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INDUSTRIAL RESEARCH-DEVELOPMENT EXPENDITURES IN CANADA

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PREFACE

This publication, prepared by the Dominion Bureau of Statistics in cooperation with the National Research Council, presents in tabular form an estimate of the magnitude and direction of the research-development program undertaken by Canadian industry in 1957 and provides an indication of the relative size of the 1958 program. The survey was conducted as a result of the interest shown in the first such publication issued two years ago, covering the years 1955 and 1956.

The current survey sought information on the cost of research-development conducted by the reporting companies, the source of these funds, and expenditures on purchases of research-development results from affiliates and others located in Canada and in foreign countries. It also requested data on the principal fields in which the work was being carried out, and the number of professionally-trained research personnel and technicians employed.

The concepts and definitions used parallel those followed in the 1955-56 survey. They were formed as a result of consultations held with senior officials of the National Research Council, scientists and administrators of Canadian companies who were known to have a substantial interest in industrial research, and with several trade and professional associations.

The assistance of the many business firms who have cooperated with us by submitting reports is gratefully acknowledged.

December, 1958.

WALTER E. DUFFETT,
Dominion Statistician.

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GENERAL REVIEW

The industrial research-development program of Canadian industry is continuing to grow both in size and in number of firms. A recent survey of over 2,800 companies operating in Canada indicated that, in 1957 there were 455 firms with such programs and an additional 364 with arrangements to obtain research-development information from others. This compares with 377 companies with such programs and 235 with arrangements to secure research-development data in 1955, reported in the first survey conducted by the Dominion Bureau of Statistics two years ago. Although over 300 additional firms were covered in this second survey, the selection was made from identical industries and on the same basis—firms with 100 or more employees.

During 1957, the 455 firms reporting research-development programs indicated expenditures totalling $99.6 million, plus an additional $49.6 million spent on government research-development prime contracts. In 1955, the 377 companies reported expenditures of $65.9 million on their own account which compares with the $99.6 million in 1957. Data on government research-development prime contracts were not collected in the initial survey.

Indications are that, in total, the same firms which spent $149 million in 1957 expect that similar expenditures for 1958 will exceed $160 million, an increase of about 8%.

The major part of the industrial research-development work was conducted within the reporting companies themselves, to the extent of over $125 million or 84% of the total in 1957. An additional $20 million, or 13%, was spent for research-development done outside Canada, of which 88% went to the United States and 11% to the United Kingdom, with the remaining 1% to other foreign countries. The balance, amounting to $4 million, or 3%, was spent for research-development done by others in Canada, mainly firms outside the corporate structure of the reporting company and research foundations. Relatively small payments were made to commercial laboratories, consultants and educational institutions.

Examination of total research-development expenditures by industry shows that, as in 1955, Transportation Equipment, Electrical Apparatus and Supplies and Chemical Products, far exceeded the expenditures in all other industries. The Transportation Equipment industry itself, which includes the manufacture of aircraft, accounted for $73 million, almost one half of the total research-development expenditures in all industries. However, it should be noted that of this total, $47.3 million was supported by government research-development prime contracts and $10.7 million by the research-development portion of government procurement contracts. The cost of research-development activity in the Electrical Apparatus and Supplies and the Chemical Products industries accounted for an additional $27 million. Together these three industries made up more than 67% of the total. Next in order of size were Products of Petroleum and Coal, Mining, Non-Ferrous Metal Products, Paper Products, Iron and Steel Products, Rubber Products industries and the Transportation and Public Utilities industries, which accounted for an additional 26% of the total cost of industrial research-development. The same industries were also the most active in the research-development field in 1955.

Continued activity and interest in the research field is indicated by the reported anticipated cost of research-development in 1958 estimated at $161 million, an increase of 8% over the 1957 figure. Transportation Equipment, as the most research-active industry, accounts for $5 million of the increase. Following in order are Products of Petroleum and Coal and Chemical Products, with a reported increase of $2 million each, and Non-Ferrous Metal Products, with an increase of $1 million. These three industries together with Transportation Equipment account for 83% of the total increase over the 1957 level. Decreases in research-development expenditures were anticipated in the Mining, Textile Products and "Other" Non-Manufacturing industries, to the extent of $1 million, the bulk of which was in the Mining industry.

Professionally-trained scientists employed on research-development projects in 1957 numbered 4,448, an increase of more than 50% over the corresponding figure in 1955. Almost one-half of this increase was due to the Transportation Equipment industry, followed by Electrical Apparatus and Chemical Products. These three industries, which also showed the highest expenditures for research, accounted for over 70% of the increase in professionally-trained research personnel. Distribution by level of training followed the same pattern as in 1955, with about three quarters of the scientists trained to the bachelor level and the remainder fairly evenly divided between those with masters' and doctors' degrees. Research-development technicians made up over one-half of the supporting personnel, which totalled 7,263.

Research activity in the engineering fields comprises 65% of the total, with all industries active in at least one phase of engineering. Other important fields of research included chemistry, metallurgy and physics which together accounted for an additional 30% of total expenditures. Some activity was reported by all industries in the closely related fields of chemical engineering or chemistry.

The increasing interest in research-development is shown by the investment in new or extended research facilities, which amounted to $12.8 million in 1957. This is more than 20% of the estimated value of all facilities used for research purposes, as reported in 1955.

Fields of Research-Development Activity (Table 4)

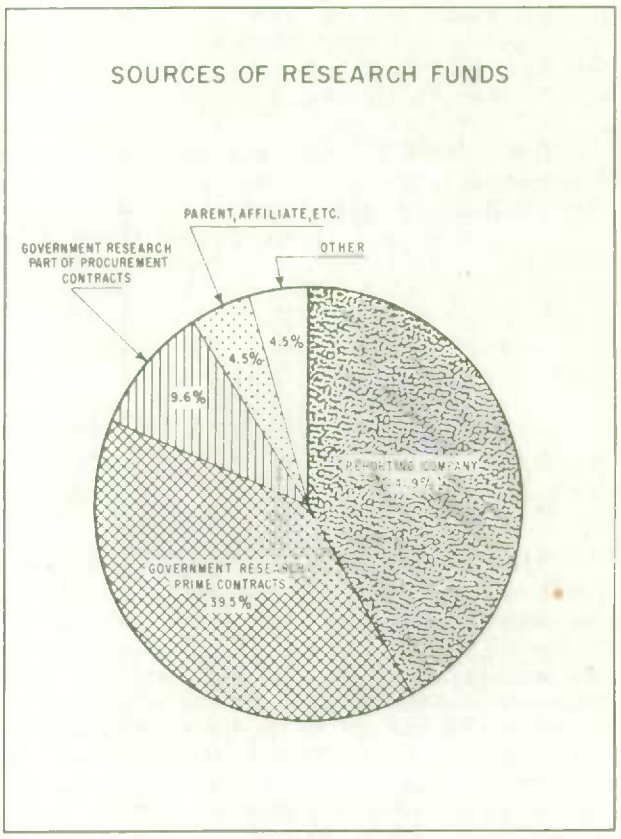
Over 70% of the total expenditures on research in 1957 were made in four of the twelve fields of research specified in the survey, with mechanical engineering accounting for 27%, "other" engineering (mainly aeronautical) 16%, electrical engineering 15%, and chemistry 13%. Expenditures in all the engineering fields combined made up almost 65% of the total. Other important fields of research were metallurgy and physics accounting for 8% and 7% of the total respectively.

As illustrated in the summary below, activity in many of the fields of research was concentrated is only a few industries.

	$000's	% of total
Electrical engineering, total	**22,301**	
Transportation equipment	8,749	
Electrical apparatus and supplies	10,973	
	19,722	88.4
Mechanical engineering, total	**39,844**	
Iron and steel products	3,426	
Transportation equipment	32,426	
	35,852	90.0
"Other" engineering, total	**23,438**	
Transportation equipment	19,369	82.6
Chemistry, total	**20,329**	
Rubber products	1,162	
Paper products	3,237	
Products of petroleum and coal	4,351	
Chemical products	7,334	
	16,084	79.1
Physics, total	**10,135**	
Transportation equipment	6,805	
Electrical apparatus and supplies	1,424	
	8,229	81.2
Geology, geophysics and earth sciences, total	**1,622**	
Mining	438	
Products of petroleum and coal	990	
	1,428	88.0
Metallurgy, total	**12,879**	
Transportation equipment	2,857	
Non-ferrous metal products	3,984	
Mining	4,001	
	10,842	84.2
Medicine, total	**2,473**	
Chemical products	1,340	
"Other" non-manufacturing (mainly health services)	1,108	
	2,448	99.0

All industries reported some activity in mechanical and "other" engineering as well as in either chemical engineering or chemistry, which are closely related fields.

Support of Research-Development Done Within the Company (Table 5)



Examination of the sources of funds for research done within the reporting company showed that the government contributed heavily, providing close to 40% of the total spent through research-development prime contracts, and an additional 10% through the research-development part of procurement contracts. Heaviest user of government funds was the Transportation Equipment industry (94%), followed by Electrical Apparatus and Supplies and Other Manufacturing which together accounted for an additional 5%. These three industries were the sole recipients of government funds obtained through the research-development part of procurement contracts.

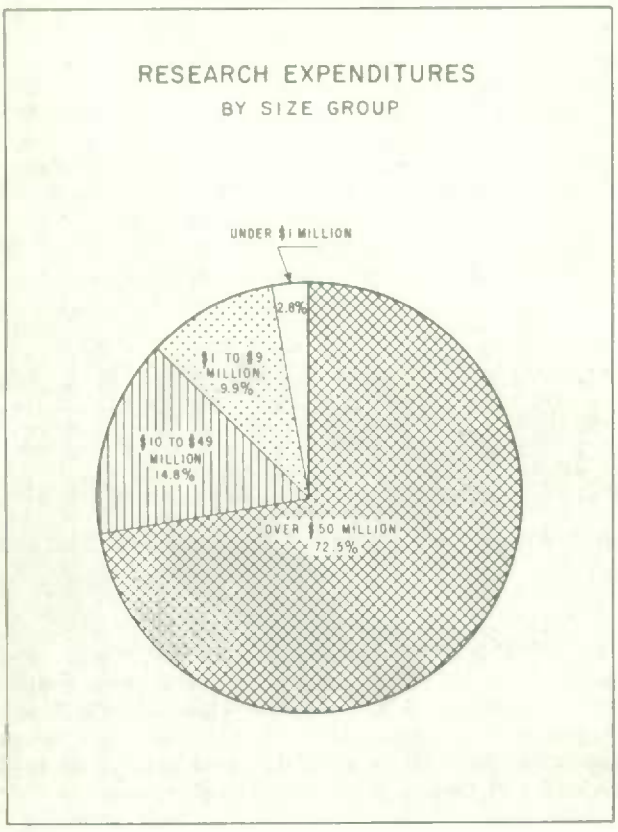
The reporting companies themselves financed a major share of research development costs, averaging 42% of the funds used. This pattern was the same in all industries except the following:

Industry and source of funds	Amount $000's	% of industry total
Transportation equipment:		
Reporting company	3,983	6.1
Parent or affiliate	35	0.1
Government	58,031	89.9
Other	2,518	3.9
Other non-manufacturing:		
Reporting company	562	22.4
Parent or affiliate	780	31.1
Government	351	14.0
Other	816	32.5

Funds originating in a parent or affiliated company formed only a small part of the total, amounting to $5.6 million. Of this amount, Electrical Apparatus and Supplies and Products of Petroleum and Coal received the greatest share, 18% and 20% respectively.

Funds coming from "other" sources were about the same in volume as funds furnished by parent or affiliated companies. Industries receiving the major portions of this type of financial support were Paper Products and Transportation Equipment, accounting for 23% and 44% respectively. This source comprises mainly funds provided by other companies for contract research. In the Other Non-Manufacturing field, outside assistance was received by hospitals from provincial grants and medical foundations and by trade associations from membership fees.

Research-Development Expenditures by Size of Firm (Table 6)



The larger firms with annual sales over $50 million performed 72% of the total industrial research program although comprising only 12% of the research-active firms. Conversely, smaller firms with annual sales between $1 million and $9 million accounted for only 10% of the research-development expenditures, although this size group contains 49% of the firms reporting research activity. In the Mining industry the smallest firms, made up of those with annual sales of less than $1 million, were responsible for a relatively large share of the total expenditures. This was largely due to a number of respondents being in the development stage and having no sales figures to report.

Direct Research-Development Expenditures (Table 7)

Direct research-development expenditures, defined as covering the research done within the reporting organization, amounted to $125 million or 84% of total research costs. The Transportation Equipment, Electrical Apparatus and Supplies and the Chemical Products industries made up 72% of the direct research-development expenditures as against 67% of the total research costs.

Industry	Direct research expenditures	
	$000's	% of total
Mining	4,835	3.9
Paper products	5,701	4.5
Iron and steel products	4,045	3.2
Transportation equipment	64,567	51.4
Non-ferrous metal products	5,626	4.5
Electrical apparatus and supplies	14,445	11.5
Products of petroleum and coal	2,934	2.3
Chemical products	11,717	9.4
All other industries	11,664	9.3
Total	**125,534**	**100.0**
	Total research expenditures	
	$000's	% of total
Mining	6,279	4.2
Paper products	6,213	4.2
Iron and steel products	4,340	2.9
Transportation equipment	72,919	48.9
Non-ferrous metal products	5,793	3.9
Electrical apparatus and supplies	15,348	10.3
Products of petroleum and coal	7,489	5.0
Chemical products	12,428	8.3
All other industries	18,335	12.3
Total	**149,144**	**100.0**

The percentages of the direct research-development expenditures performed by each size group follow the same pattern as the percentages of the total expenditures contributed by these same size groups, with the larger firms conducting the major portion.

Total direct research expenditures averaged 0.9% of the sales of research-active firms. Excluding the part financed through government research-development prime contracts, the average drops to 0.6% of the sales in 1957 which compares with 0.5% in 1955. The three most research-active industries, Transportation Equipment, Electrical Apparatus and Supplies and Chemical Products, were well above this average having spent 4.5%, 1.6% and 1.5% of their sales dollar respectively. No expenditure sales ratio could be calculated for "Other" Non-Manufacturing or for the under $1 million size group due to lack of comparable sales figures.

Distribution of Firms with Research-Development Programs (Table 8)

The industries which had the greatest number of firms bearing research costs were the Iron and Steel Products, Electrical Apparatus and Supplies and the Chemical Products industries. There is, however, no direct relationship between the number of firms paying for research and the magnitude of research expenditures in any one industry. The Transportation Equipment industry which contributed 49% of the total industrial research costs, accounted for only 5% of the total number of firms reporting research expenditures. In contrast, the Iron and Steel Products industry included 15% of the firms but was responsible for only 3% of the total research expenditures. Similarly, the Foods and Beverages industry and the "Other" Non-manufacturing industries, included slightly more than 11% of the research active firms but accounted for only 2% of the total cost of research in each case. The Non-Ferrous Metal Products industry reported 3% of the total, both in terms of expenditures and in terms of numbers of firms supporting research.

The following summary shows the number of firms with research programs and the magnitude of expenditures, each expressed as a percentage of the total.

Industry	No. of firms % of total	Research expenditures % of total
Mining, quarrying and oil wells	6.5	4.2
Foods and beverages	11.5	1.3
Rubber products	1.3	2.9
Textile products	3.3	1.0
Wood products	5.4	0.1
Paper products	6.1	4.1
Iron and steel products	15.5	2.9
Transportation equipment	4.9	48.9
Non-ferrous metal products	3.2	3.9
Electrical apparatus and supplies	8.4	10.3
Non-metallic mineral products	4.4	1.2
Products of petroleum and coal	1.3	5.0
Chemical products	9.0	8.3
Other manufacturing	3.1	1.2
Transportation, storage, communcation and public utilities	4.4	2.6
Other non-manufacturing	11.7	2.1
Total	**100.0**	**100.0**

On the basis of the number of firms engaged in research, some industries proved to be more research-active than others. The Electrical Apparatus and Supplies and Chemical Products industries each had over 45% of the surveyed firms reporting research expenditures. The research-active firms also made up over 40% of those surveyed in both Rubber Products and Products of Petroleum and Coal industries, but in these instances there were only 22 and 19 firms contacted respectively.

A total of 549 firms reported that they had free access to results of research development from one or more sources. Of these, 241 received information from Canadian sources, 322 from the United States, 40 from the United Kingdom and 15 from other foreign countries. The Iron and Steel Products, Chemical Products, Foods and Beverages and Electrical Apparatus and Supplies industries account for over half of the firms having free access to research from American sources. The largest number of firms (in any group) reporting that they received information from the United Kingdom was found in the Chemical Products industry.

Of the 549 firms supplied with research results without payment, 364 made no other payments for research except, in a few cases, grants to universities or hospitals. Information was received by 175 of these firms from a parent, subsidiary or affiliate.

Scientific Personnel (Tables 9 to 13)

The equivalent of 4,448 professionally trained scientists and engineers, of whom 3,433 held bachelors degrees, 429 masters degrees and 586 doctors degrees, were employed in research-development work by the reporting companies in 1957. The Transportation Equipment, Electrical Apparatus and Supplies and the Chemical Products industries, which had the highest expenditures for research, employed the greatest numbers of scientists and engineers. The next greatest numbers were in the Paper Products, Mining, Non-Ferrous Metal Products and the Iron and Steel Products industries. These seven industries together accounted for almost 83% of the professional employment in the research field.

The distribution of scientists with different levels of training varied from industry to industry. The "Other" Non-Manufacturing industries (including Health Service) where many medical scientists are employed, had the largest percentage of its scientific personnel at the doctorate level. Professional employees at the bachelor level predominated in all other industries. The Chemical Products, Paper Products, Products of Petroleum and Coal and the Foods and Beverages industries, all most active in the chemical research field, had over 25% of their professional employment at the doctorate level. On the other hand the Transportation Equipment, Iron and Steel Products, Transportation and Public Utility Operations and the Electrical Apparatus and Supplies Industries, all most active in engineering research, as well as the Mining industry, had less than 6% of their professional employees at the doctorate level and over 80% at the bachelor level.

Thus, in all phases of engineering research, there is a greater predominance of professional employees with bachelor degrees. Most noticeable in this respect were mechanical engineers, 95% of whom are trained at the bachelor level. Metallurgists and mathematicians also followed this same general pattern. On the other hand geologists and other earth scientists, chemists, physicists and agricultural scientists although predominantly trained to the bachelor level, have a greater percentage of professional employees with masters or doctors degrees than in the engineering field, or in the overall pattern.

Reporting companies employed the equivalent of 7,263 supporting personnel on research development work of whom 3,737 were research-development technicians, 802 were skilled craftsmen and 2,724 were other supporting personnel. The industries which employed the greatest number of scientists and engineers also accounted for the largest portion of supporting staff. These were Transportation Equipment, Electrical Apparatus and Supplies and Chemical Products followed by the Non-Ferrous Metal Products, Paper Products, Iron and Steel Products, and Mining industries. These industries accounted for 89% of supporting personnel compared with 83% of the professional employment.

The average ratio of supporting personnel to professional scientists and engineers in research-active firms was 1.6 (Table 13). The industries with the highest ratios were:

Industry	Supporting Personnel per Professional Employee
Iron and Steel Products	2.9
Non-Ferrous Metal Products	2.7
"Other" Manufacturing	2.2
Transportation Equipment	2.1
Mining, Quarrying and Oil Wells	1.8
Wood Products	1.8

The Foods and Beverages and Non-Metallic Mineral Products industries had the lowest ratio, both with 0.8 supporting personnel per professional scientist.

The overall ratio of research-development technicians to professional personnel was 0.8, of skilled craftsmen 0.2, and of other supporting personnel 0.6.

Research Grants (Table 14)

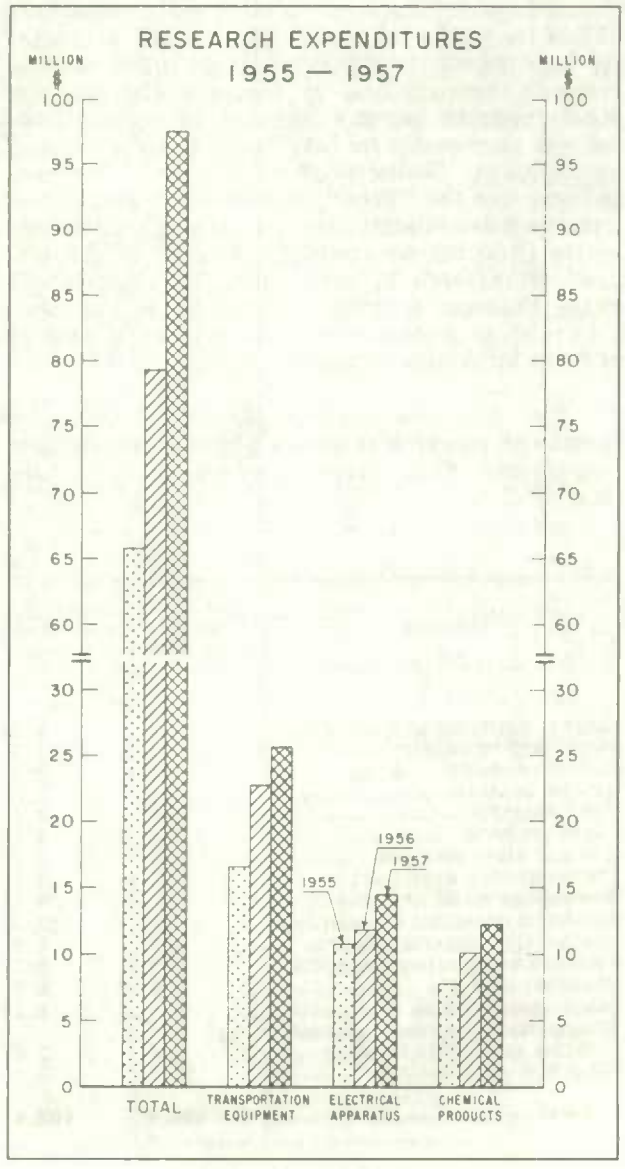
A total of 71 firms reported that they granted funds to educational institutions, research institutes, foundations and hospitals for general research-development work. These grants amounted to $559,036 of which over 70% was provided by the Chemical Products and Products of Petroleum and Coal industries, the Mining industry and the Other Non-Manufacturing industries. These same industries accounted for 42% of the firms making grants.

In some instances, medical foundations and hospitals reported making grants to other organizations. These amounts were not included as the reporting bodies were themselves receiving funds in the form of grants and this could have resulted in duplication.

Capital Expenditures on Research Facilities (Table 15)

Total capital expenditures during 1957 for new or extended facilities for use in research-development amounted to $12,782,707 which was over 20% of the total replacement value of research facilities in use in 1955. The Transportation Equipment industry alone accounted for 42% of the total, with the Chemical Products and Products of Petroleum and Coal industries responsible for an additional 20%. Next in order were the Mining, Wood and Paper Products, "Other" Non-Manufacturing and the Electrical Apparatus and Supplies industries, which together accounted for another 25%.

Research-Development Expenditures, 1955-1957 (Table 16)



Deletion of the research for which the reporting companies were reimbursed directly by the government places the 1957 research-development costs on a comparable basis with the expenditures during 1955 and 1956. The estimated increase of $13 million in 1956 was followed by a further increase in 1957 of over $20 million, amounting to a total increase of 51% in the research-development expenditures over the two year period. The three most research-active industries, Transportation Equipment, Electrical Apparatus and Supplies and Chemical Products, together accounted for over half of the increase.

Other industries showing large increases over the 1955 level were Mining, Other Manufacturing and Other Non-Manufacturing (mainly health, engineering and scientific services). In these three instances, expenditures remained much the same in 1956, with the bulk of the increase occurring during 1957. Each of these three industries also showed a percentage increase much higher than the over all average.

The relative importance of the various industries in the research field remained remarkably constant over the three year period. The Other Non-Manufacturing industries accounted for 1% of the total in 1955 and 3% of the total in 1957. In all other industries, the percentage contribution did not differ by more than 1% during the period.

TABLE 1. Research-Development Expenditures, by Industry, 1957

Industry	Expenditures for research done within the company	Payments to others in Canada	Payments to others outside Canada	Total research-development expenditures
	dollars			
Mining, quarrying and oil wells	4,835,332	151,129	1,293,026	6,279,487
Manufacturing:				
Foods and beverages	1,355,851	109,257	418,014	1,883,122
Rubber products	1,145,619	23,258	3,138,654	4,307,531
Textile products	1,292,876	17,380	171,950	1,482,206
Wood products	117,177	22,936	8,050	148,163
Paper products	5,700,747	201,048	311,567	6,213,362
Iron and steel products	4,045,081	78,699	216,263	4,340,043
Transportation equipment	64,566,901	2,711,800	5,640,126	72,918,827
Non-ferrous metal products	5,626,034	109,125	57,950	5,793,109
Electrical apparatus and supplies	14,444,799	12,000	891,641	15,348,440
Non-metallic mineral products	1,115,368	32,323	566,085	1,713,776
Products of petroleum and coal	2,934,400	11,000	4,543,118	7,488,518
Chemical products	11,717,093	31,197	680,158	12,428,448
Other manufacturing[1]	1,750,936	27,865	29,550	1,808,351
Transportation, storage, communication, and public utility operations	2,377,100	7,400	1,514,300	3,898,800
Other non-manufacturing[2]	2,508,574	235,924	347,398	3,091,896
Total	**125,533,888**	**3,782,341**	**19,827,850**	**149,144,079**
Percentage of expenditures within the company, in Canada and outside Canada to total research expenditures	84.17%	2.54%	13.29%	100%

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services and trade associations.

TABLE 2. Estimated Research-Development Expenditures, by Industry, 1958

Industry	Estimated expenditures for research done within the company 1958	Estimated payments to others 1958	Estimated total research expenditures 1958	Total research expenditures 1957	% increase or decrease
	dollars				%
Mining, quarrying and oil wells	4,143,122	1,117,549	5,260,671	6,279,487	-16.23
Manufacturing:					
Foods and beverages	1,480,150	496,790	1,976,940	1,883,122	+ 4.98
Rubber products	1,121,000	3,338,720	4,459,720	4,307,531	+ 3.53
Textile products	1,333,500	132,050	1,465,550	1,482,206	- 1.12
Wood products	124,400	27,900	152,300	148,163	+ 2.79
Paper products	6,066,393	470,325	6,536,718	6,213,362	+ 5.20
Iron and steel products	4,526,800	308,465	4,835,265	4,340,043	+11.41
Transportation equipment	67,613,104	10,379,300	77,992,404	72,918,827	+ 6.96
Non-ferrous metal products	6,837,880	272,700	7,110,580	5,793,109	+22.74
Electrical apparatus and supplies	14,871,067	1,077,200	15,948,267	15,348,440	+ 3.91
Non-metallic mineral products	1,204,781	613,108	1,817,889	1,713,776	+ 6.08
Products of petroleum and coal	3,420,000	6,204,000	9,624,000	7,488,518	+28.52
Chemical products	13,479,184	767,980	14,247,164	12,428,448	+14.63
Other manufacturing[1]	2,300,919	48,500	2,349,419	1,808,351	+29.92
Transportation, storage, communication and public utility operations	2,553,000	1,618,300	4,171,300	3,898,800	+ 6.99
Other non-manufacturing[2]	2,556,002	495,370	3,051,372	3,091,896	- 1.31
Total	**133,617,302**	**27,372,257**	**160,999,559**	**149,144,079**	**+ 7.95**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services and trade associations.

TABLE 3. Increase and Decrease in Research-Development Expenditures in Terms of Numbers of Companies, by Industry, 1957 - 1958

Industry	Number of companies anticipating decreased research expenditures in 1958	Number of companies anticipating increased research expenditures in 1958
Mining, quarrying and oil wells	7	19
Manufacturing:		
Foods and beverages	9	15
Rubber products	4	3
Textile products	4	4
Wood products	5	4
Paper products	7	17
Iron and steel products	18	33
Transportation equipment	4	18
Non-ferrous metal products	5	9
Electrical apparatus and supplies	16	26
Non-metallic mineral products	5	15
Products of petroleum and coal	2	5
Chemical products	5	40
Other manufacturing[1]	3	8
Transportation, storage, communication and public utility operations	2	4
Other non-manufacturing[2]	13	22
Total	**109**	**242**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 4. Total Research Development Expenditures, by Industry, by Field of Research, 1957

Industry	Engineering, chemical	Engineering, civil	Engineering, electrical	Engineering, mechanical	Engineering, other	Chemistry
	dollars					
Mining, quarrying and oil wells	696, 249	6, 000	6, 000	45, 636	540, 785	276, 862
Manufacturing:						
Foods and beverages	365, 503	–	–	60, 346	20, 000	903, 516
Rubber products	2, 229, 059	–	43, 650	61, 918	265, 256	1, 161, 500
Textile products	271, 250	–	4, 820	96, 555	35, 741	738, 280
Wood products	15, 000	15, 090	–	65, 300	24, 201	23, 222
Paper products	1, 148, 790	1, 928	29, 829	598, 809	112, 658	3, 237, 232
Iron and steel products	94, 850	33, 825	119, 350	3, 426, 382	260, 034	103, 500
Transportation equipment	1, 106, 554	265, 330	8, 749, 046	32, 425, 669	19, 368, 813	–
Non-ferrous metal products	306, 353	69, 000	247, 000	95, 985	278, 146	715, 651
Electrical apparatus and supplies	325, 172	43, 965	10, 973, 104	857, 500	740, 779	373, 550
Non-metallic mineral products	224, 514	122, 353	30, 050	90, 208	48, 330	484, 310
Products of petroleum and coal	945, 521	58, 020	48, 350	355, 878	670, 747	4, 351, 361
Chemical products	2, 060, 569	–	194, 390	476, 089	19, 337	7, 334, 177
Other manufacturing[1]	36, 168	–	117, 618	498, 320	959, 641	137, 624
Transportation, storage, communication and public utility operations	212, 180	311, 660	1, 668, 035	344, 130	60, 840	453, 000
Other non-manufacturing[2]	40, 450	8, 200	69, 751	344, 907	32, 726	34, 975
Total	**10, 078, 282**	**935, 371**	**22, 300, 993**	**39, 843, 632**	**23, 438, 084**	**20, 328, 760**

Industry	Physics	Geology, geophysics and other earth sciences	Metallurgy	Medicine	Agriculture	Other	Total
	dollars						
Mining, quarrying and oil wells	–	437, 596	4, 001, 419	3, 000	–	265, 940	6, 279, 487
Manufacturing:							
Foods and beverages	–	–	–	6, 260	236, 359	291, 138	1, 883, 122
Rubber products	19, 379	–	–	–	10, 000	516, 769	4, 307, 531
Textile products	133, 902	–	–	15, 845	–	185, 813	1, 482, 206
Wood products	5, 350	–	–	–	–	–	148, 163
Paper products	340, 298	11, 324	–	–	–	732, 494	6, 213, 362
Iron and steel products	12, 195	–	207, 781	–	–	82, 076	4, 340, 043
Transportation equipment	6, 805, 120	17, 500	2, 856, 740	–	–	1, 324, 055	72, 918, 827
Non-ferrous metal products	–	65, 527	3, 984, 317	–	–	31, 130	5, 793, 109
Electrical apparatus and supplies	1, 424, 126	–	265, 614	–	8, 000	336, 630	15, 348, 440
Non-metallic mineral products	95, 195	67, 250	28, 560	–	–	523, 006	1, 713, 776
Products of petroleum and coal	58, 020	989, 857	–	–	–	10, 764	7, 488, 518
Chemical products	429, 093	–	143, 096	1, 340, 115	98, 284	333, 198	12, 428, 448
Other manufacturing[1]	22, 880	–	11, 750	–	–	24, 350	1, 808, 351
Transportation, storage, communication and public utility operations	772, 110	105	32, 000	–	25, 740	19, 000	3, 898, 800
Other non-manufacturing[2]	16, 988	32, 376	1, 347, 761	1, 108, 137	43, 000	12, 625	3, 091, 896
Total	**10, 134, 656**	**1, 621, 535**	**12, 879, 038**	**2, 473, 357**	**421, 383**	**4, 688, 988**	**149, 144, 079**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services and trade associations.

TABLE 5. Sources of Funds of Research-Development Done Within Company, by Industry, 1957

Industry	Reporting company	Parent, affiliated and/or subsidiary companies	Government funds received through: A. Research-development prime contracts	Government funds received through: B. Research-development part of procurement contracts	Others	Total research done within the company
	dollars					
Mining, quarrying and oil wells	3,480,372	883,420	–	–	471,530	4,835,332
Manufacturing:						
Foods and beverages	1,239,241	115,250	1,000	–	360	1,355,851
Rubber products	842,590	191,251	111,778	–	–	1,145,619
Textile products	1,290,376	1,500	–	–	1,000	1,292,876
Wood products	117,177	–	–	–	–	117,177
Paper products	3,603,578	797,169	–	–	1,300,000	5,700,747
Iron and steel products	3,995,953	11,311	15,850	–	21,967	4,045,081
Transportation equipment	3,983,041	35,000	47,354,112	10,676,493	2,518,255	64,566,901
Non-ferrous metal products	5,545,034	14,000	40,000	–	27,000	5,626,034
Electrical apparatus and supplies	11,215,183	993,708	848,218	1,137,794	249,896	14,444,799
Non-metallic mineral products	1,085,398	29,970	–	–	–	1,115,368
Products of petroleum and coal	1,780,323	1,154,077	–	–	–	2,934,400
Chemical products	10,905,636	479,492	188,215	–	143,750	11,717,093
Other manufacturing[1]	714,958	–	653,978	267,000	115,000	1,750,936
Transportation, storage, communication and public utility operations	2,267,100	110,000	–	–	–	2,377,100
Other non-manufacturing[2]	561,510	780,148	351,365	–	815,551	2,508,574
Total	**52,627,470**	**5,596,306**	**49,564,516**	**12,081,287**	**5,664,309**	**125,533,888**
Percentage of direct research supported by reporting company, parent or affiliate, government or others	41.92%	4.46%	39.48%	9.63%	4.51%	100.00%

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 6. Total Research-Development Expenditures, by Industry and Size Group, 1957

Industry and size group[1]	Number of firms	Total research-development cost	Total research cost as % of industry total
		dollars	
Mining, quarrying and oil wells:			
1. $50 million and over	4	2,226,530	35.46
2. $10 million to $49 million	11	2,459,036	39.16
3. $ 1 million to $ 9 million	12	209,216	3.33
4. Under $1 million	7	1,384,705	22.05
Total	**34**	**6,279,487**	**100.00**
Food and beverages:			
1. $50 million and over	6	791,221	42.02
2. $10 million to $49 million	18	782,493	41.55
3. $ 1 million to $ 9 million	13	309,408	16.43
4. Under $1 million	—	—	—
Total	**37**	**1,883,122**	**100.00**
Rubber products:			
1. $50 million and over	3	3,525,488	81.84
2. $10 million to $49 million	3	736,543	17.10
3. $ 1 million to $ 9 million	3[2]	45,500[2]	1.06[2]
4. Under $1 million	[2]	[2]	[2]
Total	**9**	**4,307,531**	**100.00**
Textile products:			
1. $50 million and over	[3]	[3]	[3]
2. $10 million to $49 million	6[3]	1,184,900[3]	79.94[3]
3. $ 1 million to $ 9 million	10[2]	297,306[2]	20.06[2]
4. Under $1 million	[2]	[2]	[2]
Total	**16**	**1,482,206**	**100.00**
Wood products	13[4]	148,163[4]	100.00[4]
Paper products:			
1. $50 million and over	9	3,393,969	54.62
2. $10 million to $49 million	23	1,473,513	23.72
3. $ 1 million to $ 9 million	8	1,345,880	21.66
4. Under $1 million	—	—	—
Total	**40**	**6,213,362**	**100.00**
Iron and steel products:			
1. $50 million and over	5	1,273,009	29.33
2. $10 million to $49 million	19	1,896,387	43.70
3. $ 1 million to $ 9 million	39	1,142,882	26.33
4. Under $1 million	3	27,765	.64
Total	**66**	**4,340,043**	**100.00**
Transportation equipment:			
1. $50 million and over	6	67,023,263	91.91
2. $10 million to $49 million	8	3,771,667	5.17
3. $ 1 million to $ 9 million	13	2,123,897	2.92
4. Under $1 million	—	—	—
Total	27	72,918,827	100.00

[1] Size groups are based on annual sales value, 1957.
[2] Size groups 3 and 4 combined.
[3] Size groups 1 and 2 combined.
[4] All size groups combined.

TABLE 6. Total Research-Development Expenditures, by Industry and Size Group, 1957 – Concluded

Industry and size group[1]	Number of firms	Total research-development cost	Total research cost as % of industry total
Non-ferrous metal products:			
1. $50 million and over	[2]	[2]	[2]
2. $10 million to $49 million	3[2]	4,587,120[2]	79.13[2]
3. $ 1 million to $ 9 million	12[3]	1,205,989[3]	20.82[3]
4. Under $1 million	[3]	[3]	[3]
Total	**15**	**5,793,109**	**100.00**
Electrical apparatus and supplies:			
1. $50 million and over	3	6,859,147	44.69
2. $10 million to $49 million	10	5,568,887	36.28
3. $ 1 million to $ 9 million	34	2,864,606	18.66
4. Under $1 million	3	55,800	.37
Total	**50**	**15,348,440**	**100.00**
Non-metallic mineral products:			
1. $50 million and over	[2]	[2]	[2]
2. $10 million to $49 million	9[2]	1,210,996[2]	70.66[2]
3. $ 1 million to $ 9 million	15[3]	502,780[3]	29.34[3]
4. Under $1 million	[3]	[3]	[3]
Total	**24**	**1,713,776**	**100.00**
Products of petroleum and coal	8[4]	7,488,518[4]	100.00[4]
Chemical products:			
1. $50 million and over	6	6,836,720	55.01
2. $10 million to $49 million	12	2,776,637	22.34
3. $ 1 million to $ 9 million	31[3]	2,815,091[3]	22.65[3]
4. Under $1 million	[3]	[3]	[3]
Total	**49**	**12,428,448**	**100.00**
Other manfuacturing[5]	12[4]	1,808,351[4]	100.00[4]
Transportation, storage, communciation, and public utility operations:			
1. $50 million and over	6	3,821,000	98.00
2. $10 million to $49 million	5	22,500	.58
3. $ 1 million to $ 9 million	3[3]	55,300[3]	1.42[3]
4. Under $1 million	[3]	[3]	[3]
Total	**14**	**3,898,800**	**100.00**
Other non-manufacturing[6]	41[4]	3,091,896[4]	100.00[4]
Industry totals:			
1. $50 million and over	57	108,116,078	72.49
2. $10 million to $49 million	131	22,028,562	14.77
3. $ 1 million to $ 9 million	221	14,774,187	9.91
4. Under $1 million	46	4,225,252	2.83
Total	**455**	**149,144,079**	**100.00**

[1] Size groups are based on annual sales value, 1957.
[2] Size groups 1 and 2 combined.
[3] Size groups 3 and 4 combined.
[4] All size groups combined.
[5] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[6] Includes construction, health services, scientific and engineering services and trade associations.

TABLE 7. Direct Research-Development Expenditures as Fercentage of Sales, by Industry and Size Group, 1957

Industry and size group[1]	Direct research-development cost	Total value of sales 1957[2]	Direct research cost as % of sales[2]
	$	$000's	%
Mining, quarrying and oil wells:			
1. $50 million and over	2,098,953	297,566	0.71
2. $10 million to $49 million	1,860,498	279,843	0.66
3. $ 1 million to $ 9 million	118,436	56,655	0.21
4. Under $1 million[3]	757,445	[3]	[3]
Total	**4,835,332**	**635,880**	**0.76**
Foods and beverages:			
1. $50 million and over	722,621	952,974	0.08
2. $10 million to $49 million	483,108	486,383	0.10
3. $ 1 million to $ 9 million	150,122	65,647	0.23
4. Under $1 million	—	—	—
Total	**1,355,851**	**1,505,004**	**0.09**
Rubber products:			
1. $50 million and over	716,868	193,459	0.37
2. $10 million to $49 million	385,251	61,110	0.63
3. $ 1 million to $ 9 million	43,500[4]	7,660[4]	0.56[4]
4. Under $1 million	[4]	[4]	[4]
Total	**1,145,619**	**262,229**	**0.44**
Textile products:			
1. $50 million and over	[5]	[5]	[5]
2. $10 million to $49 million	1,069,000[5]	196,344[5]	0.54[5]
3. $ 1 million to $ 9 million	223,876[4]	50,788[4]	0.44[4]
4. Under $1 million	[4]	[4]	[4]
Total	**1,292,876**	**247,132**	**0.52**
Wood products	117,177[6]	81,400[6]	0.14[6]
Paper products:			
1. $50 million and over	3,225,719	990,125	0.33
2. $10 million to $49 million	1,145,028	576,222	0.20
3. $ 1 million to $ 9 million	1,330,000	42,211	3.15
4. Under $1 million	—	—	—
Total	**5,700,747**	**1,608,558**	**0.35**
Iron and steel products:			
1. $50 million and over	1,237,891	559,409	0.22
2. $10 million to $49 million	1,697,309	365,814	0.46
3. $ 1 million to $ 9 million	1,082,116	159,110	0.68
4. Under $1 million	27,765	1,229	2.28
Total	**4,045,081**	**1,085,562**	**0.37**
Transportation equipment:			
1. $50 million and over	59,088,263	1,164,753	5.07
2. $10 million to $49 million	3,457,627	212,515	1.63
3. $ 1 million to $ 9 million	2,021,011	68,447	2.95
4. Under $1 million	—	—	—
Total	**64,566,901**	**1,445,715**	**4.47**

[1] Size groups are based on annual sales value, 1957.
[2] Sales of firms reporting research-development expenditures.
[3] Includes firms in development stage for which no figure corresponding to sales value is obtainable.
[4] Size groups 3 and 4 combined.
[5] Size groups 1 and 2 combined.
[6] All size groups combined.

TABLE 7. Direct Research-Development Expenditures as Percentage of Sales, by Industry and Size Group, 1957 – Concluded

Industry and size group[1]	Direct research-development cost	Total value of sales 1957[2]	Direct research cost as % of sales[2]
	$	$000's	%
Non-ferrous metal products:			
1. $50 million and over	[3]	[3]	[3]
2. $10 million to $49 million	4,457,120[3]	808,105[3]	0.55[3]
3. $ 1 million to $ 9 million	1,168,914[4]	45,282[4]	2.58[4]
4. Under $1 million	[4]	[4]	[4]
Total	**5,626,034**	**853,387**	**0.66**
Electrical apparatus and supplies:			
1. $50 million and over	6,466,006	568,391	1.14
2. $10 million to $49 million	5,538,887	215,785	2.57
3. $ 1 million to $ 9 million	2,384,106	138,359	1.72
4. Under $1 million	55,800	1,612	3.47
Total	**14,444,799**	**924,147**	**1.56**
Non-metallic mineral products:			
1. $50 million and over	[3]	[3]	[3]
2. $10 million to $49 million	931,658[3]	168,648[3]	0.55[3]
3. $ 1 million to $ 9 million	183,710[4]	52,678[4]	0.35[4]
4. Under $1 million	[4]	[4]	[4]
Total	**1,115,368**	**221,326**	**0.50**
Products of petroleum and coal	2,934,400[5]	1,379,727[5]	0.21[5]
Chemical products:			
1. $50 million and over	6,560,501	511,347	1.28
2. $10 million to $49 million	2,723,252	300,312	0.91
3. $ 1 million to $ 9 million	2,433,340[4]	115,794[4]	2.10[4]
4. Under $1 million	[4]	[4]	[4]
Total	**11,717,093**	**927,453**	**1.26**
Other manufacturing [6]	1,750,936[5]	327,596[5]	0.53[5]
Transportation, storage, communication, and public utility operations:			
1. $50 million and over	2,317,100	1,862,580	0.12
2. $10 million to $49 million	10,000	97,554	0.01
3. $ 1 million to $ 9 million	50,000[4]	7,050[4]	0.71[4]
4. Under $1 million	[4]	[4]	[4]
Total	**2,377,100**	**1,967,184**	**0.12**
Other non-manufacturing[7,8]	2,508,574[5]	[8]	[8]
Industry totals:[8]			
1. $50 million and over	90,067,673	9,555,554	0.94
2. $10 million to $49 million	19,468,068	3,080,938	0.63
3. $ 1 million to $ 9 million	13,006,676	938,941	1.39
4. Under $1 million[9]	2,991,471	[9]	[9]
Grand total	**125,533,888**	**13,590,055**	**0.92**

[1] Size groups are based on annual sales value, 1957.
[2] Sales of firms reporting research-development expenditures.
[3] Size groups 1 and 2 combined.
[4] Size groups 3 and 4 combined.
[5] All size groups combined.
[6] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[7] Includes construction, health services, scientific and engineering services, and trade associations.
[8] The sales figure for "Other non-manufacturing" which is included in the Industry totals, includes the value of hospital services but has no figure corresponding to sales value for trade associations or medical foundations.
[9] New firms, trade associations, medical foundations and any other firms for which no figure corresponding to sales value was obtainable are included in this size group.

TABLE 8. Research Development Activity, by Industry, 1957

(Number of Firms)

Industry	1	2	3	4 (a)	4 (b)	4 (c)	4 (d)	5 (a)	5 (b)	6
	Total number of firms surveyed[1]	Number of firms		Number of firms paying for research results				Number of firms Receiving information free		Number of firms without research services making grants
		Without research services	With research services	Number maintaining research establishments	Number making payments to others		Total	Which also make payments for research	Which do not make payments other than grants for any research service	
					In Canada	Outside Canada				
Mining, quarrying and oil wells	217	149	53	23	13	19	34	14	19	—
Manufacturing:										
Foods and beverages	288	181	94	23	10	13	37	17	57	3
Rubber products	22	8	12	5	2	7	9	4	3	—
Textile products	106	72	27	14	5	5	16	6	11	—
Wood products	260	204	44	12	4	2	13	1	31	—
Paper products	113	52	50	24	11	12	40	13	10	1
Iron and steel products	294	154	126	59	17	15	66	16	60	—
Transportation equipment	108	59	40	27	8	7	27	15	13	—
Non-ferrous metal products	55	27	26	14	1	5	15	2	11	1
Electrical apparatus and supplies	108	34	69	47	4	10	50	25	19	—
Non-metallic mineral products	65	25	36	17	3	12	24	13	12	—
Products of petroleum and coal	19	5	11	5	2	5	8	4	3	—
Chemical products	106	25	74	47	8	15	49	24	25	—
Other manufacturing[2]	141	111	25	9	6	3	12	5	13	—
Transportation, storage, communication and public utility operations	230	183	36	9	2	5	14	6	22	3
Other non-manufacturing[3]	686	560	96	32	14	5	41	20	55	4
Total	**2,818**	**1,849**	**819**	**367**	**110**	**140**	**455**	**185**	**364**	**12**

[1] The difference between column 1 and columns 2 and 3 is made up of 150 firms which did not reply, were discarded for other reasons, or were included in another report.

[2] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.

[3] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 9. Number of Professional Research-Development Scientists Employed by Industry, by Level of Training, 1957

Industry	Level of training			Total
	Bachelor level	Master level	Doctorate level	
Mining, quarrying, and oil wells	197	20	10	227
Manufacturing:				
Foods and beverages	55	17	24	96
Rubber products	56	5	14	75
Textile products	50	9	10	69
Wood products	7	1	1	9
Paper products	165	47	84	296
Iron and steel products	140	9	3	152
Transportation equipment	1,212	75	25	1,312
Non-ferrous metal products	153	29	43	225
Electrical apparatus and supplies	672	72	43	787
Non-metallic mineral products	44	6	3	53
Products of petroleum and coal	72	26	34	132
Chemical products	408	74	205	687
Other manufacturing[1]	57	13	5	75
Transportation, storage, communication and public utility operations	110	11	2	123
Other non-manufacturing[2]	35	15	80	130
Total	**3,433**	**429**	**586**	**4,448**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 10. Number of Professional Research-Development Scientists Employed by Field and Level of Training, 1957

Field of scientific training	Level of training			Total
	Bachelor level	Master level	Doctorate level	
Engineers, chemical	399	53	51	503
Engineers, civil	40	4	3	47
Engineers, electrical	771	72	13	856
Engineers, mechanical	886	25	15	926
Engineers, other	310	41	16	367
Chemists	500	122	255	877
Physicists	105	35	45	185
Geologists, geophysicists and other earth scientists	10	11	10	31
Metallurgists	177	17	22	216
Mathematicians	42	6	4	52
Medical Scientists	22	17	103	142
Agricultural scientists	18	2	6	26
Administrators (of Research-Development)	67	16	34	117
Other[1]	86	8	9	103
Total	**3,433**	**429**	**586**	**4,448**

[1] Some firms were unable to give a detailed breakdown of the field and level of training of the research scientists employed. Their total employment of research scientists is included with "Other, bachelor level."

TABLE 11. Number of Professional Research-Development Scientists Employed by Industry, by Field of Training, 1957

Industry	Engineers, chemical	Engineers, civil	Engineers, electrical	Engineers, mechanical	Engineers, other	Chemists	Physicists
Mining, quarrying and oil wells	63	–	3	5	25	42	6
Manufacturing:							
Foods and beverages	14	–	–	–	1	49	1
Rubber products	18	–	3	5	1	45	1
Textile products	21	–	–	2	1	28	4
Wood products	–	1	–	2	4	2	–
Paper products	66	2	1	21	13	158	17
Iron and steel products	–	2	7	97	8	4	–
Transportation equipment	18	18	268	625	234	3	52
Non-ferrous metal products	35	3	14	19	5	56	21
Electrical apparatus and supplies	38	2	515	91	32	22	49
Non-metallic mineral products	14	3	1	2	5	14	2
Products of petroleum and coal	21	2	8	6	3	58	8
Chemical products	180	1	2	13	4	372	17
Other manufacturing[1]	5	–	10	14	28	11	1
Transportation, storage, communication and public utility operations	5	12	20	13	1	8	2
Other non-manufacturing[2]	5	1	4	11	2	5	4
Total	**503**	**47**	**856**	**926**	**367**	**877**	185

Industry	Geologists, geophysicists, and other earth scientists	Metallurgists	Mathematicians	Medical scientists	Agricultural scientists	Administrators	Other[3]	Total
Mining, quarrying and oil wells	7	61	3	–	–	11	1	227
Manufacturing:								
Foods and beverages	–	–	1	1	13	4	12	96
Rubber products	–	–	–	–	2	–	–	75
Textile products	–	–	–	2	–	6	5	69
Wood products	–	–	–	–	–	–	–	9
Paper products	–	–	1	–	–	9	8	296
Iron and steel products	–	18	2	–	2	8	4	152
Transportation equipment	–	41	36	–	–	9	8	1,312
Non-ferrous metal products	2	69	–	–	–	1	–	225
Electrical apparatus and supplies	–	12	2	–	–	24	–	787
Non-metallic mineral products	–	1	2	–	–	6	3	53
Products of petroleum and coal	21	–	1	1	3	–	–	132
Chemical products	–	4	2	49	5	27	11	687
Other manufacturing[1]	–	3	–	–	1	2	–	75
Transportation, storage, communication and public utility operations	–	3	2	–	–	6	51	123
Other non-manufacturing[2]	1	4	–	89	–	4	–	130
Total	**31**	**216**	**52**	**142**	**26**	**117**	**103**	**4,448**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services and trade associations.
[3] Some firms were unable to give a detailed breakdown of the field and level of training of the research scientists employed. Their total employment of research scientists is included with "Other, bachelor level".

TABLE 12. Number and Type of Supporting Personnel, by Industry, 1957

Industry	Research-development technicians	Skilled craftsmen	Other supporting personnel	Total supporting personnel
Mining, quarrying and oil wells	161	49	199	409
Manufacturing:				
Foods and beverages	40	9	30	79
Rubber products	42	8	32	82
Textile products	33	13	66	112
Wood products	5	8	3	16
Paper products	273	43	135	451
Iron and steel products	177	177	81	435
Transportation equipment	1,208	189	1,409	2,806
Non-ferrous metal products	396	31	177	604
Electrical apparatus and supplies	564	118	196	878
Non-metallic mineral products	28	8	6	42
Products of petroleum and coal	102	7	37	146
Chemical products	470	45	213	728
Other manufacturing[1]	78	57	29	164
Transportation, storage, communication and public utility operations	91	1	32	124
Other non-manufacturing[2]	69	39	79	187
Total	**3,737**	**802**	**2,724**	**7,263**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 13. Number of Supporting Personnel per Scientist and Engineer, by Industry, 1957

Industry	Total number of scientists and engineers	Total number of supporting personnel	Number of supporting personnel per scientist or engineer
Mining, quarrying and oil wells	227	409	1.8
Manufacturing:			
Foods and beverages	96	79	0.8
Rubber products	75	82	1.1
Textile products	69	112	1.6
Wood products	9	16	1.8
Paper products	296	451	1.5
Iron and steel products	152	435	2.9
Transportation equipment	1,312	2,806	2.1
Non-ferrous metal products	225	604	2.7
Electrical apparatus and supplies	787	878	1.1
Non-metallic mineral products	53	42	0.8
Products of petroleum and coal	132	146	1.1
Chemical products	687	728	1.1
Other manufacturing[1]	75	164	2.2
Transportation, storage, communication and public utility operations	123	124	1.0
Other non-manufacturing[2]	130	187	1.4
Total	**4,448**	**7,263**	**1.6**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 14. Expenditures on Research Grants, by Industry, 1957

Industry	Number of firms making grants	Total expenditures on grants (in Canada)
		$
Mining, quarrying and oil wells	4	105, 850
Manufacturing:		
Foods and beverages	13	24, 350
Wood products	7	19, 100
Paper products	3	6, 700
Iron and steel products	7	44, 900
Transportation equipment	3	49, 100
Non-ferrous metal products	3	3, 000
Non-metallic mineral products	17	176, 136
Products of petroleum and coal	5	14, 700
Chemical products		
Other manufacturing[1]		
Transportation, storage, communication, public utility operations and other non-manufacturing[2]	9	115, 200
Total	**71**	**559, 036**

[1] Includes tobacco and tobacco products, rubber products, leather products, textile products, electrical apparatus and supplies and miscellaneous manufacturing industries.
[2] Includes construction, scientific and engineering services and trade associations. Health services, including medical foundations are excluded as they are recipients of grants and their inclusion would distort the results.

TABLE 15. Estimated Capital Expenditures During 1957 on New or Extended Facilities for Use in Research-Development Activities

Industry	Capital expenditures for research facilities 1957	Replacement value of research facilities at December 31, 1955
	dollars	
Mining, quarrying and oil wells	942, 415	2, 152, 000
Manufacturing:		
Foods and beverages	142, 758	2, 555, 555
Rubber products	197, 085	1, 005, 022
Textile products	69, 300	1, 770, 867
Wood products	851, 981	5, 594, 263
Paper products	453, 650	1, 380, 230
Iron and steel products	5, 422, 746	10, 881, 093
Transportation equipment	163, 500	7, 380, 927
Non-ferrous metal products	666, 168	7, 605, 800
Electrical apparatus and supplies	111, 286	538, 767
Non-metallic mineral products	2, 565, 810	14, 361, 232
Products of petroleum and coal	325, 999	235, 500
Chemical products		
Other manufacturing[1]		
Transportation, storage, communication and public utility operations	150, 900	2, 670, 000
Other non-manufacturing[2]	719, 109	823, 861
Total	**12, 782, 707**	**58, 955, 117**

[1] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[2] Includes construction, health services, scientific and engineering services, and trade associations.

TABLE 16. Research-Development Expenditures, 1955 - 1957[1]

Industry	Total research-development expenditures 1955	Estimated research-development expenditures 1956	Total research-development expenditures 1957[1]
	dollars		
Mining, quarrying and oil wells	3,045,624	3,619,300	6,279,487
Manufacturing:			
Foods and beverages	1,705,727	1,779,122	1,882,122
Rubber products	2,719,839	2,997,234	4,195,753
Textile products	1,160,969	1,294,820	1,482,206
Wood products	94,815	87,500	148,163
Paper products	4,049,008	4,595,425	6,213,362
Iron and steel products	3,088,257	3,297,120	4,324,193
Transportation equipment	16,553,409	22,771,645	25,564,715
Non-ferrous metal products	4,530,242	5,109,200	5,753,109
Electrical apparatus and supplies	10,780,204	11,896,124	14,500,222
Non-metallic mineral products	1,101,488	1,073,927	1,713,776
Products of petroleum and coal	4,704,498	5,653,883	7,488,518
Chemical products	7,844,984	10,135,587	12,240,233
Other manufacturing[2]	454,400	687,900	1,154,373
Transportation, storage, communication and public utility operations	3,350,609	3,371,900	3,898,800
Other non-manufacturing[3]	701,542	934,060	2,740,531
Total	**65,885,615**	**79,304,747**	**99,579,563**

[1] In order to make the figures for 1957 comparable with those for 1955 and 1956 all research done within the company for which the source of funds is shown as government funds received through research-development prime contracts has been deleted.
[2] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[3] Includes construction, health services, scientific and engineering services, and trade associations.

DEFINITIONS

There is no generally accepted definition of the term "research-development". The concepts and definitions used in this survey parallel those used in the previous study covering the year 1955 which were developed in consultation with the National Research Council and others having an intimate knowledge of industrial research. They were also tested through visits to a number of companies active in the research field. The aim was to arrive at a definition which would describe the type of information required, and at the same time conform as far as possible with recognized accounting practices.

In general, research-development was defined as the activities directed to pure or basic research and to the conception and development of new products or processes or major changes in existing products. This concept would cover laboratory scale activity, the design and operation of pilot plants and the development of techniques or processes to the stage where the operation could be taken over by production departments. The design and operation of pilot plants and the development of techniques or processes may result in the inclusion of firms which do not conduct laboratory scale research. Included in research-development expenditures were supporting services, wages and salaries of all research personnel, materials and supplies used, and an estimated portion of overhead costs. This latter item would include stenographic services, delivery services, storage facilities, light, heat, power, etc.

Such activities as market research to establish consumer preference or distribution studies and sales promotion were excluded. Similarly, routine quality or quantity control of a process or product as well as costs of patents were also excluded. Changes in a process or improvements in a product to meet the requirements of a specific customer were not considered as research activity unless such changes were major in nature and resulted in the production of an improved product in volume on a continuing basis.

Although the records of some respondents did not follow the definitions as set out in the schedule, reporting companies were asked to follow the definitions as closely as possible for purposes of comparability. As a result of conversations with many officials in industry, and an examination of the individual returns received, it is felt that any variations in interpretation of the type of data to be included in the questionnaire were not significant enough to make any appreciable difference in the published data.

COVERAGE

This is the second survey of the industrial research field conducted by the Dominion Bureau of Statistics and, in the main, it parallels the previous study covering the year 1955.

As before, only those industries which were thought to be doing a significant amount of research were surveyed, and within the selected industries only those firms which were thought to be large enough to support some sort of research program on a continuing basis were contacted.

All industry groups as defined in the standard industrial classification were included except Clothing, Printing and Publishing, Retail and Wholesale Trade, Personal Services, and Fishing and Agriculture. This latter group was thought to contain few, if any, industrial firms which would carry out any appreciable amount of research-development as defined in this survey. Crown companies were included along with the private sector of Canadian business. The industries included in the survey were as follows:

Mining:

Companies primarily engaged in metal and non-metal mining, fuels, limestone quarrying and oil prospecting.

Foods and Beverages:

Companies primarily engaged in manufacturing food preparations.

Tobacco and Tobacco Products:

Companies primarily engaged in curing tobacco and manufacturing cigars and cigarettes.

Rubber Products:

Companies primarily engaged in manufacturing all kinds of natural or synthetic rubber products, such as tires, rubber footwear, mechanical rubber goods, and rubber sundries.

Leather Products:

Companies primarily engaged in tanning, curing and finishing hides and skins, and manufacturing footwear (except rubber), leather belting, leather gloves, luggage, handbags and similar products.

Textiles:

Companies primarily engaged in manufacturing cotton, woollen or silk (including artificial silk) thread, yarn or woven fabrics, dyeing and finishing textiles, and in the manufacture of cordage, rope and twine, and coating, waterproofing, and otherwise treating fabrics. (Production of clothing, and related fabrication is excluded).

Wood Products:

Companies primarily engaged in producing lumber and wood basic materials, and manufacturing finished articles made entirely or mainly of wood. Companies engaged in manufacturing furniture and window and door screens and shades, regardless of materials used, are also included.

Paper Products:

Companies primarily engaged in the manufacture of pulp either from wood or other fibres, conversion of these pulps into any kind of paper or paper board, or the manufacture of paper and paper board into converted products.

Iron and Steel Products:

Companies primarily engaged in manufacturing primary iron and steel, fabricated and structural steel, sheet metal and iron products, industrial and household machinery and agricultural implements.

Transportation Equipment:

Companies primarily engaged in manufacturing or assembling motor vehicles and parts, aircraft and parts, railroad equipment, and other transportation equipment such as boats, motorcycles, bicycles, etc.

Non-Ferrous Metal Products:

Companies primarily engaged in the smelting and refining of non-ferrous metals, and in the manufacture of aluminum, brass, and copper products, including jewellery and silverware.

Electrical Apparatus and Supplies:

Companies primarily engaged in manufacturing heavy electrical machinery, batteries, radios, television, and electronic components and electrical appliances.

Non-Metallic Mineral Products:

Companies primarily engaged in manufacturing articles made entirely or mainly of non-metallic minerals such as cement, asbestos, clay, glass, stone and concrete.

Products of Petroleum and Coal:

Companies primarily engaged in refining crude petroleum, and in manufacturing products from petroleum as well as coke and coke-oven products, paving and roofing materials, and other products made from coal.

Chemical Products:

Companies primarily engaged in manufacturing industrial chemicals, medicinal and pharmaceutical preparations, soaps and washing compounds, paints, varnishes and allied paint products, and miscellaneous chemicals including fertilizers, sweeping compounds, adhesives, polishes and dressings, etc.

Miscellaneous Manufacturing:

Companies primarily engaged in manufacturing professional and scientific instruments, surgical, medical and dental instruments, and clockwork operated devices.

Construction:

Contractors engaged in the construction of buildings and highways, heavy construction and marine construction.

Transportation, Storage and Communication:

This group includes the following:

(1) Transportation companies, primarily engaged in the operation of air or water transportation services, and steam railways.

(2) Storage companies, primarily engaged in the operation of grain elevators and other storage facilities, including refrigeration.

(3) Communication companies, primarily engaged in the operation of radio, television, broadcasting and telephone services.

Public Utility Operations:

Companies primarily engaged in the distribution of electric power, and the manufacture and distribution of gas.

Service:

This group includes the following:

(1) **Health**: This classification is confined to hospitals maintaining research-development establishments and medical foundations.

(2) **Engineering and Scientific**: Companies primarily engaged in providing engineering, chemical, metallurgical and architectural services. This includes research laboratories except medical and dental, which are classified as health services above.

(3) **Associations**: Trade or industrial organizations supported by members operating in Canadian industry, and conducting research on behalf of their paying members.

Only the larger firms were considered as being in a position to maintain full time research-development establishments. However, to ensure as complete coverage as possible, the survey was extended to include all firms in the industries noted above with 100 or more employees. As an indication of the research activity conducted by the smaller firms, of the 1,364 firms in the survey with 200 or fewer employees, only 124 reported research-development costs. Expenditures averaged $60 thousand in this group and accounted for less than 6% of the total.

Research activity is generally conducted for the benefit of the entire firm rather than in the interests of an individual branch plant. Consolidated reports were therefore requested from "multiple" firms. In cases where all branches of a firm did not

operate in the same industrial field, the firm was classified in the industry in which the major part of its operations were performed. This may lead to over or under statement of research in particular industries.

Respondents were requested to report the names of firms or associations from which they secured results of research activity, either with or without payment. Firms so reported and located in Canada, were checked against the mailing list, and, if they were not already included in the survey, they were immediately sent a questionnaire for completion. This source resulted in comparatively few additions to the mailing list, but did insure more complete coverage. It also resulted in the inclusion in the survey of a few firms with less than 100 employees.

The survey included 2,818 firms of which more than 98% submitted returns.

Survey Coverage Based on Employment

Industry	Employment			Percentage coverage of total employment	
	Total in industry[1]	Total of surveyed firms[1]	Total of research-active firms[2]	Surveyed firms	Research-active firms
Mining, quarrying and oil wells	123,228	101,491	45,462	82.4	36.9
Manufacturing:					
Foods and beverages	228,633	187,342	58,532	81.9	25.6
Rubber products	27,212	25,954	16,116	95.4	59.2
Textile products	77,706	63,879	23,142	82.2	29.8
Wood products	164,918	90,085	7,762	54.6	4.7
Paper products	189,764	181,254	119,621	95.5	63.0
Iron and steel products	227,618	185,467	67,025	81.5	29.4
Transportation equipment	139,696	131,348	73,265	94.0	52.4
Non-ferrous metal products	64,473	53,406	46,035	82.8	71.4
Electrical apparatus and supplies	94,131	85,974	83,277	91.3	88.5
Non-metallic mineral products	44,803	33,334	12,091	74.4	27.0
Products of petroleum and coal	33,156	32,514	21,485	98.1	64.8
Chemical products	71,865	59,563	43,010	82.9	59.8
Other manufacturing[3]	57,973	42,104	10,817	72.6	18.7
Transportation, storage, communication and public utility operations	418,648	378,271	268,045	90.4	64.0
Other non-manufacturing[4]	437,983	266,624	20,793	60.9	4.7
Total	**2,401,807**	**1,918,610**	**916,478**	**79.9**	**38.2**

[1] Employment in 1954.
[2] Employment in 1957.
[3] Includes tobacco and tobacco products, leather products and miscellaneous manufacturing industries.
[4] Includes construction, health services, scientific and engineering services, and trade associations.

SURVEY METHODS

All firms in the survey were originally contacted by mail. Response was exceptionally good and the final result was a completed return received from over 98% of the firms contacted.

In order to ascertain the total cost of research-development, respondents were asked to report not only the cost of their own activities in this field, but also payments made to other companies or organizations both within Canada and outside the country. To avoid duplication, firms were also asked to list the companies to which such payments were made as well as those from which payments were received for research results. Adjustments were then made on the reports received.

During the editing of the questionnaires some difficulties or differences in interpretation were encountered. These instances were clarified through correspondence or by telephone and on the advice of the respondents, adjustments were made in the reports.

Complete in duplicate. Keep one copy for your files and return one copy in the enclosed envelope to the Dominion Bureau of Statistics, Ottawa. Individual reports will be treated as CONFIDENTIAL and used only for the purpose of arriving at group totals.

FOR IMMEDIATE ATTENTION

CONFIDENTIAL KEEP ONE COPY

Department of

Trade and Commerce

Dominion Bureau of Statistics

General Assignments Division

INDUSTRIAL RESEARCH EXPENDITURES

1957

Taken in conformity with the requirements of the Statistics Act, Chap. 257 of the Revised Statutes of Canada, 1952.

This survey is being conducted in cooperation with the National Research Council, in an effort to assess the magnitude of the industrial research program in Canada in terms of total expenditures incurred in the various scientific fields, numbers of trained personnel employed, and sources of funds.

Please complete the schedule as fully as possible. Your best estimates will be satisfactory if precise figures are not available.

NOTE: In the case of parent-subsidiary operations a consolidated return covering all companies which are within the organization will be satisfactory. Please list companies covered by this report in Item 7.

DEFINITIONS

Research-development includes basic and applied research in the sciences, including medicine, and in engineering, and design and development of prototypes and processes. Do not include quality control, routine testing of products, testing of assembly line and production techniques, market research, sales promotion, sales service, geological and geophysical exploration or research in the social sciences or psychology. (SEE NOTES ON PAGE 3.)

SECTION A

1. Was any research-development conducted within reporting company during 1957? ☐ Yes ☐ No

   (a) If "YES", was any research-development done on behalf of other companies or organizations for which you were reimbursed? ☐ Yes ☐ No

   (b) If "YES" to (a) above, list names and addresses of companies or organizations purchasing this service:

   Name Address

2. (a) Did reporting company spend any funds for research-development done outside the company during 1957? ☐ Yes ☐ No

   (b) If "YES" list names and addresses of outside organizations which undertook and/or supplied you with research-development services:

   Name Address

3. (a) Did reporting company grant funds to educational institutions, research institutes, foundations and hospitals for general research-development work during 1957? ☐ Yes ☐ No

   (b) If "YES" list names and addresses of those to which these funds were granted:

   Name Address

NOTE: IF THE ANSWERS TO QUESTIONS 1, 2 AND 3 ARE "NO" PLEASE COMPLETE SECTION B AND SIGN AND RETURN AS SECTION C DOES NOT APPLY.

SECTION B

4. (a) Does reporting company have access to the results of research-development done outside your company for which no payment is made? ☐ Yes ☐ No

   (b) If "YES" list names and addresses of companies or organizations supplying this information:

   Name Address

5. Average number of persons employed by reporting company in all its activities in Canada during 1957. Include employees of subsidiaries and/or affiliates if consolidated report. (Estimate only) _____

6. Total value of sales or services rendered by reporting company during 1957. (Estimate only) $_____

7. List of companies covered by this report. (Consolidated reports only):

   Name Address

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SECTION C

8. Indicate approximate percentage of total research-development expenditures made in each of the following fields:

Engineering, Chemical		Engineering, Other		Metallurgy	
Engineering, Civil		Chemistry		Medicine	
Engineering, Electrical		Physics		Agriculture	
Engineering, Mechanical		Geology, Geophysics and Other Earth Sciences		Others (Specify)	

9. Cost of research-development performed or financed by reporting company ..... $ _____

Report total cost for all research-development. Include all professional and non-professional salaries, other direct costs and an estimated share of overhead expenses including depreciation; exclude patent expense and expenditures on construction or acquisition of buildings and durable equipment which should be reported under item 11 below.

(a) Done within your company organization (total 1957) ..... $ _____

Source of funds (approximate percentages):

(i) Reporting company ..... _____ %

(ii) Parent, affiliated and/or subsidiary companies ..... _____ %

(iii) Government funds received through:

(a) Research-development prime contracts ..... _____ %

(b) Research-development part of procurement contracts ..... _____ %

(iv) Other (Please specify) ..... _____ %

..... _____ %

Estimated cost of research-development to be done within your company organization, 1958 ..... $ _____

(b) Done outside your company organization (total 1957) ..... $ _____

Payment made to:

	In Canada	Outside Canada
(i) Parent, affiliated and/or subsidiary companies	$ _____	$ _____
(ii) Commercial laboratories and consultants	$ _____	$ _____
(iii) Other companies	$ _____	$ _____
(iv) Educational institutions – for research-development only. (See item 10 below)	$ _____	$ _____
(v) Research institutions, foundations, etc.	$ _____	$ _____
(vi) Government	$ _____	$ _____
(vii) Other (Please specify)	$ _____	$ _____
	$ _____	$ _____

Estimated cost of research-development to be done outside your company organization, 1958 ..... $ _____

10. Amount of funds granted to educational institutions, research institutions, foundations and hospitals during 1957 for general research-development work. (This amount should not be included in Item 9 above) ..... $ _____

11. Estimated capital expenditures during 1957 on new or extended facilities, including special buildings and equipment, for use in research-development activities ..... $ _____

12. Number of persons employed in research-development done within your company organization during 1957 (full-time equivalent if part-time staff engaged).

Note: Include all persons whose pay is included in cost figures in question 9(a).

(a) Research-development scientists and engineers. All classes of supporting personnel are to be excluded from this section.

Bachelor Level	Master Level	Doctorate Level		Bachelor Level	Master Level	Doctorate Level
			..... Engineers, Chemical	Geologists, geophysicists and other earth scientists			
			..... Engineers, Civil	Metallurgists			
			..... Engineers, Electrical	Mathematicians			
			..... Engineers, Mechanical	Medical Scientists			
			..... Engineers, Other	Agricultural Scientists			
			..... Chemists	Administrators (of Research-Development)			
			..... Physicists	Other (Specify)			

(b) Supporting personnel – Note: Definitions under C opposite page.

(i) Research-development technicians ..... _____

(ii) Skilled craftsmen ..... _____

(iii) Other supporting personnel ..... _____

Name and address of person making this report

.....

.....

Date of this report ..... 195 .....

Department Use

Edited _____

Checked _____

Entered _____

DEFINITIONS

A. CONCEPTS OF RESEARCH-DEVELOPMENT:

Research-development comprises activities directed to pure research and to conceiving and developing new products, new processes and major changes in products or processes, and bringing them to the stage of production. Such activities as market and sales research and process and quality control are excluded, as well as other special cases outlined below. In case of doubt, please feel free to ask about special situations which you may encounter.

The following kinds of activity are to be included in the concept of research-development:

1. Laboratory scale activity.
2. The design and operation of pilot plants or prototypes, provided the main purpose is one of the following:
   (a) To test experimental conclusions reached at the laboratory level.
   (b) To establish finished product formulas, specifications or standards.
   (c) To design special equipment required by a new or improved process.
   (d) To prepare operating instructions for use at the manufacturing level.
3. The engineering activity necessary to advance the design of a product or a process originated in the laboratory to the production stage. The design, construction and testing of full scale models prior to production is included, along with the development of designs for special manufacturing equipment and tools required.
4. The preparation of drawings, formulas, specifications and manuals of instruction for the use of manufacturing units, all of which are based on the research activities. (See No. 9 in the following section).

The following activities are not to be included in the concept of research-development:

1. Market research and development, including statistical surveys of consumer preferences, estimates of possible markets, distribution outlets, etc.
2. Development of advertising programs including sales promotion and demonstration of new products.
3. Economic research and other research in the social sciences.
4. Application for patents, including related legal work.
5. Experimental work performed to provide additional information as required for the completion of patent litigation.
6. Routine quality or quantity control of a process or products at the manufacturing level.
7. Investigation and/or analytical work in connection with mechanical interruptions in production (i.e. trouble shooting).
8. Work required for the minor modification of a specific product to meet the requirements of a specific customer.
9. Assistance furnished at the manufacturing level to facilitate production in accordance with established formulas, instructions or finished product specifications. This includes the cost of printing blueprints and instruction manuals. (See No 4 in preceding section).
10. Geological or geophysical exploration.

B. COST OF RESEARCH-DEVELOPMENT:

Include all costs incurred for research-development work done.

If you maintain a separate research-development organization, include all operating costs of this organization minus an estimated allowance of the cost of non-research technical services as outlined (Nos. 1 to 10) in the preceding section. Include also an estimate of the cost of research-development work done by company divisions or technicians not part of the research-development organization. Exclude capital expenditures. Costs incurred as a result of research-development activity within your company organization may include but are not limited to the following:

1. Wages, salaries and related costs, including "fringe benefits", of all research personnel, including scientists and all classes of supporting staff.
2. Materials and supplies used (or purchased), including the cost of purchasing, receiving, inspection, storage and transportation.
3. Literature purchased to provide background information necessary for research operations.
4. Company overhead, which is an estimated share of the functions supporting research-development activity.

If research-development operations are being conducted for your company by outside organizations, enter the cost in Section 9(b). Your entries should include the total charges for the work including professional fees and administrative costs.

C. SUPPORTING PERSONNEL:

Technicians: Technical personnel having high school graduation or equivalent and additional technical training, who assist scientists and engineers in research-development work (i.e. laboratory technicians and assistants, draftsmen, etc.).

Skilled Craftsmen: Workers in positions requiring specialized training and experience and who are engaged in research-development work (i.e. glassblowers, machinists, modelmakers, etc.).

Other Supporting Personnel: All other persons whose pay is included in Item 9(a).

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