

**BRITISH COLUMBIA MINISTRY OF ECONOMIC DEVELOPMENT**

**ECONOMIC IMPACT OF THE PROPOSED KAON FACTORY**

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Submitted to: KAON Factory Steering Committee

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## SUMMARY

TRIUMF is proposing to build and operate a KAON Factory at the site of its existing meson facility in Vancouver. The KAON Factory would significantly enhance TRIUMF's research capabilities in the area of subatomic physics and would be used by both Canadian and international scientists. Because the world-wide scientific community is in agreement that only one KAON Factory should be built, the project offers Canada the opportunity to remain at the leading edge of subatomic physics research.

The cost of constructing the KAON Factory is estimated at \$532 million over five years. The estimated annual operating cost of about \$90 million includes the \$33 million per year now spent for the meson facility.

The purpose of this study, which was jointly funded by the Government of British Columbia and TRIUMF, is to assess the economic impacts of building and operating the KAON Factory. The study has also investigated the economic impacts of the existing meson facility, which serves as a good empirical example of the type of economic activity expected to be generated by the KAON Factory.

### **OVERALL ECONOMIC IMPACT ON CANADA**

- The \$532 million investment to build the KAON Factory will generate \$1.2 billion in industrial production through both direct and indirect economic activity.
- At full operations, the \$90 million spent annually to operate the facility will yield \$161 million per year in industrial production, both directly and indirectly.





## EMPLOYMENT IMPACT ON CANADA

- During construction, nearly 18,700 man-years of employment will be created. This includes over 4,000 man-years of direct employment (i.e., TRIUMF, construction, and contracted labour) and almost 14,700 man-years of indirect employment. The national employment multiplier of 4.7 is relatively high compared to many other types of projects, but is a reasonable estimate for a high technology venture such as the KAON Factory.
- The project will directly employ 960 people at full operations, which is a doubling of the 485 jobs at the current meson facility. Total direct and indirect employment is estimated at nearly 3,000 jobs, which yields a national employment multiplier of 3.1.

## DISTRIBUTION OF IMPACTS

- During construction, it is estimated that 90% of direct project expenditures will be made in Canada, including 71% in B.C. In terms of the resulting total industrial production of \$1.2 billion, B.C. will receive about 50%, with the balance accruing to the rest of Canada.
- About 86% of the KAON Factory's operations phase expenditures are expected to be made in Canada, of which B.C. is estimated to directly receive 77%. Of the \$161 million in resulting annual industrial production, about 56% will be in B.C. and the rest spread across the country.
- British Columbia will receive about 64% of the total direct and indirect employment creation during construction and 74% during operations. This high percentage is to be expected given that the province will gain all of the direct employment. If just indirect employment is considered, B.C. will receive about 54% during construction and 62% during operations.





- In terms of the impacts on other provinces, Alberta, Ontario and Quebec will receive most of the remaining industrial production and employment benefits.

#### GOVERNMENT REVENUE

- Government revenue at the local, provincial and federal levels will be generated through both the industrial and employment activity created by the KAON Factory. This revenue is conservatively estimated at \$188 million for the construction phase and \$33 million per year for the operations phase.

#### SPIN-OFF ECONOMIC ACTIVITY

- In addition to the direct and indirect economic impacts associated with the KAON Factory, the project is also anticipated to generate spin-off activity in a number of areas, including:
  - direct revenue from the sale of KAON Factory outputs;
  - enhanced product and market development opportunities for construction and operations phase suppliers to the project;
  - commercialization of research conducted at the facility;
  - creation or attraction of new companies;
  - enhanced educational opportunities; and
  - increased tourism activity as a result of scientific conferences and visits for research purposes.





- A separate study commissioned by TRIUMF and the B.C. and federal governments estimates the value of this spin-off activity at \$480 million over 15 years.\*

#### **INTERNATIONAL PARTICIPATION**

- Since there is likely to be only one KAON Factory built in the world, the project will result in a variety of opportunities for international participation. It is expected that a number of countries will contribute to the funding of the KAON Factory, primarily through the provision of skilled technical assistance and certain machinery, equipment and materials.
- TRIUMF anticipates that international participation could account for between 10% and 20% of the cost of building the KAON Factory.

#### **IMPACT OF NOT BUILDING THE KAON FACTORY**

- It is estimated that as much as \$416 million (in 1986 dollars) has been invested to date in building and operating TRIUMF's existing meson facility.
- While the existing facility has given Canada international stature in the field of subatomic physics, its usefulness as a major research centre is expected to decline over time as accelerators incorporating newer technology and designs are built. As a result, the economic activity generated by TRIUMF would also decline as less research and experimentation takes place.

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\* Industrial Opportunities of a Canadian KAON Factory, jointly prepared by Price Waterhouse Management Consultants, Lavalin Inc., and Nordicity for the KAON Factory Steering Committee, November, 1986.





- Although the impact cannot be easily quantified, there are very likely benefits gained from being viewed by the international scientific community as a leading edge country in this area of research. This benefit will be lost to Canada if the KAON Factory is not built.





**I     TRIUMF IS PROPOSING TO BUILD AND OPERATE A KAON FACTORY IN BRITISH COLUMBIA**

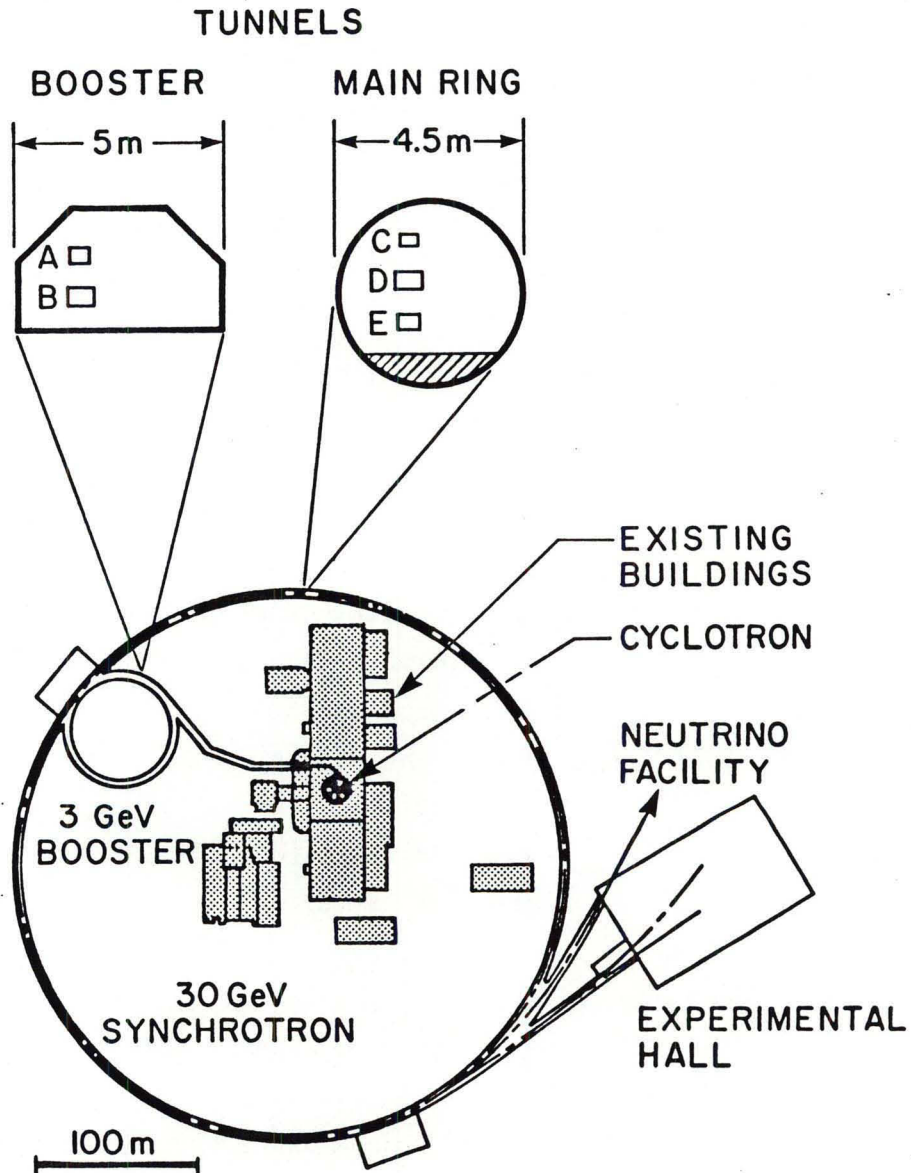
TRIUMF is Canada's national meson facility, located in Vancouver, British Columbia. Completed in 1974, the facility's basic purpose is to conduct experiments in subatomic research with pions (light mesons responsible for nuclear forces), muons (heavy electrons), protons and neutrons (the constituents of the atomic nucleus). At the heart of TRIUMF is the world's largest cyclotron, which accelerates negatively charged hydrogen ions to 75% the speed of light. Intense beams of particles are then created. These beams are used to probe the structure of matter, search for the basic building blocks of nature, and measure the fundamental forces between them. Given the size of its cyclotron, the record beam intensities, and the nature of the experiments carried out, TRIUMF is considered to be at the leading edge of subatomic research world-wide.

TRIUMF is managed as a joint venture by four universities - the University of Alberta, the University of British Columbia, Simon Fraser University and the University of Victoria. Funding for the operation of TRIUMF comes primarily from the National Research Council of Canada (NRC), with experiments supported through grants to participating scientists from the Natural Sciences and Engineering Research Council (NSERC). Funding for buildings is provided by the Province of British Columbia. Affiliated institutions provide funds to support their own activities at TRIUMF.

TRIUMF is now proposing to build and operate a KAON Factory at the site of the existing meson facility. The proposed KAON Factory would enhance TRIUMF's research capabilities in the area of subatomic physics by increasing the energy of the primary beam by a factor of 60. This energy increase would create a greater variety of particle beams, including kaons (heavy mesons) and antiprotons (a form of antimatter) with intensities 100 times greater than anywhere else in the world. This would allow for both more precise measurements in a number of areas (e.g., neutrino physics, particle spectroscopy) and a

# EXHIBIT 1

## PROPOSED LAYOUT OF THE KAON FACTORY



The cross-sections through the tunnels show the five rings used in alphabetical sequence to accelerate high intensity proton beams to 30 GeV energy. The B and D rings are for acceleration and the A, C and E rings are for intermediate storage.

greater range of tests. By operating the KAON Factory at the site of the existing meson facility, TRIUMF could take advantage of the present accelerator as an injector. This would reduce the overall accelerator costs for the KAON Factory by about one-third. Hence, the present meson facility would, in effect, be absorbed into the design and operation of the KAON Factory.\* Exhibit 1 on the facing page shows the proposed layout of the KAON Factory.

With this project, Canada has the opportunity to create a new facility which will be unique because the world-wide physics community is in agreement that only one KAON Factory should be built.

Funding for construction of the KAON Factory would come primarily from the federal government through the National Research Council. The Province of British Columbia would provide the funding for the conventional construction component of the project (e.g., buildings, tunnels, power house, landscaping). NRC would provide most of the funding for the operations phase of the KAON Factory, with NSERC continuing to support experiments through grants to participating scientists. As discussed in Chapter IV, there is also the likelihood that a portion of the project will be funded through international participation.

**A. THIS STUDY EXAMINES THE ECONOMIC IMPACTS ON CANADA OF BOTH THE PRESENT AND PROPOSED FACILITIES**

The potential impact of the KAON Factory from a scientific and research perspective has been well documented by TRIUMF. To assist the provincial and federal governments in determining the overall feasibility of the project, The Coopers & Lybrand Consulting Group was retained by TRIUMF and the British Columbia Ministry of Economic Development to conduct an economic impact assessment.

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\* A full discussion of the purpose and operations of both the existing meson facility and the proposed KAON Factory is contained in KAON Factory Proposal, prepared by TRIUMF in September, 1985.





The primary objective of this assessment is to identify the economic impacts for both British Columbia and Canada as a whole of constructing and operating the KAON Factory. To assist in determining the potential economic impacts of the proposed project, the study also examines the economic impacts of the existing meson facility. Although the KAON Factory will be much larger in terms of cost to both build and operate than the meson facility, the type of expenditures will be much the same. Hence, the meson facility serves as an excellent case study to support the conclusions reached with regard to the likely economic impacts of the KAON Factory.

The economic impact assessment is divided in four key components, each of which examines a different phase of TRIUMF. These phases include:

- the construction phase of the basic meson facility over the period of 1968 to 1974;
- the operating phase of the meson facility over the period of 1975 to 1985;
- the construction phase of the KAON Factory over a five-year period; and
- a typical year of the KAON Factory at full operations phase.

For each of these phases, the specific items addressed by the study include:

- the associated construction or annual operating costs;
- the distribution of expenditures by type and location;





- the direct, indirect and induced employment impacts and associated multipliers;
- the impacts on industrial production and value added;
- the impacts on government revenues; and
- the spin-off economic activity generated.

An explanation of the economic terms used in this report is contained in Appendix I.

In assessing the economic impacts of the KAON Factory, the study deals mainly with the total rather than incremental effects of the project. In other words, the full impacts of the KAON Factory are identified, rather than expressing them net of the impacts of the existing meson facility. This allows the reader to gain a full appreciation of the magnitude of economic activity associated with the KAON Factory. Exhibit 13 in the conclusion of the report shows the incremental impact of the KAON Factory relative to the meson facility for each form of economic activity.

The study also addresses the potential economic implications of several options for the KAON Factory project, including:

- the implications of not building the KAON Factory;
- the impact of alternative time schedules and/or smaller-scale options for construction; and
- the options with regard to international participation in the funding of the KAON Factory.



It should be noted that this study is not intended as a benefit-cost assessment of either the existing meson facility or the proposed KAON Factory. Rather, the basic thrust of the study is to identify and discuss the magnitude and type of economic activity generated within Canada by TRIUMF's construction and operations phase expenditures.

**B. SEVERAL KEY ANALYTICAL METHODS AND SOURCES OF INFORMATION HAVE BEEN USED IN THE STUDY**

This section outlines the key assumptions and methods of analysis supporting the economic impact assessment.

**1. Expenditure and Sourcing Estimates Are Preliminary for the KAON Factory**

The estimated costs and sourcing (by province and country) of materials, equipment, machinery and services for the construction and operations phases of the KAON Factory must be viewed as preliminary. TRIUMF is currently examining the capabilities and interest of Canadian suppliers to participate in the project.\* The results of this investigation should provide a more detailed picture of both where certain items will be sourced and the likely cost.

Also, the actual construction cost of the KAON Factory will largely depend upon the bids received from contractors and suppliers. This study has included a 20% contingency in the construction cost of the KAON Factory for both materials and labour. This contingency is based upon the recommendation contained in the report of the KAON Factory Technical Panel (May 9, 1986).

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\* Discussion of the capabilities of Canadian industry to participate in the project is contained in Industrial Opportunities of a Canadian KAON Factory, prepared for the KAON Factory Steering Committee by Price Waterhouse Management Consultants, Lavalin Inc., and Nordicity, November, 1986.



Notwithstanding these points, the sourcing and cost estimates presented for the KAON Factory have been carefully developed based on current information and are considered to be reasonable.

2. All Financial Data Are Expressed in Constant 1986 Dollars

All of the data presented in this report are expressed in **constant 1986 dollars**. This applies to the historical expenditure data for the construction and operations phases of the meson facility over the period of 1968 to 1985, as well as the cost estimates for the construction and operations phases of the KAON Factory, which were converted from 1985 dollars.

Several key deflators were used to convert expenditure data into 1986 dollars. These deflators were generated through the B.C. Forecasting Model of the Central Statistics Bureau (Ministry of Economic Development).

3. Statistics Canada's Interprovincial Input-Output Model Has Been Used

Given the terms of reference for the study and the nature of the project, Statistics Canada's interprovincial input-output model was selected as the best means to determine the direct, indirect and induced economic impacts at both the regional and national levels. Hence, the study has been able to identify not only the magnitude of the economic impacts on Canada, but also the distribution of the impacts across the country.

Direct economic impacts are defined in this study as all construction and operating phase expenditures made by TRIUMF for labour, materials, machinery, equipment, supplies, utilities, and other goods and services. These form the





"inputs" for Statistics Canada's interprovincial model. These direct expenditures generate two additional forms of economic impact: indirect and induced.

To minimize the terminology presented in this report, the indirect and induced impacts are referred to simply as indirect impacts.

There is a further type of economic impact that is often associated with projects such as TRIUMF. Known as spin-off economic impacts, they are not captured as part of the indirect impacts identified by input-output models. As an example, a supplier to the KAON Factory might need to develop a higher level of technology or a new production method in order to meet the project's needs. If this enhanced capability led to new market opportunities and, in turn, increased sales for the supplier, then a spin-off economic impact would have been created. This report examines the spin-off economic impacts separately from the economic impacts identified through the input-output model.

A description of the Statistics Canada interprovincial model is contained in Appendix II.

The following four chapters each examine the economic impacts of one phase of the TRIUMF project, beginning with the construction of the meson facility. The final chapter then summarizes and compares the major economic impacts for all four phases.

**EXHIBIT 2**

**MESON FACILITY CONSTRUCTION PHASE EXPENDITURES**

(1986 \$ Millions)

<u>Type of Expenditure</u>	<u>B.C.</u> \$	<u>All of</u> <u>Western Canada</u> \$	<u>Ontario</u> \$	<u>Quebec</u> \$	<u>TOTAL FOR</u> <u>CANADA</u> \$	<u>U.S.A.</u> \$	<u>Other</u> <u>Countries</u> \$	<u>TOTAL</u> <u>EXPENDITURE</u> \$
1. Metal Fabricated Products - structural steel, beams, sheet steel, pipes, rods, tubing, magnets	7.6	7.7	0.8	11.2	19.7	0.1		19.8
2. Machinery and Equipment - pumps, compressors, fans, cranes	4.8	4.9	0.9	0.3	6.1	1.6	0.7	8.4
3. Electrical Equipment - power supplies, transformers, computers, controls, communications	0.5	0.7	0.6	0.1	1.4	8.4	0.6	10.4
4. Laboratory and Scientific Equipment and Instrumentation - measurement and recording equipment	8.3	8.4	1.2	0.2	9.8	2.3	1.0	13.1
5. Conventional Construction - concrete, gravel and other materials for buildings	17.1	17.1			17.1			17.1
6. Services to Business - engineering, architecture, project management	5.1	5.1			5.1			5.1
7. Office Furniture and Supplies	4.6	4.8	0.3	0.1	5.2		0.4	5.6
8. Wages and Salaries	<u>36.5</u>	<u>36.5</u>	—	—	<u>36.5</u>	—	—	<u>36.5</u>
TOTALS	84.5	85.2	3.8	11.9	<u>100.9</u>	12.4	2.7	<u>116.0</u>
PERCENTAGE OF TOTAL EXPENDITURE	73%	74%	3%	10%	<u>87%</u>	11%	2%	<u>100%</u>



## **II     THE PRESENT MESON FACILITY - CONSTRUCTION PHASE**

This chapter examines the construction phase of the present meson facility, which took place over the seven-year period of 1968 to 1974.

### **A.    THE BASIC FACILITY COST \$116 MILLION TO BUILD AND DIRECTLY CREATED 800 MAN-YEARS OF EMPLOYMENT**

Exhibit 2 on the facing page summarizes the expenditures associated with the construction phase of the meson facility. In total, the basic facility cost \$116 million to build (\$41 million in current 1968 to 1974 dollars). It should be noted that, while construction of the basic facility took place between 1968 and 1974, this included only a portion of the current experimental facilities. It is estimated by TRIUMF that a further \$20 million (1986 dollars) was spent in the mid 1970's in bringing these facilities close to a similar level of completion as that proposed for the KAON Factory construction. These additional construction expenditures are further discussed within the analysis of the operations phase of the meson facility in Chapter III.

In terms of expenditures by type of commodity, the largest single cost was for wages and benefits, which totalled over \$36 million. An estimated 800 man-years of direct employment, including TRIUMF, contracted, and construction labour, was supported by this expenditure. The second largest expenditure (\$19.8 million) was for metal fabricated products, most notably magnets and parts of the cyclotron. Conventional construction (i.e., buildings, site preparation, and landscaping) totalled over \$17 million.

Of particular interest is the geographical distribution of TRIUMF's expenditures, which is based on the location of the supplier of each good or service. Of the total project expenditure of \$116 million, an estimated \$101 million (87%) was spent in Canada. British Columbia received nearly \$85 million (73%) of the project total.



The dominance of B.C. in terms of project expenditures is not surprising. Obviously, the proximity of local suppliers to the project provided some competitive advantages to B.C. industry for certain items. Further, the total wages and salaries for the project have been allocated to B.C. since most, if not all, of the labour was locally sourced. However, beyond these two factors, several other points should be noted.

First, many of the meson facility's components were unique and highly specialized in nature, with few, if any, sources of supply. Hence, TRIUMF built a number of components itself, which focussed more of the expenditure activity in the province. Second, in cases where TRIUMF went to outside companies, it tended to offer opportunities to local companies which demonstrated the interest and capability to provide specialized items. EBCO Industries, which fabricated and machined many of the key pieces of the cyclotron, serves as a good example of a local company which benefitted from the opportunity to participate. The industrial opportunities which arose from the construction phase of the meson facility are further discussed in Section C of this chapter.

In terms of expenditures in other regions of Canada, both Ontario and Quebec were major sources of goods and services. The expenditures made in Ontario were primarily for manufactured items (e.g., electronic equipment) not readily available in Western Canada. The Quebec expenditures were largely with one company - Davie Shipbuilding of Quebec City - which fabricated the magnets.

The United States received over \$12 million (11%) of the project's expenditures and was the primary source of such items as power supplies, RF system equipment, and specialized laboratory and scientific equipment and instrumentation. In total, about \$15 million (13%) of the expenditures made by TRIUMF on construction of the meson facility went to foreign suppliers.

# EXHIBIT 3

## ECONOMIC IMPACTS OF MESON FACILITY CONSTRUCTION PHASE

(1986 \$ Millions)

	<u>B.C.</u>	<u>All of Western Canada</u>	<u>Ontario</u>	<u>Quebec</u>	<u>TOTAL FOR CANADA</u>
<u>EMPLOYMENT</u>					
● Direct Man-Years	805	805	-	-	805
● Indirect Man-Years	<u>1,815</u>	<u>2,060</u>	<u>565</u>	<u>480</u>	<u>3,140</u>
Total	2,620	2,865	565	480	3,945
	67%	73%	14%	12%	100%
<u>VALUE ADDED</u>					
Total	67.4	79.5	22.2	17.7	122.8
	55%	65%	18%	14%	100%
<u>INDUSTRIAL PRODUCTION</u>					
● Primary Industries	3.7	10.6	1.5	0.8	13.1
● Manufacturing Industries	35.7	44.0	29.6	24.9	99.3
● Construction Industry	32.2	32.9	0.7	0.4	34.0
● Service Industries	<u>57.1</u>	<u>69.5</u>	<u>17.7</u>	<u>11.2</u>	<u>100.8</u>
Total	128.7	157.0	49.5	37.3	247.2
	52%	64%	20%	15%	100%
<u>GOVERNMENT REVENUES*</u>					
Total	24.3	27.1	5.3	5.0	45.9
	53%	59%	12%	11%	100%

\*Includes the total government revenues (municipal, provincial and federal) generated in each region.



**B. A TOTAL OF \$247 MILLION IN INDUSTRIAL PRODUCTION WAS GENERATED, YIELDING 3,950 MAN-YEARS OF DIRECT AND INDIRECT EMPLOYMENT**

Exhibit 3 on the facing page summarizes the total economic impacts on Canada resulting from TRIUMF's direct expenditure of \$116 million to construct the meson facility. The results are based on data generated by Statistics Canada's interprovincial input-output model. The model is discussed in Appendix II.

The investment of \$116 million yielded an estimated \$247 million in industrial production in Canada, with the manufacturing and service sectors benefitting in particular. British Columbia received over one-half of the industrial production, which is to be expected given that 73% of the direct project expenditures were made in the province.

An estimated 3,945 man-years of employment were generated in Canada by the project, including 805 man-years of direct employment. In other words, each direct man-year of employment generated nearly four man-years indirectly. This is an employment multiplier of 4.9, which is a reasonable employment multiplier for the construction phase of the project. A number of the purchases made by TRIUMF (e.g., metal fabricated products, machinery and equipment, business services) contained a significant portion of labour content. As well, the relatively high wages of the construction workers participating in the project would have tended to generate above average induced impacts and, therefore, more indirect man-years of employment. Chapter IV includes a comparison of the construction multipliers calculated for TRIUMF with construction multipliers estimated for several other major projects in Canada.

Within B.C., there was an estimated 2,620 man-years of total employment created by the meson facility construction phase. Based on 805 man-years of direct employment, this yields an employment multiplier for the province of 3.3.



Another way of looking at the employment impact of the project is from the perspective of the cost per man-year of direct employment created. Given that 805 man-years of employment were directly created by the project expenditure of \$116 million, the cost per man-year of employment was about \$144,100.

In terms of geographical distribution, the greatest employment impact was in B.C., where the direct man-years of employment occurred and where many of TRIUMF's expenditures were made. Within the rest of Canada, Ontario was a major recipient of expenditures due to its strong manufacturing base. Although Quebec received a significant share of TRIUMF's direct expenditures because of Davie Shipbuilding, many of the indirect impacts flowed through to Ontario, which is the source of a broad range of goods and services consumed by both industry and end users (e.g., TRIUMF employees).

A total of about \$148 million in value added was generated in Canada by the construction phase of the meson facility, of which B.C. gained \$67 million (55%).

The project also generated government revenues conservatively estimated at \$46 million within Canada, of which over \$24 million (53%) was created by B.C. sources. Appendix I contains a description of the various forms of revenue included in the estimates. Of note, business taxes are not included within the revenue estimates, which is why they are considered conservative.

**C. MANY INDUSTRIAL SECTORS BENEFITTED FROM PARTICIPATION IN THE PROJECT**

Clearly, the expenditure of \$116 million to construct the meson facility was of significant benefit to those suppliers and industry sectors across the country that participated in the project. This is evident from examining Exhibit 2, which shows where the money was spent and the types of goods and services provided. However, beyond simply the money received from TRIUMF,





a number of companies and industry sectors also benefitted in terms of "spin-offs". In other words, as a result of participating in the project, some suppliers developed products, technologies or skills which have enhanced their capabilities and, in turn, their market opportunities and competitiveness.

As discussed in the following chapter, a sample survey by Price Waterhouse of TRIUMF's major suppliers identified about \$89 million (in current dollars over time) in incremental sales by these suppliers as a result of involvement with TRIUMF.

Examples of some of the sectors where incremental sales were gained as a result of participating in building the meson facility include:

- metal fabrication;
- machining;
- DC power supply manufacturing;
- instrumentation manufacturing; and
- resonator panel manufacturing.

From an economic perspective these spin-off benefits obviously have an impact. Although it is extremely difficult to quantify the full magnitude of the effect, it is clear that additional employment and economic activity have resulted beyond that identified through the indirect and induced impacts of TRIUMF. Further, since many of the spin-off impacts are permanent in nature (e.g., enhanced production capabilities), the economic impacts of building the meson facility have continued beyond the construction phase.

The following chapter examines the economic impacts associated with the operations phase of the meson facility.

**EXHIBIT 4**

**MESON FACILITY OPERATIONS PHASE ANNUAL EXPENDITURES**

(1986 \$ Millions)

<u>Type of Expenditure</u>	<u>B.C.</u> \$	<u>All of</u> <u>Western Canada</u> \$	<u>Ontario</u> \$	<u>Quebec</u> \$	<u>TOTAL FOR</u> <u>CANADA</u> \$	<u>U.S.A.</u> \$	<u>Japan</u> \$	<u>U.K.</u> \$	<u>TOTAL</u> <u>EXPENDITURE</u> \$
1. Metal Fabricated Products	0.4	0.4	0.4		0.8				0.8
2. Machinery and Equipment	1.0	1.0			1.0	0.1			1.1
3. Electrical Equipment	0.9	1.0	0.9		1.9	3.0	0.1		5.0
4. Laboratory and Scientific Equipment and Instrumentation	0.6	0.6	0.2		0.8	0.5		0.1	1.4
5. Construction	1.5	1.5			1.5				1.5
6. Services to Business	1.1	1.2	0.8		2.0				2.0
7. Other Equipment and Supplies	0.2	0.2	0.1	0.1	0.4				0.4
8. Gases	0.5	0.5			0.5	0.2			0.7
9. Power	1.8	1.8			1.8				1.8
10. Wages and Salaries	<u>18.7</u>	<u>18.7</u>	—	—	<u>18.7</u>	—	—	—	<u>18.7</u>
TOTALS	26.7	26.9	2.4	0.1	<u>29.4</u>	3.8	0.1	0.1	<u>33.4</u>
PERCENTAGE OF TOTAL EXPENDITURE	80%	81%	7%	Less than 1%	<u>88%</u>	12%	Less than 1%	Less than 1%	<u>100.0%</u>

### **III    THE PRESENT MESON FACILITY - OPERATIONS PHASE**

This chapter examines the operations phase of the present meson facility, which began in 1975. In doing so, the analysis has focussed on fiscal year 1985-1986, which is viewed by TRIUMF as representing a typical year of operations in terms of the type and geographical distribution of expenditures. Hence, while the dollar amount spent annually by TRIUMF has varied over the years, how it is spent has remained relatively constant.

#### **A.    THE FACILITY SPENDS \$33 MILLION ANNUALLY ON A BROAD RANGE OF GOODS AND SERVICES AND DIRECTLY EMPLOYS 485 PEOPLE**

Exhibit 4 on the facing page summarizes TRIUMF's annual expenditures for its meson facility. In total, TRIUMF spent \$33 million in 1985, of which 80% was funded by NRC, 10% by NSERC, 2% by the Province of British Columbia (for buildings) and 8% from other sources, including Atomic Energy of Canada Limited and affiliated institutions. In essence, TRIUMF is a "break-even" operation, with expenditures matching funding.

In terms of expenditures by commodity, wages and salaries are the dominant item, accounting for nearly \$19 million (56%) of the total. This supports 485 employees, with an average annual wage of \$38,500 each (including benefits). These 485 employees include 85 individuals on the payroll whose wages are paid for by various grants. The second largest expenditure is for electrical equipment at \$5 million (15%), followed by services to business at \$2 million (6%), and power at \$1.8 million (5%). Of note, a portion of TRIUMF's expenditures for operation include construction activity (\$1.5 million in 1985). Most of this construction expenditure is for new buildings. B.C. is the dominant recipient of TRIUMF's expenditures, with \$27 million (80%) of the total.

# EXHIBIT 5

## ECONOMIC IMPACTS OF MESON FACILITY OPERATIONS PHASE ON AN ANNUAL BASIS

(1986 \$ Millions)

	<u>B.C.</u>	<u>All of Western Canada</u>	<u>Ontario</u>	<u>Quebec</u>	<u>TOTAL FOR CANADA</u>
<u>EMPLOYMENT</u>					
● Direct TRIUMF Jobs	485	485	-	-	485
● Indirect Jobs	500	570	160	65	805
Total	985	1,055	160	65	1,290
	76%	82%	13%	5%	100%
<u>VALUE ADDED</u>					
Total	19.5	23.9	6.3	2.4	32.9
	59%	73%	19%	7%	100%
<u>INDUSTRIAL PRODUCTION</u>					
● Primary Industries	1.4	3.9	0.4	0.1	4.6
● Manufacturing Industries	7.6	9.8	7.6	3.0	20.7
● Construction Industry	2.4	2.6	0.2	0.1	2.8
● Service Industries	22.5	26.4	5.4	1.9	34.1
Total	33.9	42.7	13.6	5.1	62.2
	55%	69%	22%	8%	100%
<u>GOVERNMENT REVENUES*</u>					
Total	10.1	10.9	1.8	0.6	13.9
	73%	78%	13%	4%	100%

\*Includes the total government revenues (municipal, provincial and federal) generated in each region.



The geographical distribution of operations-phase expenditures by TRIUMF is typical of many B.C.-based companies and institutions. That is, the majority of expenditures are made locally (80%), with Ontario receiving most of the remaining expenditures (7%) within Canada, and a small amount (1%) being spent in other provinces. The U.S. captures nearly all international expenditures (12%). The impacts on Canadian provinces other than B.C. and Ontario occur largely as a result of indirect economic activity.

In total, it is estimated that between \$250 and \$300 million (in 1986 dollars) has been spent on the meson facility since operations began in 1975. This includes the estimated \$20 million in construction activity that took place after operations began in order to bring the facility up to a level of completion similar to that proposed for the KAON Factory. When the \$116 million to build the meson facility is added, the total investment to date in TRIUMF is estimated at between \$366 and \$416 million.

**B. THE FACILITY'S ANNUAL EXPENDITURES GENERATE \$62 MILLION IN INDUSTRIAL PRODUCTION, INCLUDING 1,290 MAN-YEARS OF DIRECT AND INDIRECT EMPLOYMENT**

Exhibit 5 on the facing page summarizes the total economic impact on Canada resulting from TRIUMF's direct annual expenditure of \$33 million for operations.

The total industrial production generated each year in Canada by the meson facility is estimated at \$62 million. Of this amount, B.C. receives about \$34 million (55%), with the remainder allocated largely to Alberta, Ontario and Quebec. The manufacturing and service sectors benefit in particular from TRIUMF's operations, with a combined total of \$55 million (88%) of the \$62 million in Canadian industrial production.





In total, TRIUMF supports an estimated 1,290 jobs in Canada, including the 485 direct jobs at the meson facility. This is an operations phase multiplier of about 2.7, which means that, for each job at TRIUMF, there are another 1.7 jobs elsewhere in the Canadian economy. The majority (76%) of the employment impact is centered in B.C., which has an employment multiplier of 2.0. As noted for the construction phase, Ontario is dominant among the other Canadian provinces in terms of indirect employment because of its strong linkages with many industry sectors across the country.

On an expenditure per job basis, the meson facility supports one job per \$68,900 spent annually. This figure includes the average annual wage of \$38,500 per employee. Given that the meson facility is a high technology scientific research centre, the amount of money spent annually on a per job basis is relatively moderate.

Total value added is estimated at \$33 million for Canada, of which nearly \$20 million (59%) accrues to B.C.

Government revenues totalling around \$14 million per year within Canada are also generated directly and indirectly by TRIUMF's operations. Of this total, B.C. is the source of over \$10 million (73%) in revenue.

#### **C. A RANGE OF SPIN-OFF ECONOMIC ACTIVITY HAS ALSO BEEN CREATED**

As discussed in the previous chapter, there are additional economic impacts created by TRIUMF beyond those identified through measurement of the direct and indirect effects of the meson facility.



The spin-off impacts associated with the operations phase of TRIUMF can be broken down into two broad categories: those resulting from research conducted at the meson facility, and those resulting from enhanced capabilities gained by suppliers to the meson facility.

#### 1. Research Spin-Off Impacts

The research carried out at TRIUMF has resulted in several areas of spin-off with the potential to generate significant economic activity over the long-term. Examples of research spin-offs include:

- Pion cancer therapy research, which has played a significant role in the development of the B.C. Cancer Research Centre. The centre now employs 135 people, including a number of scientists who have been directly or indirectly involved with TRIUMF in the past, and has an annual budget of \$7.7 million.
- Isotope production for processing into radio-pharmaceuticals. This activity is carried out at TRIUMF by Atomic Energy Canada Limited's Radiochemicals Division and currently employs 17 people. AECL's sales of isotopes and radiopharmaceuticals were \$1.8 million in fiscal year 1985/86, and are projected at between \$2 and \$3 million for fiscal year 1986/87. AECL expects to increase its level of production and employment at TRIUMF over the next several years.
- Development of the positron emission tomograph (PET) machine for the treatment of certain types of cancer and investigation of the causes of Alzheimer's disease and Parkinson's disease. The PET project at the University of British Columbia employs a core group of



19 people. Beyond the obvious social benefit of this medical research and treatment, there is also the potential for commercial manufacture of the PET machine for research and clinical purposes world-wide. Some of those involved in the PET project estimate the total world-wide demand for complete PET machine systems for research purposes alone at 50 machines over the next 10 years. Each machine has an estimated sales price of \$1.5 million.

## 2. Industrial Spin-Off Impacts

Because of the unique nature of some of the machinery and equipment required by TRIUMF for operation of the meson facility, certain items cannot be sourced "off the shelf".

Hence, a number of suppliers to TRIUMF have developed specialized expertise in order to meet the operation's needs. In some cases, this enhanced capability has led to incremental sales in other markets beyond TRIUMF. Based on a sample survey of TRIUMF's major suppliers, the Price Waterhouse study found nine companies which have had incremental sales as a result of involvement with TRIUMF. The total value of these sales is estimated at about \$89 million (in current dollars over time).

Among the economic impacts of these incremental sales would be increased industrial production, value added, and employment in both B.C. and elsewhere in Canada. Where export sales have resulted, there is also an impact on Canada's trade balance with the recipient countries, particularly the U.S. The Price Waterhouse survey of TRIUMF's suppliers found that about \$69.5 million (78%) of the total of \$89 million in incremental sales were in the form of exports.





This section has highlighted some of the significant spin-offs associated with TRIUMF that should be considered in evaluating the total economic impact of the meson facility. The reader is referred to the Price Waterhouse report for a more detailed discussion of TRIUMF's spin-off effects.

The following chapter examines the economic impacts identified for the construction phase of the proposed KAON Factory.



#### **IV     THE PROPOSED KAON FACTORY - CONSTRUCTION PHASE**

This chapter examines the construction phase of the proposed KAON Factory. In doing so, the analysis has assumed a five-year construction schedule, which follows the recommendation of the KAON Factory Technical Panel. An evaluation of the economic impacts of alternative construction schedules, the possibility of international participation in the project, and the impact of not building the KAON Factory is also contained in this chapter.

As noted in the introduction, the cost of the project and each of its major components, as well as the assumed sourcing of major items, should be viewed as reasonable estimates based on information currently available to TRIUMF. Actual costs and sourcing will be largely dependent upon the bids received from contractors and suppliers. Nevertheless, the following analysis provides a reasonable indication of both the magnitude and geographical distribution of the economic impacts likely to occur. Further, the findings presented here are supported by the results of the previous two chapters on the meson facility, which serves as an excellent case study.

##### **A.     THE FACTORY WILL COST AN ESTIMATED \$532 MILLION TO BUILD AND DIRECTLY CREATE 4,000 MAN-YEARS OF EMPLOYMENT OVER FIVE YEARS**

The total estimated cost to construct the KAON Factory is estimated at \$532 million (in 1986 dollars), which includes a 20% contingency for both materials and labour. Based on the funding pattern established for other projects of this nature in Canada, the majority of funding for the project would come from the federal government through the National Research Council. The Province of British Columbia is also expected to provide funding, primarily for conventional construction. There is also the possibility that a portion of the funding can be obtained through international participation in the project.

## EXHIBIT 6

## KAON FACTORY CONSTRUCTION PHASE EXPENDITURES BY PROJECT COMPONENT

(1986 \$ Millions)

Project Components	B.C. \$	All of Western Canada \$	Ontario \$	Quebec \$	TOTAL FOR CANADA \$	U.S.A. \$	Japan \$	Europe \$	TOTAL EXPENDITURE \$
1. Accelerator Rings									
• Magnets	22.1	42.0	14.7	11.0	73.7				73.7
• RF Systems	10.9	10.9	18.0		28.9	6.6	1.0		36.5
• Vacuums	9.2	9.2	5.3		14.5	3.5		5.4	23.4
• Controls	0.6	0.8	3.0	0.9	4.7	5.6		0.9	11.2
• Power Cables	0.6	0.6	0.3	0.2	1.1			1.2	2.3
• Remote Handling	3.3	3.3			3.3	1.4			4.7
• Shielding, Beam Dumps, Neutrino Horns	76.3	76.3			76.3				76.3
• Electrical Service and Utilities	9.0	9.3	2.7	1.0	13.0	3.3		6.5	22.8
• Cooling Systems	4.8	5.1	0.1	0.2	5.4	6.5			11.9
• Power Supplies	11.5	13.4	13.2	3.9	30.5	5.8		2.1	38.4
• Instrumentation (Beam, Safety)	1.3	1.3	1.4	0.4	3.1	0.9		0.2	4.2
Subtotal	149.6	172.2	58.7	17.6	254.5	33.6	1.0	16.5	305.5
2. Conventional Construction									
• Materials, Equipment, Supplies	43.1	43.1			43.1				43.1
3. Labour									
• TRIUMF	112.0	112.0			112.0				112.0
• Contracted (Engineering, Project Mgmt, Installation)	25.2	25.2			25.2				25.2
• Conventional Construction	44.2	44.2			44.2				44.2
Subtotal	181.4	181.4			181.4				181.4
4 Miscellaneous Items (e.g. power)	2.2	2.2			2.2				2.2
TOTALS	376.3	398.9	58.7	17.6	481.2	33.6	1.0	16.5	532.2
PERCENTAGE OF TOTAL EXPENDITURE	71%	75%	11%	3%	90%	6%	Less than 1%	3%	100%



Exhibit 6 on the facing page summarizes the construction phase expenditures by project component. Exhibit 7, which faces the following page, summarizes the construction phase expenditures by commodity.

The largest single cost will be for wages and benefits, at an estimated \$181 million. This will directly support about 4,010 man-years of employment as follows:

	<u>Man-Years</u>
● TRIUMF employees	2,710
● Conventional construction workers	825
● Contracted labour (e.g., engineering, project management, machinery and equipment installation)	475

The average wage per man-year of employment on the project will be about \$45,100. This average wage is higher than the \$38,500 per year estimated for the operations phase of the KAON Factory (see Chapter V) because of the relatively high wages and benefits (\$53,400) earned by the construction and contracted workers on the project, such as skilled tradesmen and professional engineers. Most, if not all, of the labour is capable of being sourced within B.C.

Other significant project component expenditures include magnets, which for the machined and fabricated metal parts alone are estimated to cost nearly \$74 million. The value of the magnets will be boosted further once the power supplies are attached. Of note, the magnets are expected to be widely sourced across Canada since there are a number of different industry sectors (e.g., shipbuilding, electric parts manufacturers) which are capable of producing magnets. The shielding, beam dumps and neutrino horns project component will be another substantial expenditure, at a cost of about \$76 million.

**EXHIBIT 7**

**KAON FACTORY CONSTRUCTION PHASE EXPENDITURES BY COMMODITY**

(1986 \$ Millions)

<u>Type of Expenditure</u>	<u>B.C.</u> \$	<u>All of</u> <u>Western Canada</u> \$	<u>Ontario</u> \$	<u>Quebec</u> \$	<u>TOTAL FOR</u> <u>CANADA</u> \$	<u>U.S.A.</u> \$	<u>Japan</u> \$	<u>Europe</u> \$	<u>TOTAL</u> <u>EXPENDITURE</u> \$
1. Metal Fabricated Products	68.0	87.9	16.6	11.0	121.5	1.1		1.5	124.1
2. Machinery and Equipment	4.1	4.3	2.6	0.8	7.7	16.3		7.6	31.6
3. Electrical Equipment	22.8	25.1	36.7	5.0	66.8	12.7		6.8	86.3
4. Laboratory and Scientific Equipment and Instrumentation	1.3	1.4	2.7	0.8	4.9	3.5		0.6	9.0
5. General Construction Materials	90.0	90.0			90.0				90.0
6. Services to Business	8.2	8.2			8.2				8.2
7. Miscellaneous Items	0.5	0.6	0.1		0.7		1.0		1.8
8. Wages and Salaries	<u>181.4</u>	<u>181.4</u>	—	—	<u>181.4</u>	—	—	—	<u>181.4</u>
TOTALS	376.3	398.9	58.7	17.6	<u>481.2</u>	33.6	1.0	16.5	<u>532.2</u>
PERCENTAGE OF TOTAL EXPENDITURE	71%	75%	11%	3%	<u>90%</u>	6%	Less than 1%	3%	<u>100.0%</u>

Two different methods were used to determine the distribution of project expenditures on a geographical basis. The first method involved having TRIUMF staff and consultants estimate the likely sourcing of each project component based on their current knowledge of the capabilities of Canadian industry. Based on this method, it was concluded that as much as \$481 million (90%) of the total goods and services required to build the KAON Factory could be sourced in Canada. The majority of expenditures are anticipated to be made within B.C., which is estimated to receive \$376 million (71%). The majority of B.C. expenditures are expected to be for metal fabricated products, electrical equipment, conventional construction materials, and wages and salaries.

On an international basis, TRIUMF estimates that the United States will receive nearly \$34 million (6%) of the project's total expenditures. Specialized machinery and equipment and electrical equipment (e.g., computer control systems) are expected to account for the majority of U.S. sourcing by TRIUMF. European countries, such as the United Kingdom and Switzerland, are also anticipated to be a significant source of items, with nearly \$17 million (3%) of the total of \$532 million. As is the case for the U.S., specialized machinery and equipment and electrical equipment are the major reasons for this foreign sourcing. Japan is expected to be the source of \$1 million of ferrite for the RF System. This is the only major item expected to be directly sourced from Japan.

TRIUMF's estimates of the geographical sourcing of its expenditures for the construction phase of the KAON Factory correspond closely to the actual distribution of expenditures for construction of the meson facility. For example, B.C. received 73% of the meson facility's expenditures and is estimated to receive 71% of the KAON Factory's expenditures. At the national level, 87% of expenditures on the meson facility were made within

# EXHIBIT 8

## GEOGRAPHICAL DISTRIBUTION OF EXPENDITURES FOR KAON FACTORY CONSTRUCTION PHASE: COMPARISON OF TRIUMF VERSUS INPUT-OUTPUT MODEL GENERATED ESTIMATES

	<u>B.C.</u>	<u>All of Western Canada</u>	<u>Ontario</u>	<u>Quebec</u>	<u>TOTAL FOR CANADA</u>	<u>Foreign</u>	<u>TOTAL EXPENDITURE</u>
TRIUMF ESTIMATE	71%	75%	11%	3%	90%	10%	100%
INPUT-OUTPUT MODEL ESTIMATE	65%	74%	13%	3%	90%	10%	100%



Canada, while the KAON Factory is estimated to source 90% of its goods and services from within the country. Hence, there is solid empirical evidence to support the geographical sourcing estimates developed by TRIUMF.

In order to further test the sourcing estimates, a second method of analysis was conducted. This involved a run of the Statistics Canada interprovincial input-output model in what is often referred to as the "default mode". In this run, there were no assumptions made regarding the sourcing of goods and services by the KAON Factory. Instead, the only inputs were the dollar values of expenditures on a commodity by commodity basis for the construction phase of the KAON Factory, with B.C. identified as the project location. The model then calculated the distribution of expenditures across the country (as well as the portion spent outside Canada) based on the trade relationships for existing industries in B.C.

As Exhibit 8 on the facing page shows, the results of this default run are very similar to the estimates developed by TRIUMF. The only notable difference is for B.C., where the model estimates a slightly lower percentage of sourcing than does TRIUMF (65% versus 71%). Most of the difference is due to Alberta, which the model estimates will pick up more of the KAON Factory's expenditures than TRIUMF has estimated. Beyond this slight difference, the estimates are virtually identical. Of particular note is that both TRIUMF and the model estimate that 90% of the KAON Factory's expenditures could be made on goods and services from within Canada.

Based on the above analysis, it would seem reasonable to conclude that the geographical distribution of expenditures indicated in Exhibits 6 through 8 present a good estimate of the direct economic impacts of the KAON Factory construction phase at the regional level.



# EXHIBIT 9

## ECONOMIC IMPACTS OF KAON FACTORY CONSTRUCTION PHASE\*

(1986 \$ Millions)

	<u>B.C.</u>	<u>All of Western Canada</u>	<u>Ontario</u>	<u>Quebec</u>	<u>TOTAL FOR CANADA</u>
<u>EMPLOYMENT</u>					
● Direct Man-Years	4,010	4,010	-	-	4,010
● Indirect Man-Years	<u>7,910</u>	<u>9,465</u>	<u>3,430</u>	<u>1,455</u>	<u>14,655</u>
Total	11,920	13,475	3,430	1,455	18,665
	64%	72%	18%	8%	100%
<u>VALUE ADDED</u>					
Total	312.1	394.3	134.9	55.6	595.6
	52%	66%	23%	9%	100%
<u>INDUSTRIAL PRODUCTION</u>					
● Primary Industries	19.5	54.4	8.2	2.9	67.7
● Manufacturing Industries	209.8	269.3	184.1	74.3	537.5
● Construction Industry	106.2	109.8	3.9	1.3	115.4
● Service Industries	<u>261.3</u>	<u>335.6</u>	<u>97.0</u>	<u>42.2</u>	<u>482.0</u>
Total	596.8	769.1	293.2	120.7	1,202.6
	50%	64%	24%	10%	100%
<u>GOVERNMENT REVENUES**</u>					
Total	115.3	134.9	32.2	14.9	187.6
	61%	72%	17%	8%	100%

\* Based on TRIUMF's estimates of the geographical distribution of its direct expenditures (see Exhibits 6 and 7).

\*\*Includes the total government revenues (municipal, provincial and federal) generated in each region.

**B. A TOTAL OF \$1.2 BILLION IN INDUSTRIAL PRODUCTION WILL BE GENERATED, INCLUDING 18,700 MAN-YEARS OF DIRECT AND INDIRECT EMPLOYMENT**

Exhibit 9, on the facing page, summarizes the total economic impact on Canada resulting from TRIUMF's direct expenditure of \$532 million to construct the KAON Factory. These results are based on the outputs generated by Statistics Canada's input-output model using TRIUMF's estimates of its geographical distribution of expenditures. The difference between the outputs from this run and the run using the default mode are relatively minor.

The construction phase of the KAON Factory will create an estimated \$1.2 billion in industrial production within Canada over the five-year period. Of this total, B.C. is expected to get \$597 million (50%), with Alberta, Ontario and Quebec receiving much of the remainder. On an industry sector basis, manufacturing is estimated to gain \$538 million (45%) of the total production, followed by services, with \$482 million (40%).

An estimated 18,655 man-years of employment will be generated over five years, including the 4,010 man-years of employment directly associated with the project. This is a construction phase employment multiplier of about 4.7 at the national level, which is close to the multiplier of 4.9 calculated for the construction phase of the existing meson facility. At the B.C. level, the employment multiplier is 3.0, which is slightly lower than the multiplier of 3.3 calculated for the meson facility.

The national employment multiplier of 4.7 for the construction phase of the KAON Factory is relatively high compared to many other types of projects. However, it is a reasonable estimate given the nature of the project. Many of the items required by the KAON Factory will have high labour content (e.g., machinery and equipment), which will result in significant indirect employment in the industry sectors supplying the project.

## EXHIBIT 10

### COMPARISON OF THE KAON FACTORY CONSTRUCTION PHASE EMPLOYMENT MULTIPLIER WITH OTHER PROJECT EMPLOYMENT MULTIPLIERS\*

<u>Project</u>	<u>National Employment Multiplier</u>
Meson Facility	4.9
Litton Systems' ADATS Plant	4.9
<b>KAON Factory</b>	<b>4.7</b>
Expo 86	3.6
Toronto Domed Stadium	3.1

\* All of the multipliers in this exhibit were generated using Statistics Canada's interprovincial input-output model.

The results of several other economic impact studies by The Coopers & Lybrand Consulting Group using the interprovincial input-output model illustrate this point. As shown in Exhibit 10, on the facing page, the construction phases of Expo 86 in Vancouver and the proposed domed stadium in Toronto were estimated to have national employment multipliers of 3.6 and 3.1 respectively. In both cases, the indirect labour impact is relatively low given the nature of the goods required (i.e., a lot of basic construction materials as opposed to sophisticated machinery and equipment). In contrast, the Litton Systems Air Defence Anti-Tank System (ADATS) plant proposed for the Atlantic provinces was estimated in a recent study by the consultants to have a construction phase multiplier of 4.9, which is close to the multiplier of 4.7 identified for the KAON Factory. The two facilities are similar in that both require machinery and equipment with high labour content.

The majority of the employment impact will be centered on B.C., with 11,920 man-years (64%) of the total. Ontario is anticipated to account for the second greatest share of the employment impact, but it is expected that other regions of Canada will also indirectly gain employment benefits.

In terms of expenditure per man-year of direct employment, the KAON Factory construction phase will yield an estimated one man-year of employment for each \$132,700 spent. Of this amount, an average of \$45,100 will be for wages and benefits.

It is estimated that the construction of the KAON Factory will generate \$596 million in value added within Canada, of which \$312 million (52%) will be within B.C. The remaining value added will be distributed across the country in a manner similar to the employment impact.





Government revenues within Canada flowing from the project are estimated at \$188 million over the five years. Of this total, B.C. sources are estimated to directly and indirectly generate \$115 million (61%).

**C. THE PROJECT WILL PROVIDE OPPORTUNITIES FOR MANY INDUSTRIAL SECTORS ACROSS CANADA TO PARTICIPATE**

As is evident from examining Exhibits 6 and 7, construction of the KAON Factory will require a broad range of goods and services from many industry sectors. Given that approximately \$480 million (90%) of the project's expenditures are estimated to be made in Canada, the opportunities are clearly substantial.

In the same way that the construction phase of the meson facility resulted in spin-off industrial impacts, it is expected that participation in building the KAON Factory will also enhance the capabilities of some Canadian suppliers and, in turn, lead to incremental sales. Hence, the construction phase of the project is likely to generate some level of economic activity on a permanent basis, as opposed to simply over the five-year construction period.

The Price Waterhouse survey of TRIUMF's major suppliers found that all 29 of the companies that responded to the survey were interested in bidding on KAON Factory contracts. Half of these 29 companies are located in Western Canada and the other half in Eastern Canada. Among the project components of interest to these companies are:

- magnets;
- RF Systems;
- power supplies;
- computer hardware and software;



- instrumentation;
- robotics; and
- machinery and metal fabrication.

Further discussion of the potential spin-off impacts of the construction phase of the KAON Factory is contained in the Price Waterhouse report.

**D. THERE ARE ALSO OPPORTUNITIES FOR INTERNATIONAL PARTICIPATION IN THE PROJECT**

The KAON Factory would be a world-wide facility, which would attract scientists from many other countries to conduct experiments and research (as is the case with the existing meson facility). Hence, it is certainly appropriate that Canada seek the participation of other countries in the development of the factory. Further, such international participation is common for world-class research facilities. For example, Canada has provided support to both the CERN and HERA collider facilities and has recently committed to contributing to development of the U.S. space station.

There are several potential forms that international participation in the KAON Factory project could take, including:

- joint venturing between Canada and a number of other countries;
- obtaining contributions from other countries as a precondition for approval of the project; or
- seeking contributions from other countries after the project is approved.



The report of the KAON Factory Technical Panel (May 9, 1986) concluded that there is little likelihood of significant international participation under the first two options. Japan, the U.S. and a number of European countries are also very interested in building KAON Factories because of the economic, scientific, industrial and technological benefits that are expected to result. Hence, none of these countries are willing to commit support to any other country's project at this time. The KAON Factory Technical Panel believes that only after one project has obtained clear approval will the supporters of other projects resign themselves to user status (since only one KAON Factory is expected to be built world-wide) and offer to participate in another country's project. This participation will most likely be in the form of providing skilled technical assistance and/or machinery, equipment and materials, as opposed to a cash contribution.

Based on the recent experience of the HERA Collider in West Germany, it is anticipated that between 10% and 20% of the total KAON Factory construction cost of \$532 million could be supported by other countries.

The nature of international participation in building the KAON Factory will affect the project's economic impacts on Canada. As Exhibits 6 and 7 indicate, about \$50 million (10%) of the total expenditures on the KAON Factory are estimated to be for items sourced outside Canada because they are not available domestically (e.g., specialized electrical equipment and scientific equipment and instrumentation). Most of these imported items are expected to be sourced in the United States (66%) and in several European countries, such as the United Kingdom and Switzerland (33%). Japan has been identified as the likely source of about \$1 million in ferrite for the RF System. This is less than 1% of foreign sourcing for the project.





Since all of the countries mentioned above would be heavily involved in research at the KAON Factory, they are ideal candidates for participation in development of the project. If this participation is in the form of providing the \$50 million in items which the KAON Factory must source from outside the country in any case, then Canada would benefit in two ways. First, the level of funding required from the Canadian government for the project would be reduced by 10%. Second, Canadian industry would retain its full share of participation in the project (as opposed to other countries providing items which domestic industry is capable of providing). Hence, the economic activity projected to be generated in Canada would not be diluted by international participation under this scenario.

If, however, international participation increases beyond 10%, or involves the supply of items which Canadian industry is capable of providing, then there would be a reduction in the economic activity within Canada. This should not be viewed as necessarily representing a negative impact. While Canadian industry may lose the opportunity to provide certain items to the project, the level of funding required from the Canadian government would also be reduced. Hence, there is clearly a trade-off between the benefits which domestic industry will gain from involvement in the project and the costs which government will incur.

**E. THE ECONOMIC IMPACTS OF THE PROJECT WILL BE AFFECTED BY THE CONSTRUCTION SCHEDULE THAT IS SELECTED**

As noted in the introduction to this report, construction of the KAON Factory is assumed to occur over a five-year period. This is the schedule recommended by the KAON Factory Technical Panel in its May, 1986 report. While this should be viewed as the most likely construction schedule for the project, the economic impacts under several other options should be commented upon. These options include:



- a seven-year construction schedule; and
- a staged construction schedule.

Under a seven-year construction schedule, which was the option originally proposed by TRIUMF, the economic impacts identified in this report may be affected in several ways. First, a longer construction period may result in some inefficiencies and, therefore, increased costs. On the other hand, a longer construction period may give Canadian industry more time to "gear up" for involvement in the project and increase the amount of domestic participation. As well, the seven-year schedule would help ease the pressure on those industry sectors (e.g., magnet producers) where capacity may be strained by heavy demand over a short period.

An option which has been considered at various times is a staged construction schedule in which the KAON Factory is built in several discrete steps over a period longer than seven years (e.g., build A and B Rings first and C, D and E Rings later). Each stage would result in an operable component of the KAON Factory. This scenario would allow government funding to be staggered over a longer period of time. It would also reduce the demands on the capacity of Canadian industry, as discussed above. However, staged construction is also likely to result in greater project costs through to full completion due to some inefficiencies (e.g., several periods of project start-up and wind-down).

It is evident that the seven-year and staged construction schedules would offer both advantages and disadvantages compared to the five-year construction schedule. These trade-offs should be carefully evaluated in the final selection of the construction schedule for the KAON Factory.





**F. THE ECONOMIC ACTIVITY GENERATED IN CANADA BY TRIUMF WILL DECLINE OVER TIME IF THE KAON FACTORY IS NOT BUILT**

As noted in Chapter III, it is estimated that as much as \$416 million (in 1986 dollars) has been invested to date by the federal and provincial governments, the four participating universities, and other funding institutions in the construction and operation of TRIUMF's existing meson facility. This investment has given Canada international stature in the area of subatomic physics research, as well as generating substantial direct, indirect, and spin-off economic activity.

The meson facility can continue to be used for research without the construction of the KAON Factory. However, its importance as an international centre of research will decline over time as accelerators incorporating newer technology and designs are built (this effect would become particularly noticeable if another country builds a KAON Factory). Hence, Canada would lose its leading edge position in the field of subatomic physics and, with it, the reputation that comes from being a key player in the international scientific community.

The economic activity generated by TRIUMF would also decline over time as less research and experimentation takes place. Among the economic impacts would be:

- a loss of employment (e.g., scientists leaving to go to newer facilities elsewhere in the world);
- reduced industrial production (e.g., less demand by TRIUMF for goods and services);
- a drop in government revenue (e.g., through the decline in industrial production and employment); and



- reduced spin-off activity (e.g., less technology transfer to industry).

The following chapter examines the economic impacts of the operations phase of the KAON Factory.

## EXHIBIT 11

## KAON FACTORY OPERATIONS PHASE ANNUAL EXPENDITURES

(1986 \$ Millions)

<u>Type of Expenditure</u>	<u>B.C.</u> \$	All of Western Canada	<u>Ontario</u> \$	<u>Quebec</u> \$	<u>TOTAL FOR</u> <u>CANADA</u> \$	<u>U.S.A.</u> \$	<u>Japan</u> \$	<u>U.K.</u> \$	<u>TOTAL</u> <u>EXPENDITURE</u> \$
1. Metal Fabricated Products	1.3	1.3	1.2		2.5				2.5
2. Machinery and Equipment	0.8	0.8			0.8	0.1			0.9
3. Electrical Equipment	3.0	3.0	2.7		5.7	9.3	0.1		15.1
4. Laboratory and Scientific Equipment and Instrumentation	1.9	1.9	0.6		2.5	1.9		0.1	4.4
5. Services to Business	4.7	5.1	2.7		7.8	0.2			8.0
6. Other Equipment and Supplies	4.7	4.7	0.2	0.1	5.0	0.1			5.1
7. Gases	1.5	1.6			1.6	0.7			2.3
8. Power	14.4	14.4			14.4				14.4
9. Wages and Salaries	<u>37.0</u>	<u>37.0</u>	—	—	<u>37.0</u>	—	—	—	<u>37.0</u>
TOTALS	69.3	69.8	7.4	0.1	<u>77.3</u>	12.3	0.1	0.1	<u>89.7</u>
PERCENTAGE OF TOTAL EXPENDITURE	77%	78%	8%	Less than 1%	<u>86%</u>	14%	Less than 1%	Less than 1%	<u>100.0</u> %

## V

**THE PROPOSED KAON FACTORY - OPERATIONS PHASE**

This chapter examines the operations phase of the KAON Factory. In doing so, the analysis has examined what TRIUMF expects will be a typical year of operations in terms of both the magnitude and type of expenditures made by the KAON Factory.

**A. THE FACTORY WILL SPEND AN ESTIMATED \$90 MILLION ANNUALLY AT FULL OPERATIONS AND DIRECTLY EMPLOY 960 PEOPLE**

Exhibit 11 on the facing page summarizes the annual expenditures by the KAON Factory at full operations. TRIUMF estimates that it will require nearly \$90 million (1986 dollars) per year to operate the KAON Factory. The majority of this \$90 million will be funded by federal government sources (e.g., NRC, NSERC), with the rest coming from the same sources as for the meson facility (e.g., affiliated institutions). In addition, TRIUMF expects to receive about \$4 million per year in machinery and equipment provided by international participants conducting experiments at the KAON Factory. The annual cost of operating the KAON Factory will be about \$57 million more than the present annual cost of \$33 million for the meson facility.

The largest single expenditure at the KAON Factory will be for wages and salaries, which are estimated at \$37 million (41%) of the total annual expenditure of \$90 million. These wages and salaries are based on an assumed employment level of 960 people, with an average annual income of \$38,500. This is 475 more jobs than the current meson facility total of 485 positions. These positions include both operational employees and those involved in experiments.

The second largest expenditure at the KAON Factory will be for power, which will be required in major quantities in order to conduct the type of experiments for which the factory is designed. An estimated \$14 million will be spent on power each



# EXHIBIT 12

## ECONOMIC IMPACTS OF KAON FACTORY OPERATIONS PHASE ON AN ANNUAL BASIS

(1986 \$ Millions)

	<u>B.C.</u>	<u>All of Western Canada</u>	<u>Ontario</u>	<u>Quebec</u>	<u>TOTAL FOR CANADA</u>
<u>EMPLOYMENT</u>					
● Direct TRIUMF Jobs	960	960	-	-	960
● Indirect Jobs	<u>1,240</u>	<u>1,410</u>	<u>415</u>	<u>150</u>	<u>1,995</u>
Total	2,200	2,370	415	150	2,955
	74%	80%	14%	5%	100%
<u>VALUE ADDED</u>					
Total	54.6	65.2	5.7	16.4	88.0
	62%	74%	6%	19%	100%
<u>INDUSTRIAL PRODUCTION</u>					
● Primary Industries	3.5	9.4	1.0	0.3	11.0
● Manufacturing Industries	19.9	22.5	19.4	7.2	52.3
● Construction Industry	4.9	5.5	0.5	0.1	6.2
● Service Industries	<u>62.6</u>	<u>72.1</u>	<u>14.0</u>	<u>4.7</u>	<u>91.8</u>
Total	90.9	109.5	34.9	12.3	161.3
	56%	68%	22%	8%	100%
<u>GOVERNMENT REVENUES*</u>					
Total	23.6	25.7	4.8	1.5	33.0
	72%	78%	15%	5%	100%

\*Includes the total government revenues (municipal, provincial and federal) generated in each region.

year, which is 16% of the KAON Factory's annual operation costs. In contrast, the current meson facility spends about \$1.8 million per year on power, which is around 5% of its annual costs. Other major expenditures will be in the areas of electronic equipment, services to business, and miscellaneous equipment and supplies required to support the factory's day-to-day needs (e.g., office equipment and supplies).

On a geographical basis, Canada is expected to receive over \$77 million (86%) of the KAON Factory's annual expenditures. B.C. is estimated to be the source of over \$69 million (77%) per year in goods and services, the majority of which would be for wages and salaries and power. As is the case for the existing facility, Ontario will be the other major Canadian source of goods and services, particularly manufactured items and specialized services. Internationally, U.S. sources are anticipated to supply \$12.3 million (14%) of the KAON Factory's needs, with electrical equipment and laboratory and scientific equipment and instrumentation accounting for most of the expenditures. Expenditures in off-shore countries are expected to normally account for only a few hundred thousand dollars annually.

**B. THE FACTORY'S ANNUAL EXPENDITURES WILL GENERATE A TOTAL OF \$161 MILLION IN INDUSTRIAL PRODUCTION, INCLUDING 2,950 MAN-YEARS OF DIRECT AND INDIRECT EMPLOYMENT**

Exhibit 12 on the facing page summarizes the estimated economic impact of the KAON Factory for a representative year of operations.

Based on an annual expenditure of \$90 million at full operations, the KAON Factory is estimated to create a total of \$161 million per year in industrial production within Canada. This is \$99 million more each year than the \$62 million in industrial production generated by the meson facility.



B.C. is expected to gain \$91 million (56%) of the industrial production, with most of the remaining \$70 million occurring in Alberta, Ontario, and Quebec. On an industry sector basis, services are estimated to gain \$92 million (57%), followed by manufacturing with \$52 million (32%).

A total of 2,955 jobs are projected to be supported by the KAON Factory, 960 of which will be filled by direct employees of TRIUMF. This represents an operations phase employment multiplier of 3.1 at the national level, which is somewhat higher than the multiplier of 2.7 calculated for the present meson facility. About 2,200 (74%) of the jobs are estimated to be generated within B.C., which is an employment multiplier of 2.3. This is close to the B.C. multiplier of 2.0 identified for the meson facility operations phase.

The total employment impact of 2,955 jobs generated by the KAON Factory represents 1,665 more jobs than are supported directly and indirectly by the existing meson facility.

On an expenditure per job basis, the operations phase of the KAON Factory will support one job for each \$93,400 in expenditures. In contrast, the present meson facility supports one job per \$68,900 in expenditures. The difference in the level of expenditure per job at the two operations is due in part to the much larger projected expenditure (\$14.4 million) for power at the KAON Factory. The present meson facility spends only about \$1.8 million on power each year.

Value added within Canada is estimated at \$88 million per year through the KAON Factory's expenditures, of which \$55 million (62%) is allocated to B.C. This is about \$55 million more per year within Canada than the value added presently generated by TRIUMF, and about \$35 million more in B.C.

Government revenues directly and indirectly generated in Canada by the project are estimated at \$33 million per year, of which





B.C. is the source of \$24 million (72%). This is \$19 million more per year for Canada as a whole than is generated by the meson facility and \$14 million more at the B.C. level.

**C. THE FACTORY IS EXPECTED TO CREATE FURTHER SPIN-OFF ECONOMIC ACTIVITY DURING OPERATIONS**

The existing meson facility has generated some notable spin-off economic activity in Canada, as discussed in Chapter III. The operations phase of the KAON Factory is expected to have a similar effect. These spin-offs could develop through a number of channels, such as:

- enhanced product and market development opportunities for suppliers to the KAON Factory;
- creation or attraction of new companies;
- direct revenue from the sale of KAON Factory outputs;
- commercialization of research (e.g., medical);
- participation by foreign scientists in research and conferences (i.e., tourism impacts); and
- increased university enrollment in faculties involved with the KAON Factory (e.g., physics, engineering, nuclear medicine).

The Price Waterhouse study estimates the total value of spin-off activity generated by the KAON Factory at \$480 million over the first 15 years of construction and operation. Hence, the spin-off impacts of the project will generate additional employment, industrial production, value added and government revenue in Canada beyond the direct and indirect economic activity quantified in Exhibits 11 and 12.



The following chapter summarizes the major economic impacts identified for each of the four phases of TRIUMF.

**EXHIBIT 13**

**SUMMARY OF MAJOR ECONOMIC IMPACTS IN CANADA  
OF THE MESON FACILITY AND KAON FACTORY\***

	<u>Meson Facility</u>		<u>KAON Factory</u>		<u>Incremental Impact of the Operations Phase of the KAON Factory Relative to the Meson Facility</u>	
	<u>Construction</u>	<u>Operations</u>	<u>Construction</u>	<u>Operations</u>	<u>Increase</u>	<u>% Increase</u>
Expenditures (\$ millions)	\$116.0	\$33.4/year	\$532.2	\$89.7/year	\$56.3/year	169%
Direct Employment	805 man-years	485 jobs	4,010 man-years	960 jobs	475 jobs	98%
Indirect Employment	3,140 man-years	805 jobs	14,655 man-years	1,995 jobs	1,190 jobs	148%
Total Employment	3,945 man-years	1,290 jobs	18,665 man-years	2,955 jobs	1,665 jobs	129%
Employment Multiplier	4.9	2.7	4.7	3.1	0.4	15%
Expenditure per Direct Job or Man-Year of Employment Created	\$144,100	\$68,900	\$132,700	\$93,400	\$24,500	36%
Value Added (\$ millions)	\$122.8	\$32.9	\$595.6	\$88.0	\$55.1	168%
Valued Added per Direct Job or Man-Year of Employment Created	\$152,500	\$67,800	\$148,500	\$91,700	\$23,900	35%
Industrial Production (\$ millions)	\$247.2	\$62.2	\$1,202.6	\$161.2	\$99.0	159%
Industrial Production per Direct Job or Man-Year of Employment Created	\$307,100	\$128,200	\$299,900	\$167,900	\$39,700	31%
Government Revenues (\$ millions)	\$45.9	\$13.9	\$187.6	\$33.0	\$19.1	137%

\* All financial data are expressed in constant 1986 dollars.

## VI CONCLUSION

The purpose of this report has been to identify the direct and indirect economic impacts of both TRIUMF's existing meson facility and the proposed KAON Factory. The results indicate that the impacts are substantial. Exhibit 13 on the facing page summarizes the major economic impacts at the national level for each of the four phases of TRIUMF.

For the KAON Factory, which is the key focus of this study, the major direct and indirect economic impacts at the national level can be summarized as:

- \$532 million to build over five years and \$90 million annually to operate;
- \$1.2 billion in industrial production created during construction and \$161 million per year during operations;
- 18,665 man-years of total employment during construction, including 4,010 man-years of direct employment, and 2,955 jobs annually during operations, including 960 direct jobs;
- value added of \$596 million in the construction phase and \$88 million per year in the operations phase; and
- government revenues within Canada estimated at \$188 million during construction and \$33 million per year during operations.

In addition to these direct and indirect economic impacts, the KAON Factory is expected to generate various spin-off economic activity. These spin-offs have been identified in the Price Waterhouse report as including:

- direct revenue from the sale of KAON Factory outputs;





- enhanced product and market development opportunities for construction and operations phase suppliers to the project;
- commercialization of research conducted at the facility;
- creation or attraction of new companies;
- enhanced educational opportunities; and
- increased tourism activity as a result of scientific conferences and visits.

Price Waterhouse estimates the value of this spin-off activity in Canada at \$480 million over 15 years.

Several other key conclusions have also been reached with regard to the economic impacts of TRIUMF and the KAON Factory.

First, there appears to be an opportunity for international participation in the project, which could reduce the costs to Canada of building the facility by between 10% and 20%. This international participation would most likely be in the form of providing skilled technical assistance and certain machinery, equipment and materials.

Second, it has been concluded that as much as \$416 million has been invested to date in building and operating TRIUMF's existing meson facility. While this has given Canada a prominent position in the area of subatomic physics research, the usefulness of the meson facility is expected to decline over time as accelerators incorporating newer technology and designs are built elsewhere. Hence, if the KAON Factory is not built, the economic activity generated by TRIUMF will decline over time as employment, expenditures, and research are reduced. As well, Canada's reputation as a leading edge member of the international scientific community in this area of research would be lost.



There are additional scientific, research and technological impacts that must also be considered. Each of these impacts is addressed in other reports prepared by and for TRIUMF. The reader is urged to review this economic impact assessment in conjunction with these other studies in order to develop a full appreciation of what TRIUMF has contributed to both the scientific community and society in general, and the potential contribution of the KAON Factory.

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**APPENDIX I**

**GLOSSARY OF TERMS**



Direct Employment	The employment directly associated with the construction and operation of TRIUMF. This includes both employees on the TRIUMF payroll and construction and contract labour.
Indirect Employment	The employment created through expenditures made by TRIUMF in the industry sectors which supply materials, machinery, equipment, etc. to the project.
Induced Employment	The employment created through the incomes of TRIUMF's employees and contracted labour, who respond their earnings on a broad range of goods and services. To minimize the terminology in this report, the indirect and induced impacts are referred to simply as indirect impacts.
Employment Multiplier	The total direct, indirect and induced employment generated per direct job within a given region. For example, an employment multiplier of 3.0 means that each direct job on a project is associated with the equivalent of two indirect or induced jobs.
Spin-off Impacts	Those economic impacts not captured as part of the indirect impacts identified by input-output models. For example, if a supplier to TRIUMF develops a new product as a result of working on the project, and this product gives the supplier enhanced market capabilities and increased sales, a spin-off impact has been created.
Man-years	A man-year of employment is the equivalent of one full-time job for a period of one year. This is commonly used in referring to the employment impacts associated with construction or indirect economic activity, where a number of temporary or part-time jobs are created. For example, two construction workers employed for six months each on a project equals one man-year of employment.
Jobs	Used to refer to permanent, full-time employment.
Wages	All wage data for TRIUMF, construction and contracted labour includes the value of both wages and benefits.
Input-Output Model	See Appendix II.
Value Added	The value added to goods and services by Canadian industry. In other words, the value added excludes the value of any inputs sourced from outside Canada.



## Industrial Production

The total value of goods and services produced by Canadian industry, including the value of foreign inputs to Canadian industry.

## Government Revenues

Includes revenue accruing to the municipal, provincial and federal governments that is generated directly and indirectly in each region. Among the forms of revenue included are sales, gasoline, personal income, and property taxes and licences, fees and permits. Of note, business taxes are not part of the revenue estimates. Hence, the estimates shown in this report are considered to be conservative indicators of total government revenue generated by TRIUMF.





**APPENDIX II**

**A DESCRIPTION OF THE STATISTICS CANADA  
INTERPROVINCIAL INPUT-OUTPUT MODEL**



A DESCRIPTION OF THE STATISTICS CANADA  
INTERPROVINCIAL INPUT-OUTPUT MODEL

In simple terms, an input-output model is an integrated framework of economic statistics which allows for tracing the interdependence between various sectors and industries. It establishes these inter-relationships in a relative sense, so the output is equally applicable to present and future activity. In applying the output, unadjusted, to future activity, however, it must be assumed that no factor substitution will occur as a result of either relative price changes or productivity/technological improvements.

Statistics Canada's interprovincial input-output model is based on the input structure prevailing in the provincial economies in 1979. The inter-provincial input-output model differs from the national input-output model in that its output is disaggregated to each of the provincial economies. The strength of the interprovincial model, therefore, lies in its capacity to assign the economic impacts to each province.

The total effects measured from the input-output model include direct, indirect and induced impacts in order to capture the total effect of the economic activity stimulated:

- Direct benefits, measuring the impact of increased output required to satisfy the increase in demand resulting from the construction of a component or the satisfaction of a need by a visitor (e.g., earnings by construction workers).
- Indirect benefits, measuring the impact in those sectors supplying raw materials and other inputs to the sectors contributing to the direct increase in output (e.g., suppliers of aluminum to makers of window frames).





- Induced benefits, which measure the impact of the re-expenditure of the wages and salaries paid as a result of direct and indirect activities.

The result of the analysis described above is expressed as:

- Value added (GDP at factor cost) - this is the incremental worth attributed to the product within a jurisdiction by reason of its manufacture. For example, if aluminum window frames are manufactured in B.C., the value added in B.C. will be exclusive of the value of the aluminum stock bought from another province.
- Government indirect tax revenues - includes federal and provincial commodity indirect taxes, such as gasoline and liquor taxes, federal excise taxes, provincial sales taxes, import duties as well as other indirect provincial taxes, such as property taxes, motor vehicle licenses and permits and other licenses.
- Wages and salaries - the wages and salaries earned in each jurisdiction.
- Employment expressed in person-years - jobs may be permanent, temporary, full-time, or part-time.

Statistics Canada's input-output model has several limitations. These do not undermine the conclusions of the report, but they should be considered when reviewing the results. These are:

- The inter-industry trading relationships are based on 1979 data. The model does not account for changes that have taken place since that time, and there is no simple way to adjust for these changes.



- The production function is linear (Leontief type) which means that the total effect of a project is directly proportional, regardless of its size. Also, increases and decreases show the same proportional impact. In reality, the disappearance of a particular expenditure does not generate a slow-down in the economy equal to its total economic impact, unless all the funds originate from abroad. This is because a certain amount saved will be reinjected elsewhere, in a different form, in the economy.
- There is no time dimension in the model; the period of time necessary to the propagation of all the effects is not taken into account. The model measures the full impact as if it would happen instantaneously.
- The model does not adjust for supply and demand effects, such as price increases, substitution and availability of resources.
- Perhaps the most important limit of the model is that it does not consider the relative efficiency of an expenditure. In other words, the model always indicates that a large expenditure has a bigger impact on the economy than a small expenditure. Any improvement in production efficiencies normally leads to less use of human or physical resources. The model is not capable of adjusting for these efficiencies.
- The model does not consider the nature of the expenditure, its social impact, the externalities it generates, etc., so one cannot conclude about the social or economic profitability of an investment on the basis of the results provided by the model.

