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CANADA

INDUSTRIAL RESEARCH-DEVELOPMENT
EXPENDITURES IN CANADA
1955

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P R E F A C E

With the publication of this reference paper, the Dominion Bureau of Statistics, in cooperation with the National Research Council, sets out in tabular form an estimate of the magnitude and direction of the research-development program undertaken by Canadian industry in 1955 and provides an indication of the relative size of the 1956 program. Much has been said about this program by industry and its relation to the rapidly expanding Canadian industry in the post-war years, but little definite information has been available generally. It is hoped that the statistical information contained in this paper may throw some light on the subject, and assist those interested in research-development in furthering their knowledge of this important field of endeavour.

The survey of industrial research-development expenditures sought information on expenditures made directly by the companies, and on purchases of research-development results from affiliates and others located inside 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 employed.

In preparing the concepts and definitions used in the survey numerous consultations were held with senior members of the National Research Council, scientists and administrators of Canadian companies who were known to have a substantial interest in advancing the industrial research program and with several trade and professional associations.

The paper was prepared by the General Assignments Division of the Dominion Bureau of Statistics, in cooperation with the National Research Council.

The assistance of the many business firms who have cooperated with us by submitting reports is gratefully acknowledged. Without their cooperation this paper would not have been possible.

Herbert Marshall,
Dominion Statistician.

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GENERAL REVIEW

The importance of the industrial research-development program being conducted in Canada, is clearly indicated by the recently completed survey of nearly 2,500 of the larger Canadian companies. During 1955, 377 companies of those surveyed carried out research-development programs totalling almost \$66 million. The same firms estimated that their expenditures in the current year would reach almost \$80 million, an increase of 20% over last year. An additional 235 companies had facilities available to them for which no payments were made and the remainder did not make any expenditures and did not have arrangements to obtain information by other means.

By far the major part of the industrial research-development work was conducted within the reporting companies themselves, which accounted for almost \$52 million in 1955. An additional \$12 million or 18% was spent for research-development done outside Canada, of which expenditures in the United States accounted for 92%, and in the United Kingdom 4%. The remainder was spent for research conducted in other foreign countries. Of the \$2 million, or 3%, spent for research done by other companies in Canada, 58% was paid to firms outside the corporate structure of the reporting company and 7% to non-consolidated affiliated companies located in Canada. Payments to commercial laboratories or consultants, and educational institutions accounted for the remaining 20% and 15% respectively.

A breakdown of the total expenditures on research-development by industry reveals that Transportation Equipment, Electrical Apparatus and Supplies, and Chemical Products, far exceeded the expenditures in all other industries. In the Transportation Equipment industry, which includes the manufacture of aircraft, research-development costs totalled \$16.5 million, slightly more than one quarter of the total of all industries. The cost of research-development conducted in the Electrical Apparatus and Supplies, and Chemical Products industries together accounted for an additional \$18.6 million. Next in magnitude were Products of Petroleum and Coal, Non-Ferrous Metal Products, Paper Products, Iron and Steel Products, Mining, Rubber Products and the Transportation and Utilities industry. Together these 10 industries accounted for over 90% of the total cost of industrial research-development.

Increased activity and interest in the research field is indicated by the reported anticipated cost of research-development in 1956 reaching a total of over \$79 million, an increase of 20%. It is interesting to note that those industries most actively engaged in this phase of industrial development in 1955 also account for the major part of the increase. The Transportation Equipment industry reported an anticipated 1956 research expenditures increase of \$6 million, or 37% in excess of 1955 research costs. Next in order were Chemical Products, showing an increase of \$2 million, and Products of Petroleum and Coal and Electrical Apparatus and Supplies showing increases of \$1 million each. These four industries account for 78% of the total increase reported. Although the "Other Manufacturing" industry group reported the extremely high increase of 74%, this amounted to only \$220,000. Two industries reported their 1956 anticipated expenditures as slightly less than the 1955 research costs. These were the Wood Products, and Non-Metallic Mineral Products industries, which reported a total decrease amounting to only \$34,000.

FIELD OF RESEARCH-DEVELOPMENT ACTIVITY (Table 4)

Examination of the various fields of research-development activity reveals that five of the main categories accounted for over 80% of the total in 1955. These are, mechanical engineering 24%, chemistry 20%, chemical engineering 12%, electrical

engineering 21%, metallurgy 9%. Expenditures in the chemistry and chemical engineering fields, which are closely related, totalled \$21 million -- almost one-third of the total. Every industry reported some activity in the chemical research field, with the major share carried by the Chemical Products, Paper Products, and Products of Petroleum and Coal industry groups.

All industries were also active in at least one phase of engineering research, with mechanical and electrical engineering accounting for the major part of the engineering expenditures, 41%, and 35% respectively. Research expenditures in metallurgy were confined largely to the Metallic and Chemical Products industries, and Mining. Of these industry groups Non-Ferrous Metal Products accounted for 54%, and the Mining industry 19% of the \$5.6 million expended in this field.

RESEARCH-DEVELOPMENT EXPENDITURES BY SIZE OF FIRM (Table 5)

Arrangement of industrial research expenditures by size group based on the annual sales of research active firms, shows that the major part of the expenditures was due to research conducted by the larger firms -- those with annual sales in excess of \$50 million. Although this size group was responsible for 65% of research costs it included only 14% of firms maintaining research establishments. The largest block of firms (those with annual sales between \$1 million and \$9 million) which included 53% of the firms accounted for only 13% of the total expenditures. Most of the industries followed this pattern, with the exception of the Chemical Products and the Iron and Steel industries, where 30% of the expenditures in each were in the \$1 million to \$9 million sales group. In addition in the Iron and Steel industry, the size group with annual sales between \$10 million and \$49 million accounted for a further 65% of the total expenditures.

DIRECT RESEARCH-DEVELOPMENT EXPENDITURES (Table 6)

Research-development expenditures for work done within the reporting organizations accounted for \$52 million or 78% of the total with, as in the case of total expenditures, the Transportation Equipment, Electrical Apparatus and Supplies, and Chemical Products industry groups accounting for the major part of the costs. However, expenditures made directly by these three industries accounted for a greater proportion of the direct research costs than of total research costs - 59% compared with 53%. Next in magnitude were Non-Ferrous Metal Products, Paper Products, Iron and Steel Products, Mining, Transportation and Utilities, Products of Petroleum and Coal, and the Foods and Beverages industries. These groups were, in the main, the same industries as were responsible for the major part of the total research expenditures, and accounted for about the same proportion of direct costs - slightly over 90%.

Arrangement of research expenditures by size group based on annual sales shows that direct research costs followed the same pattern as total expenditures with the major part due to research conducted by the larger firms. However, the Chemical Products and Iron and Steel Products industries again had approximately one-third of direct expenditures in the \$1 million to \$9 million sales group, with the Iron and Steel Products industry showing a still heavier concentration in the \$10 million to \$49 million size group.

DIRECT RESEARCH-DEVELOPMENT EXPENDITURES/SALES RATIO (Table 6)

Direct research expenditures averaged 0.5% of the sales of firms active in this field. The three most research-active industries, Transportation Equipment, Electrical Apparatus and Supplies and Chemical Products, were well above this average having spent 1.7%, 1.3% and 1.0% of their sales-dollar respectively. The research cost/sales ratio of other industries in order of magnitude were Non-Ferrous Metal Products, Paper Products, Iron and Steel Products and Mining.

DISTRIBUTION OF FIRMS WITH RESEARCH-DEVELOPMENT PROGRAMS (Table 7)

The number of firms actively engaged in research-development did not have a direct bearing on magnitude of expenditures in any one industry. The Transportation Equipment industry, which was responsible for 25% of the total industrial research costs, accounted for only 6% of the total number of firms reporting research expenditures. In like manner, the Products of Petroleum and Coal, although accounting for 7% of the expenditures, included only 1% of the total number of firms conducting research. On the other hand, the Iron and Steel industry which was responsible for 5% of the total research costs accounted for 15% of the number of firms reporting. Similarly the Foods and Beverages industry which was responsible for 3% of the cost of this phase of industrial activity, accounted for 9% of the research-active firms. The Chemical Products industry reported 12% of the total, both in terms of expenditures and in terms of numbers of firms supporting research. The Electrical Apparatus and Supplies industry was of much the same order, accounting for 16% in terms of expenditures and 12% in terms of number of firms conducting research.

On the basis of the number of firms engaged in research in the various industries, some industries proved to be more research-active than others. In both the Electrical Apparatus and Supplies and Chemical Products industries, slightly more than 40% of the firms surveyed reported research expenditures. The research-active firms also accounted for over 40% of those surveyed in the Rubber Products industry, but there were only 20 firms contacted. The Iron and Steel industry accounted for the largest number of firms engaged in research in any one industry, 56 or 20% of the total number surveyed in that field.

On the same basis, next in order were Paper Products, Non-Metallic Mineral Products, Products of Petroleum and Coal, Non-Ferrous Metal Products and the Transportation Equipment industries, all of which had between 20% and 30% of the firms contacted reporting research expenditures.

In addition to the 377 firms reporting expenditures on research, 235 reported that, although they did not spend funds on research-development, they had access to free distribution of research-development conducted outside their own company. Of these, 116, or approximately 50%, received this service from a parent company, 81 firms secured results of research conducted in Canada without payment, the greatest number being in the Foods and Beverages and Wood Products industries. Of those having free access to results of research conducted in the United States, totalling 149, the Iron and Steel and Chemical industries accounted for almost half. Only 16 firms reported receiving results of research conducted in the United Kingdom on the same basis, with no noticeable predominance in any one industry. The number of firms that reported as being included in an arrangement which allows for free access to research results either from a parent company or through arrangement with other business firms, gives some indication of the importance of research activity to industry.

PROFESSIONALLY-TRAINED STAFF (Tables 8 and 9)

During 1955, the equivalent of 2,914 professionally-trained scientists were employed on research development projects by the reporting companies. Included in this total were 2,154 holding bachelor degrees, 341 with masters degrees, and 419 who had completed their doctorate degrees. The three top industrial groups in terms of numbers of professionally-trained employees were, Electrical Apparatus and Supplies industry with 611, Transportation Equipment, 561, and Chemical Products, 514. Next in order were the Non-Ferrous Metals, Mining, Transportation and Utility Operations, Iron and Steel Products, and Foods and Beverages industry groups. These nine industries together accounted for 87% of the total professional employment in the research field.

The distribution of scientists with different levels of training varied from industry to industry. The industries less active in the engineering research fields reported a higher proportion of professionally-trained scientists at the doctorate level. These industries, with their respective percentages of professional employees at the doctorate level were as follows: Foods and Beverages, 26%; Rubber Products, 27%; Paper Products, 25%; Products of Petroleum and Coal, 24%; and Non-Ferrous Metal Products and Chemical Products, with 22% each. The category noted as "Other Non-Manufacturing" made up largely of Health Services, Scientific and Engineering Services, and Trade Associations, had over 73% of its professionally-trained personnel at the doctorate level, but only accounted for 89 persons in all, largely medical scientists. Conversely those industries more active in the engineering field reported fewer professional employees at the doctorate level, with a correspondingly larger number with a bachelor degree. The Iron and Steel and Transportation Equipment industries each had less than 2.5% of the research scientists at the doctorate level, and the Electrical Apparatus and Supplies industry, slightly less than 5%.

Further examination of the classification of professional scientists by field of research, reveals that 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, 94% of whom are trained to the bachelor level. Metallurgists also follow this same general distribution. On the other hand chemists, physicists, geologists and other earth scientists, and biological 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.

VALUE OF RESEARCH-DEVELOPMENT FACILITIES (Table 10)

The estimated replacement value of facilities used for research-development purposes as at December 31, 1955, was reported as \$59 million. The major share of the facilities was located in the Chemical Products, Transportation Equipment and Paper Products industries which accounted for 21%, 18% and 9% respectively. In addition, a number of firms engaged in research use facilities which are also used in other phases of their operations. This is more evident in industries where the research activity is concentrated in the engineering field.

TABLE 1. RESEARCH-DEVELOPMENT EXPENDITURES, BY INDUSTRY, 1955

Industry	Expenditures for Research Done Within the Company	Payments to Others in Canada	Payments to Others Outside Canada	Total Research- Development Expenditures
	\$	\$	\$	\$
Mining, Quarrying and Oil Wells	2,257,519	130,778	657,327	3,045,624
Manufacturing:				
Foods and Beverages	1,154,495	68,211	483,021	1,705,727
Rubber Products	748,923	-	1,970,916	2,719,839
Leather Products	144,000	1,900	11,000	156,900
Textile Products	1,055,640	30,329	75,000	1,160,969
Wood Products	92,325	1,090	1,400	94,815
Paper Products	3,069,046	778,369	201,593	4,049,008
Iron and Steel Products	2,951,380	35,883	100,994	3,088,257
Transportation Equipment	13,549,127	487,857	2,516,425	16,553,409
Non-Ferrous Metal Products	3,975,231	56,511	498,500	4,530,242
Electrical Apparatus and Supplies	10,033,687	13,475	733,042	10,780,204
Non-Metallic Mineral Products	982,598	26,430	92,460	1,101,488
Products of Petroleum and Coal	1,630,563	10,500	3,063,435	4,704,498
Chemical Products	7,143,142	70,726	631,116	7,844,984
Other Manufacturing (1)	287,500	10,000	-	297,500
Transportation, Storage, Communication, and Public Utility Operations	2,215,526	26,300	1,108,783	3,350,609
Other Non-Manufacturing (2)	558,951	142,591	-	701,542
TOTAL	51,849,653	1,890,950	12,145,012	65,885,615
Percentage of expenditures within the company, in Canada and outside Canada to total research expenditures.	78.70%	2.87%	18.43%	100%

(1) Includes Tobacco and Tobacco 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, 1956

Industry	Total Research Expenditures 1955	Estimated Research Expenditures 1956	% Increase or Decrease
	\$	\$	%
Mining, Quarrying and Oil Wells	3,045,624	3,619,300	18.84
Manufacturing:			
Foods and Beverages	1,705,727	1,779,122	4.30
Rubber Products	2,719,839	2,997,234	10.20
Leather Products	156,900	169,500	8.03
Textile Products	1,160,969	1,294,820	11.53
Wood Products	94,815	87,500	- 7.72
Paper Products	4,049,008	4,595,425	13.50
Iron and Steel Products	3,088,257	3,297,120	6.76
Transportation Equipment	16,553,409	22,771,645	37.56
Non-Ferrous Metal Products	4,530,242	5,109,200	12.78
Electrical Apparatus and Supplies	10,780,204	11,896,124	10.35
Non-Metallic Mineral Products	1,101,488	1,073,927	- 2.50
Products of Petroleum and Coal	4,704,498	5,653,883	20.18
Chemical Products	7,844,984	10,135,587	29.20
Other Manufacturing (1)	297,500	518,400	74.25
Transportation, Storage,) Communication and) Public Utility Operations)	3,350,609	3,371,900	.64
Other Non-Manufacturing (2)	701,542	934,060	33.14
TOTAL	65,885,615	79,304,747	20.37

(1) Includes Tobacco and Tobacco Products and Miscellaneous Manufacturing.

(2) Includes Construction, Health Services, Engineering and Scientific Services and Trade Associations.

TABLE 3. INCREASE AND DECREASE IN RESEARCH-DEVELOPMENT EXPENDITURES
IN TERMS OF NUMBERS OF COMPANIES, BY INDUSTRY, 1955 TO 1956.

Industry	Number of Companies Anticipating Decreased Research Expenditures in 1956	Number of Companies Anticipating Increased Research Expenditures in 1956
Mining, Quarrying and Oil Wells	6	17
Manufacturing:		
Foods and Beverages	4	20
Rubber Products	-	8
Leather Products	-	4
Textile Products	3	5
Wood Products	1	3
Paper Products	7	26
Iron and Steel Products	8	32
Transportation Equipment	6	11
Non-Ferrous Metal Products	2	10
Electrical Apparatus and Supplies	8	29
Non-Metallic Mineral Products	5	10
Products of Petroleum and Coal	-	5
Chemical Products	4	34
Other Manufacturing (1)	-	5
Transportation, Storage,)		
Communication and)		
Public Utility Operations)	2	8
Other Non-Manufacturing (2)	3	10
TOTAL	59	237

(1) Includes Tobacco and Tobacco 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, 1955

Industry	Chemistry	Physics	Geology	Medicine	Agriculture	Biology
	\$	\$	\$	\$	\$	\$
Mining, Quarrying and Oil Wells	356,796	-	338,582	-	-	-
Manufacturing:						
Foods and Beverages	722,856	5,838	-	1,260	254,424	383,819
Rubber Products	712,231	35,200	-	-	-	-
Leather Products	106,900	-	-	-	-	-
Textile Products	716,370	86,400	-	5,700	-	-
Wood Products	18,697	-	-	-	26,995	-
Paper Products	2,196,046	302,515	1,695	-	30,600	61,200
Iron and Steel Products	27,270	7,790	-	-	-	-
Transportation Equipment	4,600	1,212,500	-	-	-	-
Non-Ferrous Metal Products	652,770	-	60,400	-	-	-
Electrical Apparatus and Supplies	356,841	150,067	-	-	-	-
Non-Metallic Mineral Products	350,243	2,500	-	-	-	-
Products of Petroleum and Coal	1,998,602	308,044	333,292	36,292	36,292	-
Chemical Products	4,569,505	298,607	-	949,584	115,701	26,125
Other Manufacturing (1)	107,128	25,456	-	-	-	-
Transportation, Storage,) Communication, and) Public Utility Operations)	363,500	632,000	-	-	27,783	-
Other Non-Manufacturing (2)	110,203	-	-	462,163	25,370	-
TOTAL	13,370,558	3,066,917	733,969	1,454,999	517,165	471,144

(1) Includes Tobacco and Tobacco Products, and Miscellaneous Manufacturing Industries.

(2) Includes Construction, Health Services, Scientific and Engineering Services and Trade Association.

TABLE 4. TOTAL RESEARCH-DEVELOPMENT EXPENDITURES, BY INDUSTRY, BY FIELD OF RESEARCH, 1955

Engi- neering, Chemical \$	Engi- neering, Civil \$	Engi- neering, Electrical \$	Engi- neering, Mechanical \$	Engi- neering, Other \$	Metallurgy \$	Other \$	Total \$
592,812	-	43,200	41,181	510,310	1,076,174	86,569	3,045,624
250,685	-	-	31,651	5,000	-	50,194	1,705,727
1,473,750	-	13,800	147,453	19,048	-	318,357	2,719,839
-	-	-	50,000	-	-	-	156,900
52,650	-	4,355	51,075	76,419	-	168,000	1,160,969
-	-	-	18,325	15,798	-	15,000	94,815
780,663	9,377	5,138	325,161	38,347	-	298,266	4,049,008
21,020	21,625	235,122	2,654,234	14,510	79,470	27,216	3,088,257
809,400	-	2,171,720	11,087,253	359,350	842,057	66,529	16,553,409
283,927	79,500	270,000	95,289	20,717	3,055,739	11,900	4,530,242
118,598	-	9,310,935	484,580	31,508	321,675	6,000	10,780,204
263,124	7,782	3,700	111,275	84,010	150,082	128,772	1,101,488
1,685,100	54,000	45,000	99,000	36,292	-	72,584	4,704,498
894,332	-	337,247	492,527	78,980	70,000	12,376	7,844,984
-	-	39,100	125,816	-	-	-	297,500
373,026	282,600	1,298,300	322,000	18,900	-	32,500	3,350,609
2,463	85,263	-	-	-	16,080	-	701,542
7,601,550	540,147	13,777,617	16,136,820	1,309,189	5,611,277	1,294,263	65,885,615

TABLE 5. TOTAL RESEARCH-DEVELOPMENT EXPENDITURES,
BY INDUSTRY AND SIZE GROUP, 1955

Industry and Size Group (1)	Number of Firms	Total Research-Development Cost	Total Research Cost as % of Industry Total
		\$	%
Mining, Quarrying and Oil Wells:			
1. \$ 50 million and over	3	1,345,000	44.16
2. \$ 10 million to \$ 49 million	8	1,064,212	34.94
3. \$ 1 million to \$ 9 million	13	598,281	19.64
4. Under \$ 1 million	3	38,131	1.26
TOTAL	27	3,045,624	100.00
Food and Beverages:			
1. \$ 50 million and over	7	1,081,545	63.41
2. \$ 10 million to \$ 49 million	13	456,332	26.75
3. \$ 1 million to \$ 9 million	15	167,850	9.84
4. Under \$ 1 million	-	-	-
TOTAL	35	1,705,727	100.00
Rubber Products:	9 (3)	2,719,839 (3)	100.00 (3)
Leather Products:	5 (3)	156,900 (3)	100.00 (3)
Textile Products:			
1. \$ 50 million and over	(2)	(2)	(2)
2. \$ 10 million to \$ 49 million	6 (2)	905,320 (2)	77.98 (2)
3. \$ 1 million to \$ 9 million	11 (4)	255,649 (4)	22.02 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	17	1,160,969	100.00
Wood Products:	5 (3)	94,815 (3)	100.00 (3)
Paper Products:			
1. \$ 50 million and over	9	2,518,630	62.20
2. \$ 10 million to \$ 49 million	18	1,434,635	35.43
3. \$ 1 million to \$ 9 million	8	95,743	2.37
4. Under \$ 1 million	-	-	-
TOTAL	35	4,049,008	100.00

(1) Size groups are based on annual sales value, 1955.

(2) Size groups 1 and 2 combined.

(3) All size groups combined.

(4) Size groups 3 and 4 combined.

TABLE 5. TOTAL RESEARCH-DEVELOPMENT EXPENDITURES,
BY INDUSTRY AND SIZE GROUP, 1955 (Cont'd)

Industry and Size Group (1)	Number of Firms	Total Research-Development Cost	Total Research Cost as % of Industry Total
		\$	%
Iron and Steel Products:			
1. \$ 50 million and over	4	164,174	5.31
2. \$ 10 million to \$ 49 million	13	1,976,093	63.99
3. \$ 1 million to \$ 9 million	35	931,274	30.16
4. Under \$ 1 million	4	16,716	.54
TOTAL	56	3,088,257	100.00
Transportation Equipment:			
1. \$ 50 million and over	4	14,146,829	85.46
2. \$ 10 million to \$ 49 million	8	1,291,755	7.80
3. \$ 1 million to \$ 9 million	10 (4)	1,114,825 (4)	6.74 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	22	16,553,409	100.00
Non-Ferrous Metal Products:			
1. \$ 50 million and over	(2)	(2)	(2)
2. \$ 10 million to \$ 49 million	5 (2)	4,009,000 (2)	88.49 (2)
3. \$ 1 million to \$ 9 million	10 (4)	521,242 (4)	11.51 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	15	4,530,242	100.00
Electrical Apparatus and Supplies:			
1. \$ 50 million and over	4	6,422,500	59.58
2. \$ 10 million to \$ 49 million	4	2,663,800	24.71
3. \$ 1 million to \$ 9 million	30	1,564,179	14.51
4. Under \$ 1 million	6	129,725	1.20
TOTAL	44	10,780,204	100.00
Non-Metallic Mineral Products:			
1. \$ 50 million and over	-	-	-
2. \$ 10 million to \$ 49 million	3	784,348	71.21
3. \$ 1 million to \$ 9 million	15 (4)	317,140 (4)	28.79 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	18	1,101,488	100.00
Products of Petroleum and Coal:	5 (3)	4,704,498 (3)	100.00 (3)

(1) Size groups are based on annual sales value, 1955.

(2) Size groups 1 and 2 combined.

(3) All size groups combined.

(4) Size groups 3 and 4 combined.

TABLE 5. TOTAL RESEARCH-DEVELOPMENT EXPENDITURES,
BY INDUSTRY AND SIZE GROUP, 1955 (Concl.)

Industry and Size Group (1)	Number of Firms	Total Research Development Cost	Total Research Cost as % of Industry Total
		\$	%
Chemical Products:			
1. \$ 50 million and over	5	4,269,426	54.42
2. \$ 10 million to \$ 49 million	7	1,054,207	13.44
3. \$ 1 million to \$ 9 million	30	2,396,511	30.55
4. Under \$ 1 million	4	124,840	1.59
TOTAL	46	7,844,984	100.00
Other Manufacturing (5)	5 (3)	297,500 (3)	100.00 (3)
Transportation, Storage, Communication, and Public Utility Operations:			
1. \$ 50 million and over	7	3,101,283	92.56
2. \$ 10 million to \$ 49 million	3	241,026	7.19
3. \$ 1 million to \$ 9 million	3 (4)	8,300 (4)	.25 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	13	3,350,609	100.00
Other Non-Manufacturing (6)			
1. \$ 50 million and over	-	-	-
2. \$ 10 million to \$ 49 million	-	-	-
3. \$ 1 million to \$ 9 million	13	515,101	73.42
4. Under \$ 1 million	7	186,441	26.58
TOTAL	20	701,542	100.00
Industry Totals			
1. \$ 50 million and over	52	42,723,889	64.85
2. \$ 10 million to \$ 49 million	92	13,773,730	20.91
3. \$ 1 million to \$ 9 million	199	8,572,856	13.01
4. Under \$ 1 million	34	815,140	1.23
GRAND TOTALS	377	65,885,615	100.00

(1) Size groups are based on annual sales value, 1955.

(3) All size groups combined.

(4) Size groups 3 and 4 combined.

(5) Includes Tobacco and Tobacco Products and Miscellaneous Manufacturing Industries.

(6) Includes Construction, Health Services, Engineering and Scientific Services and Trade Associations.

TABLE 6. DIRECT RESEARCH-DEVELOPMENT EXPENDITURES AS PERCENTAGE OF SALES,
BY INDUSTRY AND SIZE GROUP, 1955

Industry and Size Group (1)	Direct Research- Development Cost	Total Value of Sales, 1955 (5)	Direct Research Cost as % of Sales (5)
	\$	\$	%
Mining, Quarrying and Oil Wells:			
1. \$ 50 million and over	1,320,000	266,854,147	.49
2. \$ 10 million to \$ 49 million	565,713	185,886,422	.30
3. \$ 1 million to \$ 9 million	337,150	61,906,319	.54
4. Under \$ 1 million	34,656	1,460,656	2.37
TOTAL	2,257,519	516,107,544	.44
Foods and Beverages:			
1. \$ 50 million and over	707,845	992,122,309	.07
2. \$ 10 million to \$ 49 million	302,751	334,203,226	.09
3. \$ 1 million to \$ 9 million	143,899	59,022,280	.24
4. Under \$ 1 million	-	-	-
TOTAL	1,154,495	1,385,347,815	.08
Rubber Products:	748,923 (3)	206,016,066 (3)	.36 (3)
Leather Products:	144,000 (3)	21,458,191 (3)	.67 (3)
Textile Products:			
1. \$ 50 million and over	(2)	(2)	(2)
2. \$ 10 million to \$ 49 million	880,320 (2)	203,305,325 (2)	.43 (2)
3. \$ 1 million to \$ 9 million	175,320 (4)	42,829,880 (4)	.41 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	1,055,640	246,135,205	.43
Wood Products:	92,325 (3)	45,139,615 (3)	.20 (3)
Paper Products:			
1. \$ 50 million and over	2,007,704	1,000,144,635	.20
2. \$ 10 million to \$ 49 million	1,012,342	509,395,702	.20
3. \$ 1 million to \$ 9 million	49,000	48,017,577	.10
4. Under \$ 1 million	-	-	-
TOTAL	3,069,046	1,557,557,914	.20

- (1) Size groups are based on annual sales volume, 1955.
- (2) Size groups 1 and 2 combined.
- (3) All size groups combined.
- (4) Size groups 3 and 4 combined.
- (5) Sales of firms reporting research-development expenditures.

TABLE 6. DIRECT RESEARCH-DEVELOPMENT EXPENDITURES AS PERCENTAGE OF SALES,
BY INDUSTRY AND SIZE GROUP, 1955 (Cont'd)

Industry and Size Group (1)	Direct Research- Development Cost	Total Value of Sales 1955 (5)	Direct Research Cost as % of Sales (5)
	\$	\$	%
Iron and Steel Products:			
1. \$ 50 million and over	149,625	316,555,333	.05
2. \$ 10 million to \$ 49 million	1,909,616	284,258,026	.67
3. \$ 1 million to \$ 9 million	875,923	130,274,894	.67
4. Under \$ 1 million	16,216	3,252,392	.50
TOTAL	2,951,380	734,340,645	.40
Transportation Equipment:			
1. \$ 50 million and over	11,841,029	605,374,288	1.20
2. \$ 10 million to \$ 49 million	939,098	138,604,239	.68
3. \$ 1 million to \$ 9 million	769,000 (4)	45,806,801 (4)	1.68 (4)
4. Under \$1 million	(4)	(4)	(4)
TOTAL	13,549,127	789,785,328	1.72
Non-Ferrous Metal Products:			
1. \$ 50 million and over	(2)	(2)	(2)
2. \$ 10 million to \$ 49 million	3,471,000 (2)	760,402,557 (2)	.46 (2)
3. \$ 1 million to \$ 9 million	504,231 (4)	47,359,061 (4)	1.06 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	3,975,231	807,761,618	.49
Electrical Apparatus and Supplies:			
1. \$ 50 million and over	6,299,500	521,730,000	1.21
2. \$ 10 million to \$ 49 million	2,322,000	106,681,000	2.18
3. \$ 1 million to \$ 9 million	1,287,737	118,710,105	1.08
4. Under \$ 1 million	124,450	3,715,752	3.35
TOTAL	10,033,687	750,836,857	1.34
Non-Metallic Mineral Products:			
1. \$ 50 million and over	-	-	-
2. \$ 10 million to \$ 49 million	771,248	57,562,138	1.34
3. \$ 1 million to \$ 9 million	211,350 (4)	65,655,950 (4)	.32 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	982,598	123,218,088	.80
Products of Petroleum and Coal:	1,630,563 (3)	1,050,811,913 (3)	.16(3)

(1) Size groups are based on annual sales volume, 1955.
(2) Size groups 1 and 2 combined.
(4) Size groups 3 and 4 combined.
(5) Sales of firms reporting research-development expenditures.

(3) All size groups combined

TABLE 6. DIRECT RESEARCH-DEVELOPMENT EXPENDITURES AS PERCENTAGE OF SALES, BY INDUSTRY AND SIZE GROUP, 1955 (Concl.)

Industry and Size Group (1)	Direct Research-Development Cost	Total Value of Sales 1955 (5)	Direct Research Cost as % of Sales (5)
	\$	\$	%
Chemical Products:			
1. \$ 50 million and over	3,871,705	386,154,151	1.00
2. \$ 10 million to \$ 49 million	1,049,519	192,336,694	.55
3. \$ 1 million to \$ 9 million	2,158,376	115,317,268	1.87
4. Under \$ 1 million	63,542	2,786,414	2.28
TOTAL	7,143,142	696,594,527	1.03
Other Manufacturing (6)	287,500 (3)	77,611,111 (3)	.37 (3)
Transportation, Storage, Communication, and Public Utility Operations:			
1. \$ 50 million and over	1,975,500	1,338,511,885	.15
2. \$ 10 million to \$ 49 million	235,026	71,625,756	.33
3. \$ 1 million to \$ 9 million	5,000 (4)	10,094,632 (4)	.05 (4)
4. Under \$ 1 million	(4)	(4)	(4)
TOTAL	2,215,526	1,420,232,273	.16
Other Non-Manufacturing: (7) (8)	558,951 (3)	n.a.	n.a.
Industry Totals: (8)			
1. \$ 50 million and over	33,049,608	7,393,619,377	.45
2. \$ 10 million to \$ 49 million	11,094,596	2,228,747,284	.50
3. \$ 1 million to \$ 9 million	7,125,209	823,813,903	.86
4. Under \$ 1 million	580,240	16,250,618	3.57
GRAND TOTAL	51,849,653	10,462,431,182	.50

(1) Size groups are based on annual sales volume, 1955.

(3) All size groups combined.

(4) Size groups 3 and 4 combined.

(5) Sales of firms reporting research-development expenditures.

(6) Includes Tobacco and Tobacco Products and Miscellaneous Manufacturing Industries.

(7) Includes Construction, Health Services, Engineering and Scientific 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.

TABLE 7. RESEARCH-DEVELOPMENT ACTIVITY, BY INDUSTRY, 1955
(Number of Firms)

	1.	2.	3.	4(a)	4(b)	4(c)	4(d)	5(a)	5(b)
	Total Number of Firms Surveyed (3)	Number of Firms		Number of Firms Paying for Research Results				Number of Firms Receiving Information Free	
		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 for Any Research Service
In Canada	Outside Canada								
Mining, Quarrying and Oil Wells	201	145	38	23	9	13	27	5	11
Manufacturing:									
Foods and Beverages	288	199	73	29	13	9	35	13	38
Rubber Products	20	9	11	6	-	5	9	4	2
Leather Products	95	83	11	4	2	1	5	2	6
Textile Products	102	72	26	16	4	4	17	8	9
Wood Products	221	187	20	5	1	1	5	3	15
Paper Products	124	66	44	25	26	11	35	17	9
Iron and Steel Products	285	175	100	50	12	12	56	19	44
Transportation Equipment	108	74	33	18	5	8	22	8	11
Non-Ferrous Metal Products	57	31	23	14	4	4	15	5	8
Electrical Apparatus and Supplies	102	46	55	42	7	11	44	22	11
Non-Metallic Mineral Products	64	31	28	13	5	9	18	4	10
Product of Petroleum and Coal	18	8	10	4	1	5	5	3	5
Chemical Products	114	38	73	41	12	15	46	20	27
Other Manufacturing (1)	32	22	6	5	1	-	5	2	1
Transportation, Storage, Communication, and Public Utility Operation	128	99	25	7	3	5	13	7	12
Other Non-Manufacturing (2)	496	437	36	16	8	-	20	10	16
TOTAL	2,455	1,722	612	318	113	113	377	152	235

(1) Includes Tobacco and Tobacco Products, and Miscellaneous Manufacturing Industries.

(2) Includes Construction, Health Services, Scientific and Engineering Services, and Trade Associations.

(3) The difference between Column 1 and Columns 2 and 3 is made up of 121 firms which did not reply, were returned by the Post Office, or were included in another report.

TABLE 8. NUMBER OF PROFESSIONAL RESEARCH-DEVELOPMENT SCIENTISTS EMPLOYED BY INDUSTRY, BY LEVEL OF TRAINING, 1955

Industry	Level of Training			Total
	Bachelor Level	Master Level	Doctorate Level	
Mining, Quarrying and Oil Wells	168	19	13	200
Manufacturing:				
Foods and Beverages	56	18	26	100
Rubber Products	34	6	15	55
Leather Products	4	-	-	4
Textile Products	44	15	12	71
Wood Products	3	4	-	7
Paper Products	126	26	50	202
Iron and Steel Products	88	11	2	101
Transportation Equipment	425	26	10	461
Non-Ferrous Metal Products	148	28	49	225
Electrical Apparatus and Supplies	514	69	28	611
Non-Metallic Mineral Products	41	6	4	51
Products of Petroleum and Coal	40	19	19	78
Chemical Products	325	76	114	515
Other Manufacturing (1)	21	3	6	30
Transportation, Storage, Communication and Public Utility Operations	95	13	6	114
Other Non-Manufacturing (2)	22	2	65	89
TOTAL	2,154	341	419	2,914

(1) Includes Tobacco and Tobacco Products, and Miscellaneous Manufacturing Industries.

(2) Includes Construction, Health Services, Scientific and Engineering Services and Trade Associations.

TABLE 9. NUMBER OF PROFESSIONAL RESEARCH-DEVELOPMENT SCIENTISTS EMPLOYED BY FIELD AND LEVEL OF TRAINING, 1955

Field of Scientific Research	Level of Training			Total
	Bachelor Level	Master Level	Doctorate Level	
Engineers, Chemical	345	52	48	445
Engineers, Civil	27	5	1	33
Engineers, Electrical	416	57	9	482
Engineers, Mechanical	416	21	7	444
Engineers, Other	220	22	10	252
Chemists	392	120	203	715
Physicists	82	28	33	143
Geologists, Geophysicists and Other Earth Scientists	19	6	8	33
Metallurgists	129	16	18	163
Mathematicians	20	3	2	25
Medical Scientists	3	3	67	73
Agricultural Scientists	15	4	3	22
Biological Scientists	18	3	7	28
Other (1)	52	1	3	56
TOTAL	2,154	341	419	2,914

(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 10. ESTIMATED REPLACEMENT VALUE OF FACILITIES USED FOR
RESEARCH-DEVELOPMENT PURPOSES BY INDUSTRY AT DECEMBER 31, 1955

Industry	Replacement Value at December 31, 1955
	\$
Mining, Quarrying and Oil Wells	2,152,000
Manufacturing:	
Foods and Beverages	2,555,555
Rubber Products	1,005,022
Leather Products	62,000
Textile Products	1,770,867
Wood Products	32,000
Paper Products	5,562,263
Iron and Steel Products	1,380,230
Transportation Equipment	10,881,093
Non-Ferrous Metal Products	7,380,927
Electrical Apparatus and Supplies	7,605,800
Non-Metallic Mineral Products	538,767
Products of Petroleum and Coal	1,750,000
Chemical Products	12,611,232
Other Manufacturing (1)	173,500
Transportation, Storage,)	
Communication and)	
Public Utility Operations)	2,670,000
Other Non-Manufacturing (2)	823,861
TOTAL	58,955,117

(1) Includes Tobacco and Tobacco Products, and Miscellaneous Manufacturing Industries.

(2) Includes Construction, Health Services, Scientific and Engineering Services, and Trade Associations.

DEFINITIONS

There is no generally accepted definition of the term "research-development". Considerable time and effort were therefore spent developing an outline of the concepts to be used in this survey. The resulting definitions as reproduced on the questionnaire 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 before the start of the survey. 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. 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. 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 on 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 first survey of the industrial research field conducted by the Dominion Bureau of Statistics.

In an attempt to have the principal tabulations completed within six months from the time the survey was started, it was decided to survey only those industries which were thought to be doing a significant amount of research, and within the selected industries to survey only those firms large enough to support some sort of research program on a continuing basis. This approach effected considerable economies in both time and effort. In a further effort to speed up results, existing mailing lists of the Bureau which had been built up over the years were used as far as possible, rather than attempting to accumulate an entire new mailing list from other sources.

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, 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 for human consumption, including the manufacture of alcoholic and non-alcoholic beverages.

Tobacco and Tobacco Products:

Companies primarily engaged in manufacturing tobacco, cigars and cigarettes.

Rubber Products:

Companies primarily engaged in manufacturing from natural or synthetic rubber, all kinds of 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 fabric, 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; the conversion of these pulps into any kind of paper or paper board; and 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 aluminium, brass, and copper products, including jewellery and silverware.

Electrical Apparatus and Supplies:

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

Non-Metallic Mineral Products:

Companies primarily engaged in the manufacture of 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 sub-groups:

- (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 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.

Services:

This group includes the following sub-groups:

- (1) Health: This classification is confined to hospitals maintaining research-development establishments.
- (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 employees or more. As an indication of the research activity conducted by the smaller firms, of the 1152 firms in the survey with 200 or fewer employees, only 93 reported expenditures on research-development and accounted for less than 5% 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.

The main part of the mailing list was secured from an Unemployment Insurance Commission listing of establishments falling within the established size group and industrial categories noted above. Many of the establishments so listed proved to be branch plants, which were grouped for a consolidated report. It should be noted that all branches of a firm do not necessarily operate in the same industrial field. Where a firm operated in two or more fields it was classified in the industry in which the major part of its operations were performed.

The basic mailing list established by the above method was augmented by firms which had previously reported heavy capital investment in recent years or were known to have a high level of investment in capital assets.

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 ensure more complete coverage.

The survey included 2,455 firms of which 99% submitted returns.

SURVEY METHODS

All firms in the survey were originally contacted by mail. The first contact included an explanatory letter along with copies of the questionnaire to be used. Two follow up notices at intervals of two weeks were then sent to all firms whose reports had not been received. Response up to this point in the survey was well above average but in order to secure as complete coverage as possible, further contacts were made by telephone or telegram from the various regional offices. The final result was a completed return from 99% of the companies 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 requested to exclude from their total cost all research-development work done for any company or organization in Canada for which they were reimbursed. Trade associations supported by the fees of their members for any research undertaken were asked to report the total cost of research activity, as there was no direct payment.

During the editing of the questionnaires some difficulties or differences in interpretation were encountered. In a number of instances total expenditures of reporting companies did not appear to be adequate to support the number of professional research scientists employed. In most cases it was found that the salaries of the professional employees had been omitted in the total cost of research or that the employees so reported were engaged in research activity on a part-time basis only. In other instances, "Total Value of Sales in 1955" was interpreted as the sales of research-development results. On several schedules, it was reported that expenditures were made outside the company, but there were no entries to show the amounts or the names and addresses of the organizations to whom funds were paid. In other cases, the amounts paid to outside organizations for research services were quoted, but the names and addresses were omitted. These difficulties were clarified through correspondence or by telephone. On the advice of the reporting firms adjustments were made in the reports.

QUESTIONNAIRE USED

**INDUSTRIAL RESEARCH EXPENDITURES
1955**

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

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 and in numbers of professionally-trained personnel employed.

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

- 1. Was any research-development conducted within the company during 1955 Yes No
- 2. Did the company spend any funds for research-development done outside the company in 1955 Yes No

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 9.

(a) Does your 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 firms supplying this information

Name Address

NOTE. - IF THE ANSWERS TO QUESTIONS 1 AND 2 ARE "NO" PLEASE SIGN AND RETURN AS THE FOLLOWING QUESTIONS DO NOT APPLY

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

Chemistry	Agriculture	Engineering, Electrical
Physics	Biology	Engineering, Mechanical
Geology	Engineering, Chemical	Engineering, Other
Medicine	Engineering, Civil	Other (specify)

Cost of research-development:

A. Done within your company organization for your own use:
Report total cost for all research-development. Include all professional and non-professional salaries, other direct costs and an estimated share of overhead expenses; exclude capital expenditures or patent expense. Do not include research-development costs incurred on behalf of other companies or organizations in Canada for which you are reimbursed. \$

B. Done by outside organizations for your company:

(i) by subsidiaries or affiliates—

(a) located in Canada (does not apply in consolidated returns) \$

(b) located outside Canada \$

(ii) by commercial laboratories and consultants —

(a) in Canada \$

(b) outside Canada \$

(iii) by other companies or organizations —

(a) in Canada \$

(b) outside Canada \$

(iv) by educational institutions (for research-development only) \$

Total expenditures on research-development made by your company during 1955 \$

C. Estimate of total expenditures on research-development anticipated for 1956 \$

Please list name(s) and address(es) of outside organizations which undertook and/or supplied you with research-development services:

Name Address

Estimated replacement value of facilities including special buildings and equipment used in research-development activities at December 1955 \$

Total value of sales or services rendered in 1955 by reporting company \$

Number of research-development scientists and engineers employed during 1955 (full-time equivalent if part-time staff engaged). All classes of supporting staff are to be excluded in this section.

Bachelor Level	Master Level	Doctorate Level		Bachelor Level	Master Level	Doctorate Level
		 Engineers, Chemical			
		 Engineers, Civil			
		 Engineers, Electrical			
		 Engineers, Mechanical			
		 Engineers, Other			
		 Chemists			
		 Physicists			
			Geologists, geophysicists and other earth scientists			
			Metallurgists			
			Mathematicians			
			Medical Scientists			
			Agricultural Scientists			
			Biological Scientists			
			Other (specify)			

List of companies covered by this report (consolidated reports only)

Name Address



DEFINITIONS

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 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 preference, 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.

Cost of Research-Development is to include all costs incurred for research-development work done for your own use.

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 for your own use 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.

NOTE: Do not include the costs of research-development done for other companies or organizations and for which you are reimbursed by a company or organization in Canada. Such costs will be reported by the other organizations concerned.

If research-development operations are being conducted for your company by outside organizations, enter the cost in Section 4(B). Your entries should include the total charges for the work including professional fees and administrative costs.