or less	$21,000	$19,500	7.1%
3-5 years	23,000	20,900	9.1
6-9 years	26,800	25,400	5.2
10-14 years	30,300	28,200	6.9
15-19 years	33,100	27,200	17.8
20-24 years	35,400	28,400	19.8
25 years or more	37,600	*	—
Engineering, math., and physical sciences			
2 years or less	$21,200	$20,500	3.3%
3-5 years	23,000	21,600	6.1
6-9 years	26,900	24,600	8.6
10-14 years	30,300	25,700	15.2
15-19 years	32,700	26,800	18.0
20-24 years	35,000	28,300	19.1
25 years more more	37,500	30,400	18.9
Life sciences			
2 years or less	$19,300	*	--
3-5 years	22,900	$20,500	10.5%
6-9 years	25,700	23,100	10.1
10-14 years	30,300	*	—
15-19 years	35,800	*	--
20-24 years	36,200	*	—
25 years or more	37,600	28,200	25.0

*Data unreliable; estimated sampling errors are ± $2,000 or greater.

+The behavioral and social sciences are included in "all fields" but are not shown separately due to relatively large sampling errors.

NOTE: Only those full-time employed are included.

SOURCE: Survey of Doctorate Recipients, National Research Council

FIGURE 1.4 Median salaries of R&D personnel by primary work activity and years of experience, 1977.

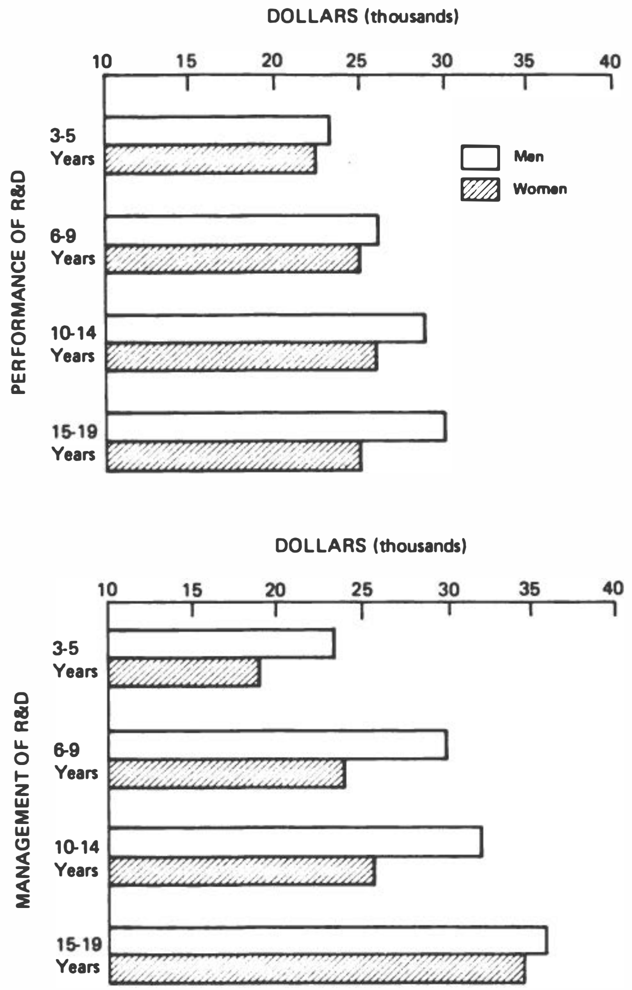


Figure 1.4 and Table 1.9 show median salaries paid to R&D personnel in the engineering, mathematical, and physical sciences according to primary work activity, years of experience, and sex. In this analysis, the life sciences and behavioral and social sciences are not shown separately due to the small number of women on which the salary estimates would be based. Women engaged in performance of R&D (i.e., basic research, applied research, and development) with 3-5 years experience typically earned $1,000 less than their male colleagues, while for those with 15-19 years of experience, the differential increased to $5,000. Among women managers of R&D, the salary patterns were quite different, with a consistently large (20 percent) gap in pay, except for those with 15 or more years experience.

TABLE 1.9 Median salaries of R&D personnel in engineering, mathematics, and physical sciences, 1977

	Men	Women	Diff.
Primary work activity:			
Performance of R&D			
3-5 years experience	$23,200	$22,400	3.4%
6-9 years	26,000	25,200	3.1
10-14 years	28,900	26,300	9.0
15-19 years	30,000	25,100	16.3
Management of R&D			
3-5 years experience	$23,400	$18,800	19.7
6-9 years	30,000	23,900	20.3
10-14 years	32,000	25,800	19.4
15-19 years	36,100	34,400	4.7

*Data unreliable; estimated sampling errors are greater than ± $2,000.

NOTE: Only those full-time employed are included.

SOURCE: Survey of Doctorate Recipients, National Research Council

Educational background of women in industry

Across all fields, similar proportions of men and women in industry had earned doctorates from prestigious departments. In both the EMP fields (engineering, mathematics, and physical sciences) and the life sciences, the women are significantly more likely to have received their Ph.D.s from highly rated departments while the reverse holds in the behavioral and social sciences (Table 1.10).

TABLE 1.10 Recent science and engineering Ph.D.s employed in industry in 1977

	% from prestigious doctoral departments[1]			
	1970 - 1976 Ph.D.s		1975-1976 Ph.D.s only	
	Men	Women	Men	Women
All fields	41%	41%	40%	38%
Engineering, mathematics and physical sciences	43	49	44	55
Life sciences	35	41	28	34
Behavioral and social sciences	29	24	24	11

[1]Based on Roose-Andersen rating of doctoral departments, published in Kenneth D. Roose and Charles J. Andersen, *A Rating of Graduate Programs*, American Council on Education, Washington, D.C. 1970.

SOURCE: Survey of Doctorate Recipients, National Research Council.

Financial support during graduate school

A number of companies provide financial aid to graduate students in science and engineering departments. The extent to which women students receive such support is relevant in that it may create early ties with industry and lead to subsequent employment.

Of the scientists and engineers awarded doctorates in 1976, about 800, including 80 women, had received support at some time during graduate school from company educational funds. It should be stressed that this represents less than one twentieth of all doctoral science and engineering students, so that such support is only a small contribution to financial aid. The majority of the recipients were in the physical sciences and engineering. Table 1.11 shows that in all departments but the social sciences, male and female students are about equally likely to be supported by industry funds.

TABLE 1.11 Recent science and engineering Ph.D.s who received support from company educational funds during graduate school

New Ph.D.s who have received support		Physical sciences		Engineering		Life sciences		Social sciences	
		Men	Women	Men	Women	Men	Women	Men	Women
1972	No.	310	17	379	3	77	10	90	12
	%	6.2	4.8	11.4	14.3	1.9	1.5	2.1	1.2
1973	No.	271	12	377	2	80	10	97	15
	%	5.8	3.3	11.9	4.4	2.0	1.2	2.2	1.3
1974	No.	235	16	341	4	75	11	90	20
	%	5.5	4.5	11.7	12.5	2.0	1.4	2.1	1.5
1975	No.	256	19	315	3	108	20	112	15
	%	6.1	5.0	11.3	6.0	2.8	2.2	2.5	1.0
1976	No.	283	26	307	6	107	28	97	18
	%	7.3	6.6	11.7	11.8	2.8	3.0	2.1	1.1

SOURCE: Commission on Human Resources, National Research Council, *Summary Report, Doctorate Recipients from United States Universities*, 1972-1976 reports in the series.

Quality of Men and Women Ph.D.s

A previous report by this Committee sought to assess the relative quality of men and women scientists at receipt of the Ph.D. Given that no objective measures of research potential exist, the Committee concluded that based on academic records, elapsed time from BA to Ph.D., and ranking of graudate departments attended, women scientists and engineers on the average are at least equal to men in quality at receipt of the doctorate.[5]

Postdoctoral training prior to employment

Between 1970 and 1976 an increasing proportion of Ph.D.s in the physical and life sciences elected postdoctoral study following graduation.[6] This presumably reflects the fact that fewer traditional jobs have been available in recent years. When asked whether they had held a postdoctoral appointment prior to employment in industry about 40 percent of the men in selected fields reported "yes". Postdoctoral training was far less prevalent among industrially employed women, except in the biosciences (Table 1.12).

TABLE 1.12 Recent science and engineering Ph.D.s employed in industry in 1977 and percent who had received postdoctoral training, by field and sex

	Doctoral scientists in industry 1977			
	Men		Women	
Field	1970-1976 Ph.D.s	% Who have held postdoc.	1970-1976 Ph.D.s	% Who have held postdoc.
Physics	1,442	40% (±4%)	39	13% (±7%)
Chemistry	4,858	38 (±2%)	283	30 (±4%)
Medical sciences	797	41 (±5%)	61	23 (±11%)
Biological sciences	1,386	37 (±4%)	159	45 (±8%)

NOTE: Estimated sampling errors are shown in parentheses.

SOURCE: Survey of Doctorate Recipients, National Research Council

[5]Committee on the Education and Employment of Women in Science and Engineering, Commission on Human Resources, National Research Council, *Climbing the Academic Ladder: Doctoral Women Scientists in Academe* (Washington, D.C.: National Academy of Sciences, 1979).

[6]Commission on Human Resources, National Research Council, *Summary Report, Doctorate Recipients from United States Universities*, 1970-1976 reports in the series (Washington, D.C.: National Academy of Sciences).

Industry's views of the desirability of postdoctoral education tend to be mixed. Some companies regard the additional academic training as a disadvantage in that it motivates the young Ph.D. away from applied research and may further create an aloofness that is not consonant with larger team-oriented research. Other companies prefer the greater specialization gained by the postdoctoral, particularly in certain rapidly-changing high technology fields. In the past, only a minority of corporations have actively recruited from among postdoctoral students for new personnel.[7] The fact that in recent years a growing proportion of young Ph.D.s in industry have taken postdoctorals may indicate that companies are now increasing their recruiting at this level.

In any case it is not clear that the generally lower incidence of postdoctoral training among women than men in industry has significant implications to their employers.

Industry hiring

Among recent graduates of science and engineering departments, women have been less likely than men to seek positions in industry. The reasons for this are not known, but will be explored by this Committee in a more intensive study of industrial recruitment. Data are available, however, on the number of new Ph.D.s who were looking for industrial employment, and how women fare in receiving job offers.

TABLE 1.13 Number of 1970-1976 doctorate recipients seeking positions in industry and percent who had signed contracts at the time of receiving the Ph.D., by field, cohort and sex (estimated).

	Men			Women		
	Total planning employment in industry	Have definite job	Still seeking	Total planning employment in industry	Have definite job	Still seeking
Total	16,551	79%	21%	619	72%	28%
Field						
Engineering, mathematics and physical sciences	13,691	79	21	300	74	26
Life sciences	1,794	77	23	98	52	48
Behavioral & social sci.	1,066	81	19	221	80	20
Year of Doctorate						
1970-1972	7,305	81	19	154	68	32
1973-1974	5,145	76	24	199	84	16
1975-1976	4,101	80	20	266	66	34

SOURCE: Survey of Doctorate Recipients, National Research Council

[7]National Research Council, *The Invisible University: Postdoctoral Education in the United States* (Washington, D.C.: National Academy of Sciences, 1969), pp. 197-204.

One measure of their success is whether they have a definite job at the time of receiving the doctorate. Table 1.13 shows that 79 percent of the men had definite jobs at the time of Ph.D. compared with 72 percent of the women. It should be underscored that the figures are based on graduates who reported they were seeking positions in industry -- men or women who were looking for other kinds of positions or who expected to be unemployed are not included. A greater success in receiving early offers is particularly evident for men in the life science fields. About three-fourths of the male Ph.D.s but only one-half of their female counterparts had definite commitments.

If we examine selected cohorts, there appears to have been a relative improvement in employment prospects for women who earned degrees in 1973 and 1974, followed by a sharp decline for the 1975-1976 women graduates.

Summary and Discussion

Despite a rise in the proportion of recent women Ph.D.s employed in industry between 1973 and 1977, women are still less than three percent of all doctoral scientists and engineers in industry. In several fields, their rate of industrial employment is less than half that of their availability in the doctoral work force. The average increase in women's R&D employment -- six percent -- matched the average industrial rate of growth in R&D personnel during this period, greatly exceeded it in the electrical equipment industry, and fell far short of the growth in "other nonmanufacturing" industries.

The primary work functions of men and women differ significantly. Women are much more likely than men to be engaged in research and in "other" activities, and men are twice as likely as women to be managers.

Salaries of female scientists and engineers are lower than those of males, by percentages ranging from about three to almost 25 percent in various fields and levels of experience. The salary differences remain when earnings are controlled by primary job function, and are larger for managers than for research personnel. These salary differentials increased from 1973 to 1977, and remain large for all but the most recent hires.

The evidence cited in this report suggests that despite the similarity of women and men doctoral scientists in terms of educational background and quality, women are less readily recruited and hired for industrial positions.

There are thus a number of important indications that despite affirmative action requirements which now go back nearly ten years, male scientists are hired earlier and paid more. The differences become most marked in the life sciences, where the pool of doctoral women is relatively large. This is in contrast to the situation in academe, where the fields of mathematics and chemistry were found to be least receptive to advancement of women, as documented in an earlier report of this Committee.

With the information available at present, we can do little more than speculate about the reasons for these considerable differences. Does the small proportion of women doctorates who seek industrial employment reflect in some measure a perception that such positions will not be congenial or rewarding? We know very little about the specific factors involved in such employment choices and decisions for both men and women. For example, are women scientists less attracted to year-round employment due to family responsibilities? Does work location or individual mobility play a larger role here than in academic employment? Are women scientists in industry more likely than those in academe to be married, and thus to be especially constrained in their choices? We also have no information about the extent to which companies maintain explicit or implicit anti-nepotism policies (which are known to have a disproportionate impact on women), or whether they recruit through open advertising in all cases. Further, the relatively isolated location of some major research laboratories may make them undesirable for two-career couples, who are known to prefer the multiple choices available in metropolitan areas. These issues underscore the need for information on the marital status of women scientists in industry.

Given that there are considerable differences among industries in the degree of utilization of women scientists and engineers, there may also be some companies which are markedly more successful than others within the same industry in recruiting, hiring, and promoting women. Undoubtedly, in some cases such successes result from particular affirmative action efforts. It is also possible that some companies have developed a tradition of more equitable employment without such stimulus.

The sex differences in hiring rates and salaries which persist suggest that affirmative action mandates are not enforced at professional levels in industry, but a firm conclusion of this sort must await a more detailed study. The fact that women are such a small fraction of the doctoral work force in industry implies that they are widely scattered but does not preclude the possibility that they are concentrated in a few companies in certain specialized work functions which are typically lower-ranking and lower-salaried. At any rate, the available data do not indicate the reasons for the differences we find in employment, work activities, and salaries for men and women Ph.D.s in industry.

PART 2

WOMEN SCIENTISTS AND ENGINEERS IN THE FEDERAL GOVERNMENT

The federal government has a long history of laws and executive orders prohibiting employment discrimination. Executive Order 11478, issued in 1969, required each agency and department to maintain an affirmative program of equal employment opportunity. With the passage of the Equal Employment Opportunity Act of 1972, enforcement provisions were strengthened.

A number of internal government structures have been created to deal with affirmative action programs, recruitment policies, and bias complaints. The Federal Women's Program (FWP) was established in 1967 under the provisions of Executive Order 11375. FWP managers, located throughout the federal agencies and departments, are responsible for identifying barriers within their organization and working with agency officials on corrective strategies. Agency-wide oversight of EEO policies is carried out by the Office of Personnel Management. (See box on next page.)

Recent sex discrimination cases brought against federal agencies have focused attention on possible bias in promotions. In a July 1978 consent agreement, the Justice Department acknowledged that there had been widespread discrimination against women professionals at the Department of Energy. The suit was brought by a manpower analyst and some 255 other women in scientific and other professional positions. More recently, a discrimination suit was won by a woman mathematician at the National Institutes of Health, granting her a retroactive pay raise. In the DOE case, the government reportedly agreed that there was an $8 million salary discrepancy for men and women in the same types of positions.[1]

What is the situation for women scientists and engineers in other departments and agencies? Of particular interest is whether women are being hired, paid, and promoted at the same rate as men with similar training.

In this section we will examine employment data on men and women scientists in the federal government for 1974 and 1978. The data were obtained from the Office of Personnel Management's computerized files and include the entire population of interest rather than a sample. (See box on page 3 for a description of the data base and its scope.) Included in the following analyses are persons who were trained in science and

[1] *Washington Post*, 15 July 1978, p. 5.

In February 1979 Alan K. Campbell, Director of the Office of Personnel Management, submitted a statement to the Senate Committee on Human Resources for hearings on "The Coming Decade: American Women and Human Resources Policies and Programs". Following is an excerpt of his statement on Federal employment of women:

With regard to Federal employment, women comprised 30.7 percent of the total Federal civilian work force in 1977. They comprised 77.1 percent of employees in grades 1 through 4, but they comprised only 3.4 percent of employees in grades 16 through 18. Despite the large number of women in the Federal Career Service, few of them have reached the executive levels.

Of particular concern today is the scanty representation of women in grades 13 through 15 since these comprise the "feeder group," the ranks which produce tomorrow's executives. Since Federal managers tend to fill top jobs almost exclusively from within, the paucity of women in the "feeder grades" makes it extremely unlikely that the supergrade situation for women will improve markedly so long as we hold to present staffing habits.

Hard data such as these explain why the Federal Women's Program (FWP) was established in 1967 -- "to enhance employment and advancement opportunities for women in Government." The purpose of the FWP is to assist women in applying for, obtaining, and advancing in Federal employment. The Federal Women's Program Office, which is part of the Affirmative Employment Programs Office of the Office of Personnel Management, provides Government-wide leadership and guidance to the Federal Women's Program.

Each Federal agency and department is required to have an FWP Manager, and today there are over 50 full-time and 10,000 part-time FWP Managers around the world. Each FWP Manager works to identify special employment problems for women within the Manager's organization. Then the FWP Manager works with top organization management to develop and implement strategies for eliminating barriers to full employment opportunities for women.

Over the past 10 years, we have certainly seen some progress. Although there still are far too few women in the "feeder" grades and in the supergrades, there has been a significant increase in the number of women in professional and technical jobs in grades 7 through 11. Federal employment for women has been enhanced through repeal of restrictions on women bearing firearms as Federal employees, repeal of height restrictions for most Federal jobs, changes in leave provisions which allow advancing up to 30 days of sick leave for maternity, and increased use of part-time employment and flexible working schedules. But we still have a long way to go.

The Civil Service Reform Act of 1978 includes provisions such as merit pay for supervisors and managers, recruitment for women and minorities where they are underrepresented, and new performance appraisal systems -- provisions with tremendous potential impact on Federal women. The Office of Personnel Management plans to delegate much of the responsibility for implementing these provisions to agencies. Therefore, the primary focus for agency FWP Managers in the coming years will be to help forge these implementing regulations and to assure that agency personnel policies and practices are both creative and equitable with regard to employment for women.

engineering fields, Bachelor's degree and above.[2] The population is further restricted to those employed in professional scientific or engineering positions or in certain administrative categories.[3] Both competitive and excepted personnel are included. However, the analyses are limited to graded positions.

Utilization by field

Between 1974 and 1978 the number of women scientists and engineers in the federal service grew by 50 percent from just under 8,000 to nearly 12,000. Total employment of scientists and engineers increased 16 percent over the same period.

Women now account for one in thirteen of the federally employed scientists and engineers. Their representation varies considerably by field, however, as shown in Table 2.1.

TABLE 2.1 Number and percent women among scientists and engineers in the federal government by field, 1978

Field*	All degree levels No. Women	% Women
All science/engr fields	11,713	7.5
Mathematicians/statisticians	1,963	18.6
Computer specialists	229	12.1
Physicists	206	2.8
Chemists	979	13.5
Other physical scientists	550	6.1
Engineers	617	0.9
Agricultural scientists	551	2.6
Bioscientists	1,929	17.3
Social scientists*	4,648	23.3

*Field of highest degree. Specialties included in each of the field categories are shown in Appendix C.

[2] Purposely excluded are degree recipients in the health and medical professional fields. The academic fields of science and engineering that were included are listed in Appendix C, Table C-1.

[3] See Appendix C, Table C-2, for definitions of the selected occupational series and titles.

At the Ph.D. level, the government employed about 800 women scientists and engineers in 1978, compared with fewer than 500 four years earlier. The proportion of women among doctorate-level personnel -- in the federal government and nationwide -- is shown in Table 2.2. Women appear to be under-represented in nearly all fields, markedly so in biosciences.

TABLE 2.2 Percent women among doctoral scientists and engineers in the federal government, 1978, and percent in the total labor force

Field of doctorate*	Ph.D.s in federal government+ No. men	No. women	% women	Total labor force** % women
All science/engr. fields	13,953	761	5.2	9.7
Mathematicians/statisticians	511	33	6.1	6.9
Computer scientists	50	1	2.0	6.8
Physicists	1,491	32	2.1	2.5
Chemists	1,593	95	5.6	6.1
Other physical scientists	1,878	62	3.2	3.6
Engineers	2,291	23	1.0	0.5
Agricultural scientists	1,232	15	1.2	2.0
Bioscientists	3,011	251	7.7	15.6
Social scientists	1,842	245	11.7	18.0

*Specialties included in each of the field categories are shown in Appendix C.

+Central Personnel Data File, U.S. Office of Personnel Management.

** Survey of Doctorate Recipients, National Research Council, 1977

Grade distribution

The categories of federal employment are defined by Civil Service grade levels. Comparing the grade distribution of men and women over time is a measure of their relative status and rates of advancement.

Table 2.3 shows that in 1978, 45.2 percent of the men were GS 13's and above compared with only 21.3 percent of the women scientists. The gap is only slightly less than that in 1974, when the comparable data were 45.4 and 20.6 percent, respectively. However, there is evidence of an increased proportion of women in grades 15-18 -- up from 2.4 to 2.9 percent. This increase in the upper levels, while modest, is important due to the high visibility of such positions.

For women Ph.D. scientists and engineers in particular, the progress

TABLE 2.3 Percent grade distribution of scientists and engineers in the federal government by sex, 1974 and 1978

Grade	1974 Men	1974 Women	1978 Men	1978 Women
	(All degree levels)			
Below 11	13.8	41.4	12.8	39.4
11	17.5	19.7	16.6	19.1
12	23.2	18.4	25.4	20.2
13	23.9	13.2	23.6	12.9
14	12.8	5.0	13.0	5.5
15	7.3	2.1	7.4	2.4
16-18	1.4	0.3	1.2	0.5

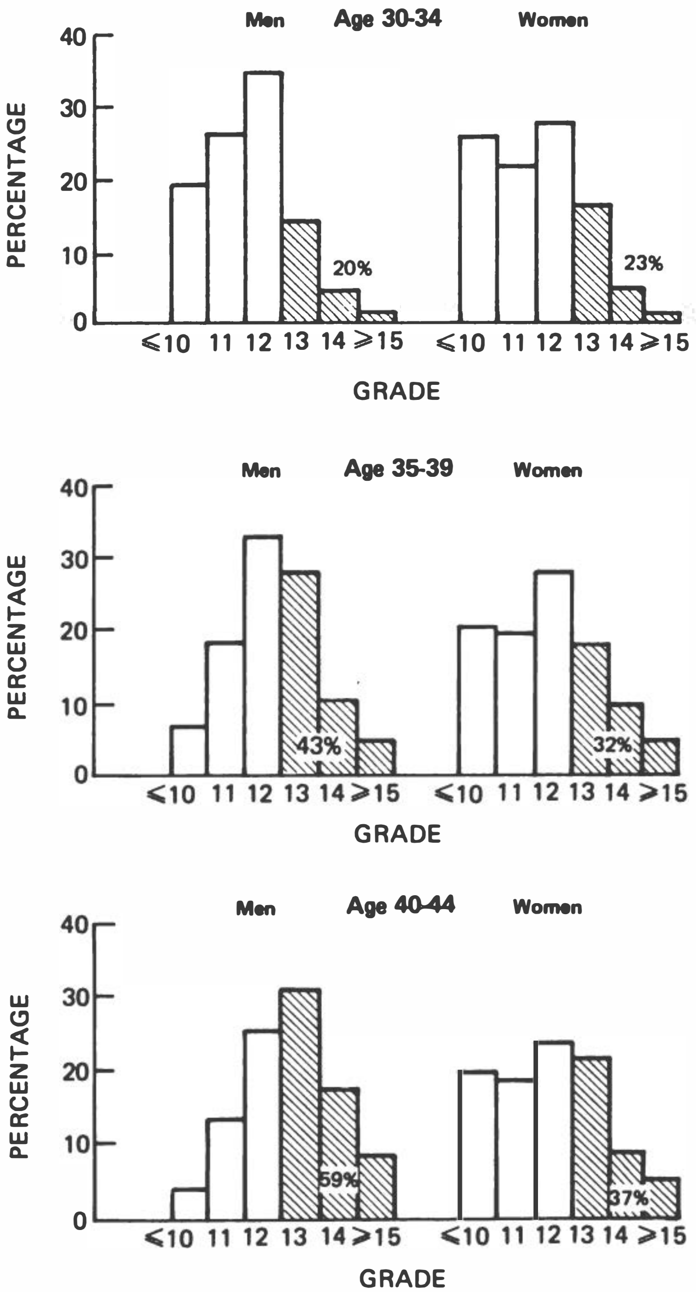
is less obvious. While the proportion of men in grades 15-18 remained the same over this period -- about 23 percent -- the comparable figure for women Ph.D.s dropped from approximately 12 to 10 percent (Table 2.4). This may be partly due to an influx of women hired at the GS 11 and 12 levels which will be discussed later in this report (See page 35).

TABLE 2.4 Percent grade distribution of Ph.D. scientists and engineers in the federal government by sex, 1974 and 1978

Grade	1974 Men	1974 Women	1978 Men	1978 Women
	(Ph.D.s only)			
≤11	5.4	13.0	6.3	18.2
12	16.4	21.8	16.4	26.0
13	31.0	33.4	28.9	29.3
14	23.5	20.0	25.0	16.4
15	18.4	10.0	19.3	8.4
16-18	5.1	1.9	4.2	1.7

Since women comprise relatively more of the recent hires, it is worthwhile to control by age in comparing their grade distribution with that for men. Except for the younger age groups, women scientists have a grade profile very different from men in the same five-year cohort (Figure 2.1). And while the grade distribution for men shifts upward significantly in the late thirties and the forties, the profile for women over the same age span does not change materially. In all age groups, well over half of the women scientists have not advanced past GS 12, whereas by the early forties nearly 60 percent of their male colleagues have.

FIGURE 2.1 Percent grade distribution of scientists and engineers in the Federal Government by age and sex, 1978.



Senior-level positions

In Table 2.5, we compare the proportions of men and women scientists and engineers in "senior-level" positions (GS 13-15) and in the "super-grades" (GS 16-18) by field. In most fields of science and engineering, men are two to three times as likely to be found in grades 13-15. Even in the social sciences where women fare best relative to their male counterparts, only one-fourth of the women are in senior-level positions compared with nearly one-half of the men.

TABLE 2.5 Percent of scientists and engineers in grades 13-18 by field and sex, 1978

	GS 13-15		GS 16-18	
Field*	Men	Women	Men	Women
Mathematicians/statisticians	47%	24%	1.0%	0.4%
Physical scientists	51	18	1.8	0.4
Engineers	49	18	0.9	0.2
Agricultural scientists	20	6	0.7	0.0
Bioscientists	38	14	1.2	0.2
Social scientists	46	25	2.9	0.8

*Field of highest degree. Specialties included in each of the field categories are shown in Appendix C.

Promotions between 1974 and 1978

In order to better assess the changes in recent years, it will be necessary to examine separately the statistics for (i) scientists and engineers who were employed in the federal government in both 1974 and 1978, and (ii) those hired since 1974.

For women scientists and engineers who were already in the federal service in 1974, an important measure of progress is their rate of promotion. As indicated in Table 2.6, women were promoted at a faster rate than their male counterparts between 1974 and 1978. Forty percent of the women scientists and engineers who were at GS 12 in 1974 had been promoted to a higher grade by 1978 compared with only 28 percent of the men. It should be pointed out, however, that in 1974 there were already some 45,000 men scientists and engineers in the higher grades compared with about 1,100 women. In this light, the seeming female advantage in promotion rates is not unexpected. Nonetheless, the promotion of women into grades 13-15 is critical as these are "feeder" grades for executive posts.[4] Also important is the finding that about 10 percent of the women scientists in GS 15 positions in 1974 had moved into the supergrades.

TABLE 2.6 Scientists and engineers full-time employed in the federal government 1974-1978: selected statistics on grade promotions

	Number at grade in 1974		% promoted between 1974 and 1978	
	Men	Women	Men	Women
All fields				
GS 11	17,934	1,053	47.7%	56.6%
GS 12	24,302	1,031	28.0	40.1
GS 13	25,422	740	18.3	27.5
GS 14	12,936	262	15.7	22.9
GS 15	6,772	105	5.4	9.5
Physical scientists				
GS 11	2,272	251	51.4%	45.0%
GS 12	3,785	182	29.2	30.8
GS 13	4,283	132	20.7	22.0
GS 14	2,370	34	19.0	35.3
GS 15	1,377	16	4.5	18.8
Bio-scientists				
GS 11	898	180	46.3	39.4
GS 12	1,103	133	37.3	33.9
GS 13	1,204	84	28.3	19.0
GS 14	645	35	21.3	25.7
GS 15	336	8	8.0	0.0

In the physical sciences and biosciences -- the two largest groups of scientists in the federal government -- the relative rates of promotions of women were favorable, except at the lower levels, where men moved up faster.

Whether or not one has a Ph.D. is generally thought to be less critical for advancement in the government than in academe. This view is supported by the fact that as of 1978 only one-third of the 1,844 scientists and engineers in the supergrades were Ph.D.s. Even so, it may be of interest to examine Ph.D.s separately in terms of promotions. Table 2.7 shows that male doctoral scientists and engineers were promoted out of GS 12-13 more frequently than were comparable women, whereas at GS 14-15, the women scientists had higher promotion rates. In biosciences, which include one-third of all doctoral women in the federal service, promotion of women lagged consistently behind that for men.

[4] See remarks made by the director of the Office of Personnel Management in box on page 26.

TABLE 2.7 Ph.D. scientists and engineers full-time employed in federal government 1974-1978: selected statistics on grade promotions

	Number at grade in 1974		% Promoted between 1974 and 1978	
	Men	Women	Men	Women
All fields				
GS 12	1,455	68	55.7	54.4
GS 13	2,850	104	35.3	33.6
GS 14	2,125	56	24.5	26.8
GS 15	1,514	27	5.9	11.1
Physical scientists				
GS 12	501	26	54.7	50.0
GS 13	969	31	36.5	32.2
GS 14	824	15	26.3	53.3
GS 15	654	7	4.6	28.6
Bioscientists				
GS 12	393	26	52.2	38.5
GS 13	710	43	33.0	23.3
GS 14	420	21	24.2	14.3
GS 15	243	7	8.2	0.0

Salary increases

How did women scientists and engineers fare in terms of salary increases over the 1974-1978 period? The following analysis of salaries is limited to persons full-time employed in the federal government in both years. Comparisons are controlled by age due to the disproportionately large number of women in the younger age groups.

TABLE 2.8 Salary increases for full-time staff 1974-1978: scientists and engineers in the federal government

	Median salaries, 1974		Median salaries, 1978		Average annual increase (%)	
Age in 1978	Men	Women	Men	Women	Men	Women
Under 30	$11,860	$10,860	$21,300	$20,800	15.8%	17.6%
30-34	15,980	15,690	24,790	24,540	11.5	13.0
35-39	20,370	19,190	28,070	26,580	8.3	8.5
40-44	23,140	20,290	32,090	27,830	8.5	8.2
45-49	24,510	20,750	32,770	28,750	7.5	8.5
50 and over	26,000	22,200	33,770	30,100	6.8	7.9

In general, median salaries for women scientists and engineers increased somewhat faster than those for men, resulting in a slightly narrower salary gap in 1978. In the 50-and-over age group, median salaries had increased at an average annual rate of 7.9 percent for women, compared with 6.8 percent for men; the salary differential remained substantial, however, at $3,700 in 1978. The largest differential occurred in the mid-career group -- those age 40-44 -- where women scientists and engineers were typically paid $4,300 less than men.

Women in Management

Women scientists and engineers were promoted to management positions at a faster rate than men in the same age groups -- a finding that is consistent with the data on grade promotions presented earlier. Only one in twenty of the women age 45 and over held managerial jobs in 1974, while one in ten did so four years later. Despite the recent progress, male scientists and engineers in the same age group were nearly twice as likely to be employed as managers in 1978 (Table 2.9).

TABLE 2.9 Scientists and engineers in the federal government: Percent in managerial positions* by age and sex

Age in 1974	1974 % Managers		1978 % Managers	
	Men	Women	Men	Women
Total	12.3	4.2	14.7	7.3
Under 30	5.6	4.5	8.3	6.4
30-34	7.1	2.8	9.7	6.8
35-39	11.4	4.0	15.0	6.2
40-44	14.1	2.9	17.1	7.7
45-49	16.9	5.8	18.3	10.2
50 and over	17.7	5.3	18.3	8.7

*Includes positions for which management, planning, or administration is the "functional classification".

NOTE: Includes only those employed in the federal government in both 1974 and 1978.

New Hires

Between 1974 and 1978 about 5,900 women scientists and engineers were hired into the Civil Service, accounting for 13 percent of the new accessions.

Table 2.10 shows the proportion of women among those hired from outside the government by field of training, and separate statistics for the 10 agencies employing the largest numbers of scientists and engineers. Women comprised only two percent of the newly hired engineers but nearly 30 percent of the social scientists.

Within academic specialties there is considerable variation among agencies in the proportion of women hired. HEW ranked first in the proportion of women scientists hired -- close to 40 percent. Both NASA and the Veterans Administration (VA), show higher-than-average employment of women in at least eight out of nine fields, while the Environmental Protection Agency (EPA) and the Department of Transportation (DOT) have a lower-than-average record in seven out of nine fields. The Defense Department is lower in all nine fields, for the lowest overall proportion of women scientists and engineers among these 10 agencies.

TABLE 2.10 PROPORTION OF WOMEN AMONG NEW HIRES: Proportion of women among scientists and engineers hired into the federal service between 1974 and 1978 (all degree levels)

Field*		All Agencies	Defense	USDA	HEW	VA	Interior	Commerce	Treasury	DOT	NASA	EPA
All science/engr. fields	%	13.4	7.3	11.8	38.5	21.6	10.2	20.3	23.8	9.5	16.5	10.1
Mathematicians/statisticians		25.7	19.7	29.3	31.1	26.3	22.9	36.2	29.5	29.6	52.9	13.6
Computer specialists		14.1	9.3	19.4	20.0	21.9	23.9	17.2	14.3	6.8	30.0	35.7
Physicists		5.8	3.7	18.2	15.2	7.7	6.7	3.1	0	0	22.4	3.8
Chemists		16.1	10.6	15.0	30.1	29.4	19.1	20.0	14.6	6.3	26.9	11.0
Other physical scientists		10.0	7.7	14.0	25.7	33.3	11.7	5.0	12.5	6.7	16.7	7.2
Engineers		2.3	1.8	3.0	5.6	1.6	2.7	2.5	1.1	2.6	5.5	3.6
Agricultural scientists		8.4	5.4	9.2	26.3	18.2	3.6	22.1	10.0	24.1	11.1	6.0
Bioscientists		21.4	19.6	16.4	45.9	26.7	11.3	23.4	54.5	15.4	50.0	18.5
Social scientists		28.6	18.5	31.5	45.0	33.8	26.3	30.3	28.6	24.2	27.8	24.5

*Field of highest degree. Specialities included in each of the field categories are shown in Appendix C.

Among Ph.D. scientists and engineers hired into the federal government since 1974, women account for only about 8 percent of the total, although they are more than 16 percent of the recent doctorate-holders (Table 2.11). In other words, the number of women Ph.D.s among new accessions is about half that suggested by their presence in the pool of new Ph.D.s. Their hiring rates, which vary considerably by field, most nearly correspond to availability in physics and mathematics.

TABLE 2.11 PROPORTION OF WOMEN AMONG NEW PH.D. HIRES: Proportion of women among Ph.D. scientists and engineers hired into the federal service between 1974 and 1978, and their percent availability among graduates during the same period.

Field of doctorate	% Women among new Ph.D. hires 1974 - 1978	% Women among Ph.D.s awarded 1974 - 1978
All science/engr. fields	8.3%	16.8%
Mathematicians/statisticians	9.2	11.7
Computer specialists	0.0	9.3
Physicists	4.0	4.9
Chemists	8.1	11.2
Other physical scientists	4.7	7.4
Engineers	1.3	1.9
Agricultural scientists	3.7	5.7
Bioscientists	11.3	23.4
Social scientists	15.5	26.8

Status of new hires

Examining the new accessions by highest degree earned and years since degree, it is evident that a woman scientist is typically hired at a lower grade than a comparable male (Table 2.12). This was found at all degree levels and number of years since the degree was earned.

Among Ph.D.s, the sex differences in starting salaries are slight, but for those six years or more past the doctorate, the differential grows to at least $2,400.

TABLE 2.12 **MEDIAN GRADES AND MEDIAN SALARIES OF NEW HIRES: Median GS levels and salaries of scientists and engineers hired between 1974 and 1978 by highest degree earned, years since degree, and sex**

Highest degree earned	Median grade 1978 Men	Median grade 1978 Women	Median salary, 1978 (full-time staff) Men	Median salary, 1978 (full-time staff) Women
Bachelor's/Master's				
Years since:				
0	6.4	6.0	$16,100	$13,700
1-2	8.0	6.8	16,100	13,800
3-5	10.4	9.1	19,200	16,000
6-10	11.4	10.8	23,100	19,800
>10	12.5	11.1	29,500	23,400
Doctorate				
Years since:				
0	11.3	*	19,800	*
1-2	11.7	11.6	23,400	23,200
3-5	12.2	12.0	25,100	23,900
6-10	12.9	12.5	29,800	27,400
>10	14.0	13.0	37,500	31,700

*Fewer than 20 women.

Summary and Discussion

The federal government is a relatively minor employer of scientists and engineers, and the difference between the proportions of male and female scientists in government employment is much smaller than in industry. Nonetheless the disparities found -- in grade levels and therefore salaries -- closely parallel those in industry, with one major exception. That is that the higher promotion rates for women in recent years give some evidence of explicit efforts at equalization.

Of concern, however, is the continuing tendency to hire new women scientists at lower grade levels and salaries than men. While the extent of this practice has been reduced for recent doctorates, it is quite marked at the bachelor's and master's degree levels, which include the great majority of new hires. The imbalance created by the relative preponderance of women scientists at Grade 12 and below has increased since 1974.

While the finding that women were promoted to managerial positions more rapidly in the last few years is evidence of efforts at equalization, the fact that men in the same age groups are still twice as likely as women to be managers illustrates the magnitude of the inequalities which remain.

The available data do not identify causes for the sex differences.

For example, the analyses do not indicate to what extent the women scientists may have interrupted their careers in order to care for children and what impact this may have had on their long-term advancement in the government. A study of matched-pairs of men and women scientists in federal careers would offer the possibility of clarifying this issue.

CONCLUSIONS AND RECOMMENDATIONS

A comparison of industrial and government employment for women scientists and engineers suggests several parallels: in both sectors women and men are distributed differently both in terms of rank or grade level and in terms of work activities; women with identical education and work experience as men earn less and have less expectation of advancement. That this situation, a reflection of the general historical patterns of employment, should still obtain for older employees is perhaps no surprise: the very fact that they were disadvantaged in employment over a long period may now make them less experienced and knowledgeable and therefore less qualified. That newly trained women scientists face a very similar future despite nearly a decade of equal-opportunity mandates is cause for grave concern.

This is not to minimize the very real gains which have been made: the increases in the proportion of new hires in both government and industry, the reduction of salary differences for new hires in industry, and the growth in promotion rates and consequently salaries for women in government, represent significant advances. But they are only first steps.

While the percentage of women scientists employed in industry remains low, at about half that of their presence in the work force, it has increased dramatically in recent years. Even if women were hired at a utilization rate equivalent to men in each specialty, however, their total number in industry would remain relatively small in the forseeable future. This is especially true for minority women scientists who still represent less than one tenth of one percent of all doctoral scientists. For women in general, the proportions of new doctorates in the engineering, mathematical and physical sciences -- the dominant fields for Ph.D.s in industry -- are small and are expected to rise relatively slowly. Industrial employment of life and social scientists, with large fractions of women, is much lower than in the EMP fields.

Nonetheless, the disproportionately high unemployment rate of women scientists, especially in the physical sciences, suggests that recruiters may not be tapping this pool of available talent or that the doctoral women themselves may not be aware of opportunities in industry.[2]

A study to explore the reasons for low recruitment and hiring of women scientists in industry is now being planned by this Committee.

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[1]The conditions reported here also prevail in the academic sector, as documented in a previous report by this Committee, *Climbing the Academic Ladder: Doctoral Women Scientists in Academe.*

[2]As of 1977, unemployment rates for male and female Ph.D.s, respectively, were: in physics, 1.0 and 5.7 percent, and in chemistry, 0.9 and 5.0 percent. See *Science, Engineering, and Humanities Doctorates in the U.S., 1977 Profile*, p. 30.

Support of this effort is urged. Too little is known about general industrial needs and recruitment of doctoral scientists, on the one hand, and about the employment choices of women scientists on the other, to make any specific program recommendations at this time.

The markedly different distribution of primary work activities for men and women in industry suggests persistent sex stereotyping of jobs, which is generally recognized as the basic cause of salary differences. The fact that a disproportionately high fraction of women scientists and engineers remains engaged in basic or applied research, without promotion to management, and that their placement in "other", undefined work functions is even more unbalanced strongly implies a need for more effective equal opportunity monitoring at professional levels. A question that has been raised but cannot be answered at this time is to what extent women apply for these lower positions.

Salary differences between men and women persist even when controlled for field, full-time equivalent years of experience, or work function. Given the necessarily very small number of women scientists and engineers in a particular field, experience level, or function in a specific company, no general statistical analysis can reveal whether such differences may be justified in individual cases. The utility of regression analyses of the type widely used in assessing faculty salary differentials[3] should be explored. In any case it is recommended that, in addition to federal compliance requirements, companies internally conduct analyses of salaries and focus efforts on speedy rectification of any unjustified differences.

With regard to employment in federal agencies, where salaries are fixed according to grade levels, our data suggest that far more attention should be paid to equal initial job placements. If women scientists, on the average, are consistently assigned to lower starting grades than men regardless of their similarity in education and attainments, as our data indicate they are, then affirmative action within government agencies must focus on these initial grade placements. A special effort should be made to effect retroactive adjustments, where necessary, for women hired within the last few years.

Finally, greater attention must be paid to holders of other degrees. This Committee has been primarily concerned with doctoral women scientists and engineers in the past, although the above recommendations are intended to apply to bachelor's and master's degree recipients as well. Our brief review of government employment of women scientists and engineers at the lower degree levels shows that inequalities in grade assignment and consequently in salary are proportionately far more serious for this much larger group than for women doctorates. This finding suggests and urgent need to study in depth the employment of women with bachelor's and master's degrees in industry.

[3] Alan E. Bayer and Helen S. Astin, *Sex Differentials in the Academic Reward System*, Science, Vol. 188, 1975, pp. 796-802.

The fresh recognition of the importance of industrial research and development to our national future underscores the need for full use of available talent and hence the salience of equal industrial employment opportunities for women scientists and engineers.

APPENDIX A
QUESTIONNAIRE

OMB No 099-RO294

1977 SURVEY OF DOCTORATE RECIPIENTS

CONDUCTED BY THE NATIONAL RESEARCH COUNCIL WITH THE SUPPORT OF THE NATIONAL SCIENCE FOUNDATION, THE NATIONAL ENDOWMENT FOR THE HUMANITIES, AND THE NATIONAL INSTITUTES OF HEALTH

THE ACCOMPANYING LETTER requests your assistance in this biennial survey of Ph.D.'s in the humanities, sciences, and engineering.
PLEASE READ the instructions for each question carefully and answer by printing your reply or checking the appropriate box.
PLEASE CHECK the pre-printed information to be certain that it is correct and complete.
PLEASE RETURN the completed form in the enclosed envelope to the Commission on Human Resources, JH 638, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.
NOTE: THIS INFORMATION IS SOLICITED UNDER THE AUTHORITY OF THE NATIONAL SCIENCE FOUNDATION ACT OF 1950, AS AMENDED. ALL INFORMATION YOU PROVIDE WILL BE TREATED AS CONFIDENTIAL AND USED FOR STATISTICAL PURPOSES ONLY. INFORMATION WILL BE RELEASED ONLY IN THE FORM OF STATISTICAL SUMMARIES OR IN A FORM WHICH DOES NOT IDENTIFY INFORMATION ABOUT ANY PARTICULAR PERSON. YOUR RESPONSE IS ENTIRELY VOLUNTARY AND YOUR FAILURE TO PROVIDE SOME OR ALL OF THE REQUESTED INFORMATION WILL IN NO WAY ADVERSELY AFFECT YOU.

If your name and address are incorrect, please enter correct information above. Include ZIP CODE

If there is an alternate address through which you can always be reached, please provide it on the line below. (10)

C/O Number Street City State ZIP Code (11)

1. Date of Birth Mo. Day Year (12-16)	2. State or Foreign Country of Birth (17-18)	3. Citizenship 0 ☐ U.S.A. 1 ☐ Non-U.S.A., Specify Country ____ (19) (20-21)	4. Sex 1 ☐ M 2 ☐ F (22)

5. What is your racial background?
0 ☐ American Indian or Alaskan Native
1 ☐ Asian or Pacific Islander
2 ☐ Black
3 ☐ White
(23)

5a. Is your ethnic heritage Hispanic?
0 ☐ Yes
1 ☐ No
(24)

6. List in the table below all collegiate and graduate degrees, excluding honorary degrees, that have been awarded to you. Please check the pre-printed information, including the number and name of the specialty from the list on page 4, to be certain that it is correct and complete.

Type of Degree	Granted Mo Yr.	Major Field (Use Specialties List) Name Number	Institution Name	City (or Campus) & State
Bachelor's				
Master's				
Doctorate				
Other(Specify) ____				

7. What was your employment status as of February 6-12, 1977? (Check only one category.)

Employed full-time in field of Ph.D. ☐ 1
Employed full-time in field other than field of Ph.D. ☐ 2
Employed part-time ☐ 3
Were you seeking full-time employment?
1 ☐ Yes 2 ☐ No (66)
Postdoctoral appointment (fellowship, traineeship, research associateship, etc.) ☐ 4
Unemployed and seeking employment ☐ 5
Not employed and not seeking employment ☐ 6
Retired and not employed ☐ 7
Other, specify ____ ☐ 8
(65)

7a. If you were employed full-time during February 6-12, 1977, in a field other than your field of Ph.D., what was the MOST important reason for taking the position?

Preferred position outside Ph.D. field ☐ 1
Promoted out of position in Ph.D. field ☐ 2
Better pay ☐ 3
Locational factors ☐ 4
Position in Ph.D. field not available ☐ 5
Other, specify ____ ☐ 6
(67)

If you checked 5, 6 or 7, ANSWER ONLY 8a, 9a, 13, 14 and 17 of the following questions

8. Which category below best describes the type of organization of your principal employment OR postdoctoral appointment during February 6-12, 1977? (Check only one category.)

Business or industry	☐ 1	Hospital or clinic	☐ 10
Junior college, 2-year college, technical institute	☐ 2	U.S. military service, active duty, or Commissioned Corps, e.g., USPHS, NOAA	☐ 11
Medical school	☐ 3	U.S. government, civilian employee	☐ 12
4 Year college	☐ 4	State government	☐ 13
University, other than medical school	☐ 5	Local or other government, specify ______	☐ 14
Elementary or secondary school system	☐ 6	Non-profit organization, other than those listed above	☐ 15
Private foundation	☐ 7	Other, specify: ______	☐ 16
Museum or historical society	☐ 8		
Research library or archives	☐ 9		(68-69)

8a Which of the above categories best describes the type of organization related to your first position following the receipt of your doctorate? (List only one category)

____
Type of Organization (70 71)

9. What percent of time did you devote to each of the following activities during the week of February 6-12, 1977? (Total should equal 100%.)
What were your primary (A) and secondary (B) work activities? (Check only one in each column.)

	%		A		B
Management or administration of					
Research and development	____	(10)	☐	1	☐
Other than research and development	____	(12)	☐	2	☐
Both	____	(14)	☐	3	☐
Basic research	____	(16)	☐	4	☐
Applied research	____	(18)	☐	5	☐
Development of equipment, products, systems, data	____	(20)	☐	6	☐
Development of humanities resource materials	____	(22)	☐	7	☐
Design	____	(24)	☐	8	☐
Teaching	____	(26)	☐	9	☐
Writing, editing	____	(28)	☐	10	☐
Curatorial	____	(30)	☐	11	☐
Production	____	(32)	☐	12	☐
Consulting, specify ______	____	(34)	☐	13	☐
Professional services to individuals	____	(36)	☐	14	☐
Quality control, inspection, testing	____	(38)	☐	15	☐
Sales, marketing, purchasing, estimating	____	(40)	☐	16	☐
Other, specify ______	____	(42)	☐	17	☐
Total =	100%			(44-47)	

9a. Which of the above categories best describes the primary work activity related to your first position following the receipt of your doctorate?

____
Primary Work Activity Number (48-49)

10. From the Degree and Employment Specialties List on page 4 select and enter both the number and title of the employment specialty most closely related to your principal employment or postdoctoral appointment during the week of February 6-12, 1977. Write in your specialty if it is not on the list.

____
Number Title of Employment Specialty (50-52)

11. Please give the name of your principal employer (organization, company, etc. or, if self employed, write "self"), and actual place of employment as of the week of February 6-12, 1977.

____
Name of Employer (53-58)

____
Number Street

____
City State ZIP Code
(59-63)

12. What was the basic annual salary* associated with your principal professional employment during the week of February 6-12, 1977? If you were on a postdoctoral appointment (e.g., fellowship, traineeship, research associateship), what was your annual stipend plus allowances?

$ ____________ per year (64-66)

*NOTE Basic annual salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work

IF ACADEMICALLY EMPLOYED:

a Check whether salary was for ☐ 9-10 months or ☐ 11-12 months (67)

b Did you hold a tenured position during February 6-12, 1977? 0 ☐ Yes 1 ☐ No (68)
If Yes, what year was tenure granted? ____________ (69 70)

c What was the rank of your position? (Check only one.)

1 ☐ Professor
2 ☐ Associate Professor
3 ☐ Assistant professor
4 ☐ Instructor
5 ☐ Lecturer
6 ☐ Other, specify ____________ (71)

d What, if any, administrative position did you hold?

1 ☐ Dean
2 ☐ Department Chairman
3 ☐ President or Chancellor
4 ☐ Vice-President or Vice Chancellor
5 ☐ Other, specify ____________
6 ☐ Does not apply
(72)

13 How many full-time equivalent years of professional work experience, including teaching, have you had? ____________ Year(s)
(73-74)

14. Following completion of your doctorate have you ever held a fellowship, traineeship, or research associateship? 0 ☐ Yes 1 ☐ No
(75)

15. Listed below are selected topics of national interest. If you devoted a proportion of your professional time which you considered significant to any of these problem areas during the week of February 6-12, 1977, please check the box for the one on which you spent the MOST time.

1 ☐ Health
2 ☐ Defense
3 ☐ Environmental protection, pollution control
4 ☐ Education
5 ☐ Space
6 ☐ Crime prevention and control
7 ☐ Energy and fuel
8 ☐ Food and other agricultural products
9 ☐ Natural resources, other than fuel or food
10 ☐ Community development and services
11 ☐ Housing (planning, design, construction)
12 ☐ Transportation, communications
13 ☐ Cultural life
14 ☐ Other area, specify: ____________
15 ☐ Does not apply

(10-11)

16. Was any of your work in the week of February 6-12, 1977 supported or sponsored by U.S. Government funds?

0 ☐ Yes 1 ☐ No 2 ☐ Don't know (12)

If Yes, which of the following federal agencies or departments were supporting the work? (Check all that apply.)

13 ☐ Agency for International Development
14 ☐ Energy Research & Development Administration
15 ☐ Environmental Protection Agency
16 ☐ National Aeronautics & Space Administration
17 ☐ National Endowment for the Arts
18 ☐ National Endowment for the Humanities
19 ☐ National Science Foundation
20 ☐ Nuclear Regulatory Commission
21 ☐ Smithsonian Institution
22 ☐ Department of Agriculture
23 ☐ Department of Commerce
24 ☐ Department of Defense

Department of Health, Education, and Welfare
25 ☐ National Institutes of Health
26 ☐ Alcohol, Drug Abuse & Mental Health Administration
27 ☐ National Institute of Education
28 ☐ Office of Education
29 ☐ Other, specify: ____________
30 ☐ Department of Housing and Urban Development
31 ☐ Department of the Interior
32 ☐ Department of Justice
33 ☐ Department of Labor
34 ☐ Department of State
35 ☐ Department of Transportation
36 ☐ Other agency or department, specify: ____________
37 ☐ Don't know source agency

17. If you received your doctoral degree in science or engineering or are employed as a scientist or engineer, please check all that apply below:

☐ (a) Changed positions during the period 1973 to 1976
☐ (b) Received doctoral degree in 1965 or later and employed sometime since receiving your doctoral degree in industry, government, or as non-faculty academic staff
☐ (c) Held a postdoctoral appointment any year during 1970-1976 inclusive
☐ (d) None of the above apply (38-41)

If you have checked a, b, or c, please give a brief career history starting with the position prior to your present position and continuing back in time for a maximum of four positions after receiving your doctoral degree (include postdoctoral appointments).

Name and Location (City and State) of Employer	Position Title	Dates Held	Primary Work Activity*	Employment Specialty (Use Degree & Employment Specialties List)	Reason for Leaving Position
1					
2					
3					
4					

*Enter code (1-17) from the list given in item 9

(a) Of the positions described above as well as your present position, please check any in which your doctoral training was/is not being used.
☐ Position 1 ☐ Position 2 ☐ Position 3 ☐ Position 4 ☐ Present Position ☐ None

(74-79)

DEGREE AND EMPLOYMENT SPECIALTIES LIST

MATHEMATICAL SCIENCES

000 · Algebra
010 · Analysis & Functional Analysis
020 · Geometry
030 · Logic
040 · Number Theory
052 · Probability
055 · Math Statistics (see also 544, 670, 725, 729)
060 · Topology
082 · Operations Research (see also 478)
085 · Applied Mathematics
089 · Combinatorics & Finite Mathematics
091 · Physical Mathematics
098 · Mathematics, General
099 · Mathematics, Other*

COMPUTER SCIENCES

071 Theory
072 · Software Systems
073 · Hardware Systems
074 · Intelligent Systems
079 · Computer Sciences, Other

PHYSICS & ASTRONOMY

101 · Astronomy
102 · Astrophysics
110 Atomic & Molecular Physics
120 Electromagnetism
130 · Mechanics
132 · Acoustics
134 · Fluids
135 · Plasma Physics
136 Optics
138 Thermal Physics
140 · Elementary Particles
150 · Nuclear Structure
160 · Solid State
198 · Physics, General
199 · Physics, Other*

CHEMISTRY

200 · Analytical
210 · Inorganic
215 Synthetic Inorganic & Organometallic
220 · Organic
225 · Synthetic Organic & Natural Products
230 · Nuclear
240 · Physical
245 · Quantum
250 · Theoretical
255 Structural
260 · Agricultural & Food
265 · Thermodynamics & Material Properties
270 Pharmaceutical
275 · Polymers
280 · Biochemistry (see also 540)
285 · Chemical Dynamics
298 · Chemistry, General
299 · Chemistry, Other*

EARTH, ENVIRONMENTAL AND MARINE SCIENCES

301 · Mineralogy, Petrology
305 · Geochemistry
310 · Stratigraphy, Sedimentation
320 · Paleontology
330 Structural Geology
341 · Geophysics (Solid Earth)
350 · Geomorph & Glacial Geology
391 · Applied Geol, Geol Engr & Econ Geol
395 · Fuel Tech & Petrol Engr (see also 479)
360 · Hydrology & Water Resources
370 · Oceanography
397 · Marine Sciences, Other*
381 · Atmospheric Physics & Chemistry
382 · Atmospheric Dynamics
383 · Atmospheric Sciences, Other*
388 · Environmental Sciences, General (see also 480, 528)
389 · Environmental Sciences, Other*
398 · Earth Sciences, General
399 · Earth Sciences, Other*

ENGINEERING

400 · Aeronautical & Astronautical
410 · Agricultural
415 · Biomedical
420 · Civil
430 · Chemical
435 · Ceramic
440 · Electrical
445 · Electronics
450 · Industrial & Manufacturing
455 · Nuclear
460 Engineering Mechanics
465 · Engineering Physics
470 Mechanical
475 · Metallurgy & Phys Met. Engr
476 · Systems Design & Systems Science (see also 072, 073, 074)
478 Operations Research (see also 082)
479 Fuel Technology & Petrol Engr
480 · Sanitary & Environmental
486 · Mining
497 Materials Science Engr.
498 · Engineering, General
499 · Engineering, Other*

AGRICULTURAL SCIENCES

500 Agronomy
501 · Agricultural Economics
502 · Animal Husbandry
504 Fish & Wildlife
505 Forestry
506 · Horticulture
507 Soils & Soil Science
510 Animal Science & Animal Nutrition
511 Phytopathology
517 · Food Science & Technology (see also 573)
518 Agriculture, General
519 · Agriculture, Other*

MEDICAL SCIENCES

520 Medicine & Surgery
522 Public Health & Epidemiology
523 Veterinary Medicine
524 Hospital Administration
526 · Nursing
527 · Parasitology
528 · Environmental Health
534 · Pathology
536 Pharmacology
537 Pharmacy
538 Medical Sciences, General
539 Medical Sciences, Other*

BIOLOGICAL SCIENCES

540 Biochemistry (see also 280)
542 · Biophysics
543 · Biomathematics
544 · Biometrics, Biostatistics (see also 055, 670, 725, 729)
545 · Anatomy
546 Cytology
547 Embryology
548 Immunology
550 Botany
560 Ecology
562 Hydrobiology
564 Microbiology & Bacteriology
566 Physiology, Animal
567 Physiology, Plant
569 Zoology
570 Genetics
571 Entomology
572 Molecular Biology
573 Food Science & Technology (see also 517)
574 Behavior/Ethology
576 Nutrition & Dietetics
578 Biological Sciences, General
579 Biological Sciences, Other*

PSYCHOLOGY

600 Clinical
610 Counseling & Guidance
620 · Developmental & Gerontological
630 · Education
635 · School Psychology
641 · Experimental
642 · Comparative
643 Physiological
650 · Industrial & Personnel
660 · Personality
670 · Psychometrics (see also 055, 544, 725, 729)
680 · Social
698 · Psychology, General
699 · Psychology, Other*

SOCIAL SCIENCES

700 · Anthropology
703 Archeology
708 · Communications*
709 · Linguistics
710 · Sociology
720 · Economics (see also 501)
725 · Econometrics (see also 055, 544, 670, 729)
729 · Social Statistics (see also 055, 544, 670, 725)
740 · Geography
745 Area Studies*
751 · Political Science
752 · Public Administration
755 · International Relations
770 Urban & Regional Planning
775 · History & Philosophy of Science
798 · Social Sciences, General
799 · Social Sciences, Other*

HUMANITIES

802 · History & Criticism of Art
804 History, American
805 · History, European
806 · History, Other*
808 · American Studies
830 Music
831 · Speech as a Dramatic Art (see also 885)
833 · Religion (see also 881)
834 · Philosophy
836 · Comparative Literature
878 · Humanities, General
879 · Humanities, Other*
891 Library & Archival Sciences

LANGUAGES & LITERATURE

811 · American
812 · English
821 · German
822 · Russian
823 · French
824 · Spanish & Portuguese
826 · Italian
827 · Classical*
829 · Other Languages*

EDUCATION & OTHER PROFESSIONAL FIELDS

938 Education
801 · Art, Applied
881 · Theology (see also 833)
882 · Business Administration
883 · Home Economics
884 · Journalism
885 · Speech & Hearing Sciences (see also 831)
886 · Law, Jurisprudence
887 · Social Work
897 · Professional Field, Other*

899 **OTHER FIELDS***

*Identify the specific field in the space on the questionnaire

APPENDIX B
SAMPLING ERRORS FOR THE 1977 SURVEY OF DOCTORATE RECIPIENTS

As noted on page 3, data from the National Research Council's Survey of Doctorate Recipients is subject to error due to sampling variability. Estimated sampling errors for selected statistics on women in industry are provided below (Tables B-1 and B-2).

Sampling errors for percent statistics. The sampling errors for percent statistics were computed as $s = \sqrt{\frac{pq}{n}}$ where

p = the percent x 100

q = 1 - p

and n = the size of the sample on which the percent is based.

The finite population correction factor, $\sqrt{\frac{N-n}{N-1}}$, has been omitted since it would have a negligible effect on most of the calculated errors.[1] The above formula also assumes a simple random sample whereas a stratified random sample was used. However, it has been shown that alternate standard error calculations, taking stratification into account, yield estimates that are quite similar to those derived from the more general formula used here.[2]

[1]As a result of omitting the finite population correction factor, the sampling error will be somewhat overestimated.

[2]Betty D. Maxfield, Nancy C. Ahern, and Andrew W. Spisak, *Science, Engineering and Humanities Doctorates in the United States: 1977 Profile* (Washington, D.C.: National Academy of Science, 1978) pp. 78-79. See comparison of sampling errors based on (i) a simple random sample, and (ii) the stratified random sample, for the 1977 Survey of Doctorate Recipients.

TABLE B-1 Estimated sampling errors (in parentheses) for selected statistics on doctoral women scientists in industry, 1977

	Men	Women
% Employed in business/industry		
All Ph.D.s	25.4 (0.3)	7.0 (0.3)
New Ph.D.s	25.1 (0.9)	9.1 (1.0)
% Women among Ph.D.s in industry		
Engineering, mathematics, and physical sciences	n/a	1.9 (0.2)
Life sciences	n/a	4.8 (0.6)
Behavioral & social sciences	n/a	9.5 (1.5)
% Distribution of doctoral scientists and engineers in industry by primary work activity		
Management of R & D	27.7 (0.6)	13.5 (1.5)
Basic research	6.7 (0.3)	14.8 (1.5)
Applied research	25.5 (0.6)	29.3 (1.9)
Development	16.3 (0.5)	7.0 (1.1)
Management of non-R & D	9.5 (0.4)	4.6 (0.9)
Other activities	14.3 (0.5)	30.9 (2.0)
% of Ph.D.s in industry who earned doctorate from prestigious department		
1970-1976 Ph.D.s	40.6 (1.0)	40.9 (2.7)
1975-1976 Ph.D.s only	39.5 (2.0)	37.8 (4.5)
% of recent Ph.D.s in industry who had received postdoctoral training		
Physics	39.9 (4.2)	12.8 (7.3)
Chemistry	38.0 (2.2)	30.4 (4.3)
Medical sciences	41.2 (4.7)	23.0 (10.9)
Biological sciences	37.0 (3.6)	45.3 (8.4)

Sampling errors for median salaries. Sampling errors were computed for all median salary figures shown in Part 1 of this report.[3] The sampling error estimates, again assuming a simple random sample, were computed as follows:

1. Since the median is the estimated 50th percentile figure, the sampling error for p = .50 was calculated:

$$\sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{.50(.50)}{n}} = \sqrt{\frac{.25}{n}}$$

2. The above resulted in an upper and lower bound on .50. Multiplied by 100, these were translated to upper and lower percentiles.

3. The salaries associated with the upper and lower percentile figures were then calculated, providing a two-thirds confidence interval for the median salary.[4]

   Example: The estimated median salary in 1977 for recent women Ph.D.s in industry is $22,100 (Table 1.10). This is based on a sample of 305 such women. In this case, the sampling error for p = .50 is:

$$\sqrt{\frac{.50(.50)}{n}} = \sqrt{\frac{.25}{305}} = .03$$

   Given that p =.50 $\pm$ .03, the upper and lower percentiles of interest are (.05 - .03)100 and (.05 + .03)100 or the 47th and 53rd percentiles. Next, the 47th and 53rd percentile salaries for the recent women Ph.D.s are computed--$21,900 and $22,400. The two-thirds confidence interval for the estimate of $22,100 is thus $21,900-$22,400.

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[3]The procedure for estimating sampling errors of medians was derived from Morris H. Hansen, William N. Hurwitz, and William G. Madow, *Sample Survey Methods and Theory*, vol. 1 (New York: John Wiley & Sons, Inc., 1953), pp. 448-449.

[4]For readers not familiar with this term, a two-thirds confidence interval is the interval from one standard error or sampling error below the estimate to one standard error above the estimate. With two-thirds or 67 percent confidence, the interval includes the average result that would have been obtained from all possible samples of the same design.

It should be noted that the confidence intervals for the median salaries are generally not symmetric. This is because the salaries tend to be more variable above the median than below the median.

Table B-2 below shows the estimated confidence intervals for median salaries that appeared in text Tables 1.7-1.9 and Figures 1.3-1.4.

TABLE B-2. Estimated confidence intervals for median salaries, doctoral scientists and engineers in industry

From:				Median salary ($ in thousands)	2/3 Confidence interval[a] ($ in thousands)
TABLE 1.7	1934-1957 Ph.D.s:				
	All fields	(1973)	Men	$28.1	$27.9-28.4
			Women	22.3	21.7-22.9
		(1977)	Men	37.7	37.3-38.0
	EMP fields	(1973)	Men	27.7	27.4-28.2
			Women	22.1	21.2-22.7
		(1977)	Men	37.4	36.8-38.0
	Life sciences	(1973)	Men	28.9	28.3-29.6
		(1977)	Men	37.8	36.6-38.9
	1958-1969 Ph.D.s:				
	All fields	(1973)	Men	22.8	22.7-22.9
			Women	20.5	20.2-20.8
		(1977)	Men	31.4	31.2-31.6
			Women	27.5	26.6-28.2
	EMP fields	(1973)	Men	22.7	22.6-22.8
			Women	20.4	20.0-20.8
		(1977)	Men	31.3	31.1-31.5
			Women	27.2	26.3-27.9
	Life sciences	(1973)	Men	23.1	22.8-23.4
			Women	19.7	19.0-20.4
		(1977)	Men	32.0	30.8-32.6
			Women	26.9	25.7-28.5
	Behavioral and social sciences	(1973)	Men	27.7	25.9-29.0
	1970-1972 Ph.D.s:				
	All fields	(1973)	Men	18.7	18.6-18.8
			Women	16.3	15.7-16.9
		(1977)	Men	26.8	26.5-27.1
			Women	24.0	23.2-24.4
	EMP fields	(1973)	Men	18.7	18.6-18.8
			Women	16.4	15.7-17.0
		(1977)	Men	26.8	26.5-27.1
			Women	23.5	22.5-24.1
	Life sciences	(1973)	Men	17.7	17.5-17.9
			Women	14.8	14.3-15.5
		(1977)	Men	25.6	25.1-26.1
			Women	22.3	21.7-22.9
	Behavioral and social sciences	(1973)	Men	20.2	19.0-20.8
			Women	17.5	17.2-17.8
		(1977)	Men	29.8	28.5-30.9
			Women	30.4	28.6-32.1

[a]There is 2/3 or 67 percent confidence that the interval includes the value being estimated.

TABLE B-2. (continued) Estimated confidence intervals for median salaries, doctoral scientists and engineers in industry

From:			Median salary ($ in thousands)	2/3 Confidence interval[a] ($ in thousands)
FIGURE 1.3	1934-1957 Ph.D.s	Men	$37.7	$37.3-38.0
		Women	30.0	27.9-31.6
	1958-1969 Ph.D.s	Men	31.4	31.2-31.6
		Women	27.5	26.6-28.2
	1970-1972 Ph.D.s	Men	26.8	26.5-27.1
		Women	24.0	23.2-24.4
	1973-1974 Ph.D.s	Men	24.2	24.1-24.4
		Women	21.3	20.8-22.3
	1975-1976 Ph.D.s	Men	21.6	21.5-21.7
		Women	21.2	20.7-21.6
TABLE 1.8	All fields			
	2 years experience or less	Men	21.0	20.8-21.2
		Women	19.5	19.0-20.0
	3-5 years	Men	23.0	22.8-23.2
		Women	20.9	20.6-21.3
	6-9 years	Men	26.8	26.6-27.1
		Women	25.4	24.5-26.4
	10-14 years	Men	30.3	30.2-30.4
		Women	28.2	26.5-29.2
	15-19 years	Men	33.1	32.7-33.5
		Women	27.2	26.3-28.9
	20-24 years	Men	35.4	35.0-35.8
		Women	28.4	27.5-30.3
	25 years or more	Men	37.6	36.9-38.3
	EMP fields			
	2 years experience or less	Men	21.2	21.0-21.4
		Women	20.5	19.9-21.1
	3-5 years	Men	23.0	22.9-23.2
		Women	21.6	20.9-22.1
	6-9 years	Men	26.9	26.7-27.2
		Women	24.6	24.0-25.8
	10-14 years	Men	30.3	30.1-30.4
		Women	25.7	25.1-26.9
	15-19 years	Men	32.7	32.4-33.1
		Women	26.8	25.3-28.1
	20-24 years	Men	35.0	34.5-35.4
		Women	28.3	27.4-30.1
	25 years or more	Men	37.5	36.9-38.2
		Women	30.4	29.0-31.9
	Life sciences			
	2 years experience or less	Men	$19.3	$18.8-19.8
	3-5 years	Men	22.9	22.5-23.3
		Women	20.5	19.9-21.1
	6-9 years	Men	25.7	25.3-26.3
		Women	23.1	22.3-24.2
	10-14 years	Men	30.3	30.0-30.6
	15-19 years	Men	35.8	35.3-36.5
	20-24 years	Men	36.2	35.3-37.4
	25 years or more	Men	37.6	35.9-39.0
		Women	28.2	26.1-30.0
	Behavioral & social sciences			
	3-5 years experience	Men	23.2	22.2-24.7
	6-9 years	Men	27.8	26.6-29.5
	10-14 years	Men	31.4	30.6-32.5
		Women	30.2	29.6-32.2

[a]There is 2/3 or 67 percent confidence that the interval includes the value being estimated.

TABLE B-2. (continued) Estimated confidence intervals for median salaries, doctoral scientists and engineers in industry

From:			Median salary ($ in thousands)	2/3 Confidence interval[a] ($ in thousands)
TABLE 1.9	EMP fields			
	Performance of R&D			
	2 years experience or less	Men	21.4	21.1-21.6
		Women	21.2	20.8-21.5
	3-5 years	Men	23.2	23.1-23.4
		Women	22.4	22.1-22.8
	6-9 years	Men	26.0	25.7-26.2
		Women	25.2	24.5-26.3
	10-14 years	Men	28.9	28.8-29.2
		Women	26.3	25.0-28.4
	15-19 years	Men	30.0	29.5-30.3
		Women	25.1	24.5-26.3
	Management of R&D			
	3-5 years	Men	23.4	22.6-24.3
		Women	18.8	18.1-20.6
	6-9 years	Men	30.0	29.6-30.3
		Women	23.9	23.2-31.0
	10-14 years	Men	32.0	31.5-32.5
		Women	25.8	25.2-27.5
	15-19 years	Men	36.1	35.6-36.5
		Women	34.4	33.0-36.2

[a]There is 2/3 or 67 percent confidence that the interval includes the value being estimated.

APPENDIX C
DEFINITION OF FEDERALLY EMPLOYED SCIENTISTS AND ENGINEERS

For the analyses in Part 2 of this report, scientists and engineers were defined as individuals who had earned degrees in science and engineering and who were employed in selected scientific, engineering, or administrative positions, according to the Central Personnel Data File.[1]

Degree criteria. Only those persons who had earned a baccalaureate or higher degree in a science or engineering field were selected. The academic discipline codes that were included are shown in Table C-1. Individuals with professional degrees in medicine and law as their highest degree were not included.

Occupation criteria. The population was further restricted to persons employed in selected professional scientific and engineering positions or in certain administrative categories. The occupational codes and corresponding titles are listed in Table C-2.

Primary job function. Those engaged primarily in clinical practice, as indicated by "functional classification", were excluded from the analyses.

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[1]The file, which is maintained by the Office of Personnel Management, is briefly described on page 3 of this report.

TABLE C-1 Definition of Science and Engineering Fields*

Name of Field	Code
Mathematics/statistics	
Mathematics, general	1701
Statistics, mathematical & theoretical	1702
Applied mathematics	1703
Other, related	1799
Operations research	0507
Computer sciences	
Computer and information sciences, general	0701
Information sciences & systems	0702
Data processing	0703
Computer programming	0704
Systems analysis	0705
Other, related	0799
Physics	
Physics, general (excluding biophysics)	1902
Molecular physics	1903
Nuclear physics	1904
Chemistry	
Chemistry, general (excludes biochemistry)	1905
Inorganic chemistry	1906
Organic chemistry	1907
Physical chemistry	1908
Analytical chemistry	1909
Pharmaceutical chemistry	1910
Other physical sciences	
Physical sciences, general	1901
Astronomy	1911
Astrophysics	1912
Atmospheric sciences & meteorology	1913
Geology	1914
Geochemistry	1915
Geophysics & seismology	1916
Earth sciences, general	1917
Paleontology	1918
Oceanography	1919
Metallurgy	1920
Other, related	1999

Name of Field	Code
Engineering	
Engineering, general	0901
Aerospace, aeronautical, astronautical	0902
Agricultural	0903
Bioengineering and biomedical	0905
Chemical engineering (includes petroleum refining)	0906
Petroleum engineering (excludes petroleum refining)	0907
Civil, construction, transportation	0908
Electrical, electronics, communications	0909
Mechanical	0910
Geological	0911
Geophysical	0912
Industrial & management	0913
Metallurgical	0914
Materials	0915
Ceramic	0916
Textile	0917
Mining, mineral	0918
Engineering physics	0919
Nuclear	0920
Engineering mechanics	0921
Environmental, sanitary	0922
Ocean	0924
Engineering technologies (B.S. & higher)	0925
Other, related	0999
Agricultural sciences	
Agriculture, general	0101
Agronomy (field crops, crops management)	0102
Soils science (management, conservation)	0103
Animal science (husbandry)	0104
Dairy science (husbandry)	0105
Poultry science	0106
Fish, game, wildlife management	0107
Horticulture (fruit, vegetable production)	0108
Ornamental horticulture (floriculture, nursery science)	0109
Agricultural, farm management	0110
Agricultural economics	0111
Food science, technology	0113
Forestry	0114
Natural resources management	0115
Agriculture, forestry technologies (B.S. & higher)	0116
Range management	0117
Other, related	0199
Environmental design, general	0201
City, community, regional planning	0206

*Based on the "academic discipline" of highest degree earned, as indicated in the Central Personnel Data File.

TABLE C.1 (continued)

Biological sciences	Code
Biological, general	0401
Botany, general	0402
Bacteriology	0403
Plant pathology	0404
Plant pharmacology	0405
Plant physiology	0406
Zoology, general	0407
Pathology, human & animal	0408
Pharmacology, human & animal	0409
Physiology, human & animal	0410
Microbiology	0411
Anatomy	0412
Histology	0413
Biochemistry	0414
Biophysics	0415
Molecular biology	0416
Cell biology (cytology, cell physiology)	0417
Marine biology	0418
Biometrics, biostatistics	0419
Ecology	0420
Entomology	0421
Genetics	0422
Radiobiology	0423
Nutrition, scientific (excludes nutrition in home economics and dietetics)	0424
Neurosciences	0425
Toxicology	0426
Embryology	0427
Wildlife biology	0498
Other, related	0499
Foods, nutrition	1306

Social sciences	Code
Psychology, general	2001
Experimental psychology	2002
Clinical psychology	2003
Psychology for counseling	2004
Social psychology	2005
Psychometrics	2006
Statistics in psychology	2007
Industrial psychology	2008
Developmental psychology	2009
Physiological psychology	2010
Other, related	2099
Family relations, child development	1305
Social sciences, general	2201
Anthropology	2202
Archaeology	2203
Economics	2204
Geography	2206
Political science, government	2207
Sociology	2208
Criminology	2209
International relations	2210
Afro-American cultural studies	2211
American Indian studies	2212
Mexican-American cultural studies	2213
Urban studies	2214
Demography	2215
Other, related	2299
Communications, general	0601
Linguistics	1505
Area studies	0301 to 0399
Public administration	2102
Biological and physical sciences & engineering, general	4902,4904

TABLE C-2 Occupational Titles Included in the Federal Employment Analyses (only for those with degrees in science and engineering)

PROFESSIONAL

CODE	TITLE	CODE	TITLES
1510	Actuary	0406	Agricultural extension
1515	Operations research	0434	Plant pathology
1520	Mathematics	0436	Plant protection&quarantine
1529	Mathematical statistician	0437	Horticulture
1530	Statistician	0454	Range conservation
		0457	Soil conservation
		0460	Forestry
		0470	Soil science
1310	Physics	0471	Agronomy
		0475	Agricultural management
1320	Chemistry	0480	General fish & wildlife
		0482	Fishery biology
1301	General physical science	0485	Wildlife refuge management
1313	Geophysics	0486	Wildlife biology
1315	Hydrology	0487	Husbandry
1321	Mettalurgy		
1330	Astronomy & space science	1306	Health physics
1340	Meteorology	0401	General biological science
1350	Geology	0403	Microbiology
1360	Oceanography	0405	Pharmacology
1372	Geodesy	0410	Zoology
		0413	Physiology
		0414	Entomology
0801	General engineering	0430	Botany
0803	Safety engineering	0435	Plant physiology
0804	Fire prevention engineering	0440	Genetics
0806	Materials engineering		
0810	Civil engineering		
0819	Sanitary engineering	0101	Social science
0830	Mechanical engineering	0110	Economist
0840	Nuclear engineering	0130	Foreign affairs
0850	Electrical engineering	0131	International relations
0855	Electronics engineering	0135	Foreign agricultural affairs
0858	Biomedical engineering	0140	Manpower research and analysis
0861	Aerospace engineering	0150	Geography
0880	Mining engineering	0180	Psychology
0881	Petroleum engineering	0184	Sociology
0890	Agricultural engineering	0190	General anthropology
0892	Ceramic engineering	0193	Archeology
0893	Chemical engineering	1370	Cartography
0894	Welding engineering	1373	Land surveying
0896	Industrial engineering	0020	Community planning

ADMINISTRATIVE

CODE	TITLE	CODE	TITLES
0301	General clerical & administrative	0342	Office services management
0330	Digital computer systems	0343	Management analysis
0334	Computer specialist	0345	Program analysis
0340	Program management	0346	Logistics management
0341	Administrative officer	0391	Communications management
		0132	Intelligence
		0136	International cooperation