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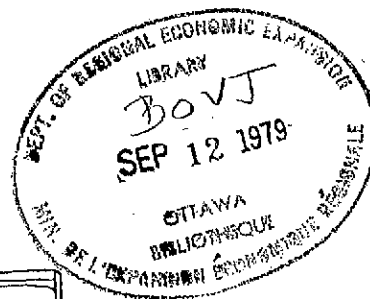
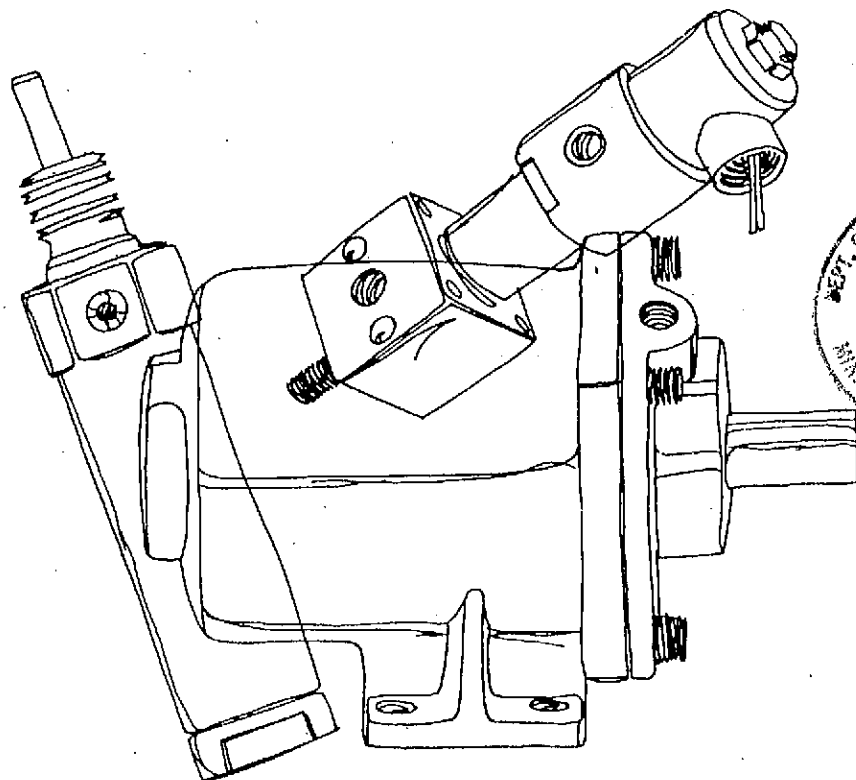
STUDY OF OPPORTUNITIES IN HYDRAULIC COMPONENTS

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## HYDRAULIC SYSTEMS COMPONENTS

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## SUMMARY

The opportunity for a Canadian company based in a development region to enter the Canadian market for hydraulic components appears to be limited. It is possible that such a new entrant could aim to capture a share of the total North American market, but the evaluation of this possibility lies outside the scope of this report.

Within Canada, opportunities may exist for a company to enter specialized market segments such as larger cylinders, special types of valves, etc. but these would likely be small markets.

Canadian consumption of hydraulic components was reported by Statistics Canada as \$34 million in 1970 (domestic production was reported as \$15.3 million and imports as \$18.6 million). We estimate that this figure would have grown to \$40-45 million by 1972. The rate of growth in consumption appears to be between 5-8% annually. U.S. production of hydraulic components was reported by the National Fluid Power Association as \$1.26 billion in 1972 and the average annual growth rate as 7.8% annually since 1968.

Hydraulic cylinders can be divided into two main types: standard cylinders (lower quality, for use in mobile equipment) and specialty cylinders (higher quality, for use in industrial applications). Standard cylinders are made for the agricultural implement market in Canada, mainly in Winnipeg, and there is some manufacturing of specialty cylinders in Canada. Except for the agricultural market, a large proportion of the cylinder market appears to be supplied from major U.S. plants, which can achieve significant economics of scale.

A substantial proportion of the cylinder market -- estimated at 22% in the U.S. in 1967 -- is captive; that is, the user companies make their own cylinders and purchase the valves. In our study, we observed some tendency towards self-manufacture in Canada, e.g. Massey-Ferguson are planning to purchase cylinders from their own plant in Germany for their Brantford combine plant.

Valve manufacture takes place in two stages: component manufacture and assembly. The principal U.K. and U.S. valve manufacturers carry out both stages. In Canada, we were told that the U.K. and U.S. subsidiaries carry out only the assembly process. A great variety of types and sizes is required, which can only be economically supplied by a plant with a large volume of business in each of the sizes it manufactures.

The opportunity for a Canadian supplier of hydraulic components appears to be limited for the following principal reasons:

- the final markets for most equipment using hydraulic components are international ones and a large proportion of the equipment made in Canada is eventually exported.
- therefore, manufacturers of equipment using hydraulic components tend to prefer components made by internationally known companies.
- these companies tend to specialize in order to achieve economies of scale, e.g. Vickers is said to have withdrawn from cylinder manufacturing and concentrated on valve manufacturing.
- component manufacturers work with equipment manufacturers from the design stage on so that components tend to be "designed into" the equipment using them.

- strong relationships tend to develop between component manufacturers and equipment manufacturers, making it more difficult for a new entrant to break in without a sustained marketing effort.

It does appear, however, that opportunities may exist for a new Canadian supplier to manufacture specialty components. For example, Gearmatic Co. Ltd. seems to have been successful by specializing in the marine hydraulics field; and Fluid Power Ltd. specializes in cylinders of large bore and stroke. These specialized market segments would need to be carefully examined on a North American scale to determine whether a Canadian based company could profitably enter them.

## HYDRAULIC SYSTEM COMPONENTS

### Primary Products

#### 1. Basic Components

Pumps - piston, gears and vane type

Valves - pressure control, flow control  
and directional control

Motors - gear vane and piston types

#### 2. Linear Actuators

Cylinders - single and double acting  
telescoping

#### 3. Accumulators

Piston, bladders and diaphragm types

#### 4. Intensifiers (boosters)

Intermittent and continuous types

#### 5. Rotary Actuators

Vane, jack screw, rack and pinion

### Accessory Products

#### 1. Gauges and Instruments

Pressure gauges  
Pressure switches  
Liquid level gauges  
Flow meters  
Thermometers

#### 2. Fluid Conductors and Connectors

Tubing  
Hose  
Fittings  
Swivels  
Quick disconnects

#### 3. Fluid Conditioners

Filters and strainers  
Heaters  
Heat exchangers

#### 4. Fluids

Petroleum based fluids  
Synthetic fluids

## BACKGROUND

An oil hydraulic system is a type of fluid power system, utilizing liquid as a means of transmitting power and controlling speed. There is a very large number of applications in which hydraulic equipment is being used and this number is increasing steadily. A non-exhaustive list of applications of hydraulic systems is found as Appendix D.

For reference, a detailed definition of a closed hydraulic system is:

"A system which transmits power through the use of pressurized fluid and is normally comprised of: a flow-pressure generator (hydraulic pump), a pressure limiting device (hydraulic relief valve) and a linear or rotary actuator (cylinder or motor); the devices (components) are normally connected by fluid conductors, either hose or rigid tubing (lines); the complete system is often referred to as a circuit."

Our study specifically excluded pumps and motors, (the subject of another study), and we decided to concentrate our attention on cylinders (actuators) and valves since these form the most important components. However, for reference the table opposite shows the primary and accessory components associated with hydraulic systems.

The widespread use of hydraulic systems in industry is a result of their versatility, control, lightweight, safety and ease of operation. For example:

- Most original equipment manufacturers (OEM's) and users feel that hydraulic systems represent a definite convenience factor. Hydraulic devices are normally easier to install and to maintain than mechanical or electro-mechanical devices. Further, the inherent lubricating characteristics of hydraulic fluids are beneficial in terms of component life.
- Hydraulic components have an excellent power-to-weight ratio. As component design and manufacturing techniques improve, the pressure capability of hydraulic components continues to increase, thus creating even smaller, lighter-weight components.
- Hydraulic systems are inherently safe devices. Safety and reliability can be designed into a hydraulic system, which would be difficult, if not impossible, with a mechanical system. Overload protection is readily available in fluid power systems by using relief valves and/or safety valves, a facility not found in most mechanical systems.
- Certain functional requirements make it almost impossible to transmit power by methods other than hydraulics.

Cylinders (also referred to as linear actuators, rams or plungers) are available in many different configurations. The most commonly used cylinders are the single acting, double acting and telescoping types (piston type cylinders).

Piston type cylinders are available in many styles, including tie rod, mill type, welded head and threaded head types.



ESTIMATED CANADIAN CONSUMPTION OF HYDRAULIC COMPONENTS

1967 - 70

(Million dollars)

	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>Average annual growth</u>
Domestic production	12.4	13.9	15.4	15.3			
Imports	<u>16.9</u>	<u>15.6</u>	<u>21.2</u>	<u>18.6</u>	<u>18.7</u>	<u>21.9</u>	
Total consumption	29.3	29.5	36.6	33.9			5.0%

Source: Statistics Canada 42.214  
65.007

Many specific detailed characteristics and design criteria go into the designing and manufacturing of quality cylinders. Even so, linear actuators are one of the simplest devices to manufacture in the fluid power industry. It is relatively easy for any manufacturing company to produce cylinders with a minimal investment in machine tools. Ease of manufacture and the large OEM demand, have made cylinders a popular item for self-manufacture.

In contrast, valves are a much more complex component to design and manufacture. Generally, valves can be divided into three categories: directional control type, pressure control type and flow control type. Directional control valves are used to start, stop and control the direction of motion of hydraulic actuators. Pressure control valves generally are used to limit the pressure in an hydraulic system. Flow control valves primarily control the rate of speed of the actuator.

#### MARKET POTENTIAL

##### Consumption (Imports and Production)

The table opposite shows the estimated Canadian consumption of hydraulic components 1967-1970. The domestic production figures are taken from Appendix A and the import figures from Appendix B. The table indicates that the total domestic consumption has shown an average annual growth of 5%. Total consumption stood at \$29.33 million in 1967 growing to \$36.6 million in 1969 and declining to \$33.9 million in 1970. Extrapolating from these figures the current domestic consumption is

approximately \$40-45 million. Since the economy was depressed in 1970, the annual growth rate over the whole period lies between 5-8%.

This would parallel the growth rate experienced in the U.S. According to the National Fluid Power Association, in 1972, the hydraulic component market in the U.S. was \$1.26 billion. Growth since 1968 had been 7.8% annually.

This rate is the same as that published by a leading U.S. consulting firm in 1967 for the U.S. component market growth from 1957 to 1964. Appendix C gives an Industry, Trade and Commerce estimate of the total Canadian demand for hydraulic components. It is considerably higher than the combined imports and manufactured totals. The reason is that equipment containing hydraulic components is included in these figures, and this does not apply to the consumption figures given earlier.

#### Exports

Official statistics indicate that there is no export of hydraulic components. However, a large proportion of components produced in Canada or imported, are eventually exported as an integral part of a more complex piece of equipment. Certain Original Equipment Manufacturers (OEM's), whom we have talked to, indicated that domestic consumption accounted for 5-10% of their total production.

#### Market Segments

Although hydraulic components and systems are found in equipment throughout industry in general, the following major market segments can be identified.

<u>Market Segment</u>	<u>% of Total</u>
Mobile equipment (agricultural, earthmoving, logging, mechanical handling, etc.)	50%
Industrial (e.g., injection moulding, machine tools, etc.)	25
Marine (hoists, winches, steering equipment, etc.)	15
Miscellaneous	<u>10</u>
Total	<u>100%</u>

The largest of these segments is the mobile equipment market which includes farm, lumber, earth moving and materials handling equipment. In the mobile equipment market, there are two types of demand. Firstly, there is the OEM portion of the market and secondly, there is a large replacement market. It has been estimated that each cylinder manufactured for the mobile equipment field will typically be replaced 5 times during the lifetime of the equipment on which it is installed.

The miscellaneous segment includes aerospace/military applications which are unique in their requirements, with weight and performance being of primary importance. Few companies have the technical expertise to supply this area. Various other applications in this segment include materials handling not covered in mobile equipment, mining, dam and lock gate control, etc.

There is a fairly uniform distribution of the market across geographic segments. Mining, marine and logging applications contribute to the west coast portion. Agricultural demands predominate

in the midwest. Ontario and Quebec have the largest industrial requirements along with a large mobile consumption. The east coast requires considerable hydraulic equipment for marine applications.

#### Growth Potential

The industrial market will continue to grow as automation moves into a greater variety of in-plant machinery. While pneumatic equipment is predominant in the industrial segment, there is a movement towards increasing use of hydraulics. The high cost of labour is an incentive to automate wherever possible.

The mobile equipment market is characterized by the largest amount of self manufacture of hydraulic cylinders. This policy of vertical integration is designed to decrease the dependency of the OEM's on the hydraulic cylinder suppliers. Thus, the potential for cylinders is limited, but OEM's are not equipped to manufacture valves and so there will be a steady increase in the market for valves.

The marine segment was reported to exhibit above-average growth potential with an increasing trend towards hydraulically powered shipboard loading and unloading equipment. This is in addition to the traditional uses of hydraulic equipment in steering equipment, capstan drives, winches, etc.

#### SUPPLY

There is a very large number of manufacturers of hydraulic components and systems supplying the Canadian market. The major suppliers are either U.S. companies or subsidiaries of a U.S.

parent company. Many companies manufacture cylinders in Canada whereas there is practically no manufacturing of valves in this country. Valves are imported either complete or in component form and assembled subsequently.

The principal manufacturers of cylinders include:

Alco Equipment  
Winnipeg, Manitoba

Bata Engineering Ltd.  
Batawa, Ontario

Fluid Power Ltd.  
Rexdale, Ontario

King Hydraulics Ltd.  
Woodstock, Ontario

Miller Fluid Power (Canada) Ltd.  
Mississauga, Ontario

Monarch Machinery Ltd.  
Winnipeg, Manitoba

Parker-Hannifin (Canada) Ltd.  
Burlington, Ontario

Spotton Mfg. Ltd.  
Mississauga, Ontario

Cylinders are relatively simple components to manufacture.

They range from the cheap 'throw-away' variety used in the mobile equipment field to more complex and higher quality types found in industrial applications. The relative ease with which new suppliers can enter the market (low capital investment, limited technical expertise required) accounts for the existence of many suppliers (including a number of Canadian companies). There is no domestic supply of extremely large cylinders, as the necessary machinery does not exist.

Both Alco and Monarch manufacture cylinders for the agricultural portion of the mobile equipment segment. Agricultural cylinders typically range from 2" to 6" bore. Monarch do not manufacture for an OEM but rather for the replacement market. They project this market as reaching approximately \$2½ million in two years. Monarch have indicated that they do export their cylinders. Alco, a division of Allied Farm Equipment, Inc., supply cylinders to International Harvester. Vickers have recently discontinued supplying hydraulic cylinders in both Canada and the U.S.

The principal suppliers of valves include the following (the Canadian manufacturers act mainly as distributors):

Cessna  
Wichita, Kansas

Dowty Equipment of Canada Ltd.  
Ajax, Ontario

Gresen Manufacturing Co.  
Minneapolis, Minnesota

Parker-Hannifin (Canada) Ltd.  
Burlington, Ontario

Racine Hydraulics (Canada) Ltd.  
Weston, Ontario

Vickers Div. Sperry Rand Canada Ltd.  
Rexdale, Ontario

Vickers dominate the supply of valves, motors and pumps. They are very active in practically all market segments: agricultural, aerospace, industrial, etc. Gresen and Cessna are particularly effective in the mobile equipment segment. Dowty shows good penetration in the marine, mining and aircraft segments. It has

been estimated that Vickers enjoy a 60% share of the industrial market, while Cessna and Gresen control 60-80% of the mobile equipment segment.

A company's position in the market is said by customers to be dependent on the following criteria:

- capacity (range of sizes made)
- design competence
- ability to solve customers' technical problems
- delivery performance
- price

The current supply of castings in Canada is said to be not sufficiently diversified to service a potential Canadian valve supplier. There are few foundries and delivery is poor as they tend to schedule production to suit the automotive industry. Tubing for cylinder manufacture is not rolled by Canadian mills in a sufficient range of sizes. Stelco is reported to be the only manufacturer of hydraulic cylinder tubes in Canada. As a result companies import most of their casting and steel tube requirements from the U.S.

#### MARKETING CHARACTERISTICS

Suppliers may or may not utilize an intermediary in marketing their product. Many suppliers deal with the consumer directly while others employ agents, distributors and licensed manufacturers (of cylinders) in local areas. Distributors are often hydraulic systems specialists. They will handle one or more lines of



components (in some cases) manufacturing non-competitive lines.

Generally a supplier would deal directly with an OEM and have distributors handle the replacement supply.

The large companies such as Vickers, Gresen and Cessna work very closely with the OEM's from the time a new piece of equipment is conceived, supplying them with considerable technical support. Suppliers tend to build up extensive experience in one or more market segments (e.g., Gresen in the mobile equipment field).

OEM's over a period of time have gradually built up a close working relationship with a particular supplier whose equipment tends to be designed into the finished equipment. Entry into the market by another supplier of valves, pumps, etc., would thus require not only considerable technical expertise and production capability but a very considerable marketing effort to achieve any market penetration at the expense of existing suppliers.

#### INDUSTRY CHARACTERISTICS

##### Patents

Patents are relatively unimportant in the fluid power industry compared to other industries. Many existing patents are ignored and many elements of fluid power technology are not patentable.

##### Self Manufacture

The mobile equipment OEM's tend to self manufacture hydraulic cylinders to decrease their dependence on suppliers. Where

these OEM's are Canadian subsidiaries, the cylinders are manufactured by the parent company in the U.S. and imported (without duty if destined for agricultural equipment). Companies fitting this pattern include:

Agricultural equipment and earth moving

International Harvester (also buy some)  
Massey-Ferguson (currently purchase but planning to import from  
own plant in Germany)  
John Deere  
Caterpillar  
White Motor Corp. (moving toward self manufacture)

Logging

Timberjack  
CanCar

Mechanical handling equipment

Blue Giant  
Eaton, Yale  
Lansing Bagnall

In the trailer industry, Trailmobile manufacture their own cylinders while Fruehauf buy from a cylinder manufacturer. These two companies are said to account for some 75% of the trailer industry.

However, there are certain major manufacturers in the mobile market who purchase their hydraulic cylinders, e.g.:

Clark Equipment (logging and mechanical handling)  
GM Diesel (off-highway trucks)  
Hyster (mechanical handling)

Purchasing Procedure

A significant feature of the hydraulics industry is that in the OEM field the specification of equipment is performed to a large extent, by a company's engineering personnel. A large portion of the equipment manufactured in Canada is designed in the U.S. Inevitably, U.S. components are specified at the design stage. Purchasing agents normally perform only an expediting role when such components are specified. It was not possible to rank the criteria used by consumers in selecting an equipment supplier. However, the criteria included:

- reputation            - quality
- price                 - reliability
- delivery              - service and previous experience

A further important criterion is the availability of the hydraulic components in the U.S. and the rest of the world. A large proportion of the Canadian market for hydraulic components enter equipment that is destined for export. OEM's are not predisposed towards specifying components for their equipment which cannot be obtained outside Canada.

Users of hydraulic components indicated that they are looking for better delivery as this is a continuing problem with hydraulic components.

PRODUCTION

Production in the U.S. of hydraulic components is characterized by considerable automatic or semi-automatic content.

The large U.S. market justifies the use of numerically controlled equipment. In Canada the bulk of cylinders are said to be produced on manually controlled lathes.

"Manufacture" of valves in Canada invariably implies assembly rather than manufacture. All components imported under import clause 42700-1 and subsequently assembled into equipment do not pay duty since the components are not manufactured in this country. However, if a Canadian manufacturer should begin operation, it is probable that the tariff of 15% would be levied on imported components.

#### RESEARCH AND DEVELOPMENT

There is very little research and development being carried out in Canada. Fully 95% takes place in the U.S. There are various problems relating to the use of hydraulic systems including: heat dissipation, leakage, erosion, leakage contamination, noise, odour and fire hazard. Research is currently investigating solutions to these problems.

Leakage problems are being minimized by the development of integrated (manifold) systems which eliminate much hosing and connections. Investigation of fluid erosion has led to the development of a technology of cutting soft materials with high pressure water, the pressure being provided by an hydraulically driven intensifier pump.

A COMPARISON OF HYDRAULIC COMPONENT COST BETWEEN  
A HIGH PRESSURE SYSTEM AND A LOW PRESSURE SYSTEM

<u>Component</u>	<u>Industrial Applications</u>		<u>Mobile Applications</u>	
	<u>6,000 psi</u>	<u>1,000 psi</u>	<u>6,000 psi</u>	<u>1,000 psi</u>
Pumps	22.7	5.7	20.8	5.3
Accumulators	5.0	8.0		
Valves	38.4	31.9	8.4	10.0
Actuators	16.6	32.2	47.8	51.0
Auxiliary Eqt	17.3	22.2	23.0	33.7
Total	100.00	100.00	100.0	100.0

There will be an increase in horse-power ratings with a corresponding rise in flow rates and/or pressures. More sophisticated and reliable control systems are being developed using fluidic logic techniques. It has been reported to us that a considerable amount of research is being carried out to reduce the noise associated with high pressure systems.

#### COSTS

The distribution of cost between elements in production varies depending on the type of application considered. Generally, as the quality of a cylinder increases, the labour content increases. Typical cylinders produced for the mobile equipment market range in value from \$50 to \$200. A \$50 cylinder would involve approximately 1 hour of labour during production.

The production of industrial valves is characterised by a high labour content.

The table opposite compares the hydraulic component cost between high and low pressure systems for both industrial and mobile applications. The cylinder (actuator) is the most significant cost of an hydraulic system for mobile applications. The control valving is the most costly part of industrial hydraulic systems.

#### PLANT LOCATION CRITERIA

Cylinder manufacturers have indicated that their location is market oriented. As delivery is F.O.B. factory/distributor,

transportation costs across Canada can be significant. The availability of skilled labour is not important. In contrast, the production of valves, pumps, etc. is both market and resource oriented. A local supply of skilled labour is a prime consideration.

CANADIAN PRODUCTION OF HYDRAULIC EQUIPMENT

1967 - 70

(Thousand dollars)

<u>Description</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
Cylinders - Air and Hydraulic	4,194	6,420	6,655	6,520
Hydraulic Power Units, Hose Assemblies and Fittings	<u>8,186*</u>	<u>7,485</u>	<u>8,768</u>	<u>8,813</u>
	<u>\$12,380</u>	<u>\$13,905</u>	<u>\$15,423</u>	<u>\$15,333</u>

\*Does not include Hos. Assemblies  
and Fittings

Source: Statistics Canada 42.214



CANADIAN IMPORTS OF HYDRAULIC EQUIPMENT

1967 - 72

(Thousand dollars)

<u>Description</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>
Fluid Drive Couplings and Parts	1,091	773	1,179	1,093	1,009	1,153
1 Cylinders and Parts	4,193	3,280	4,062	4,130	4,223	4,866
2 Pumps and Parts	4,008	4,331	6,979	5,945	6,544	7,919
3 Valves and Parts	3,457	3,126	4,326	3,374	3,805	4,092
4 Power Transmission Equipment NES	4,139	3,990	4,651	4,038	3,142	3,878
	<u>\$16,888</u>	<u>\$15,500</u>	<u>\$21,197</u>	<u>\$18,580</u>	<u>\$18,723</u>	<u>\$21,908</u>

Notes:

1. Includes: Piston rod, rings, end covers etc.
2. Includes: All pumps going into hydraulic power transmission equipment. Possibly 50% are parts, 50% systems and sub-systems
3. Includes: All valves going into hydraulic power transmission equipment. Includes vane, gear, piston, etc. Possibly 50% components, 50% systems and sub-systems.
4. Includes: Miscellaneous control systems, power units, torque converters, accumulators, snubbers, actuators etc.

Source: Statistics Canada: 65.007

ESTIMATE OF THE DEMAND FOR HYDRAULIC  
COMPONENTS IN CANADA (\$,000,000) (=IMPORTS + PRODUCTION)  
(Including Agricultural, Industrial, Mobile, Marine, etc.)

<u>Description</u>	<u>Size</u> <u>(\$,000,000)</u>	Note:
Power Packages (Pump, Motor Valving Reservoir, Hose)	10	1. All items are either being imported as integral parts of end use items or as individual components for further fabrication. The distribution is 50% for each.
Pumps (Vane, Axial, Radial, etc.)	22	
Motors (Vane, Axial, Radial, etc.)	12	2. When an end use item containing hydraulic equipment enters Canada duty free, the hydraulic equipment is also admitted duty free.
Control Valves (Solenoid, Pilot, etc.)	41	
Actuators (Cylinders and door operators)	12	
Hydrostatic Transmission Equipment	9	3. However, a restriction would be placed on replacement parts if there were a Canadian manufacturer of such replacement parts.
Accessory Equipment (Filters, Snubbers, Accumulators, etc.)	<u>3</u>	
Total	<u>109</u>	

Source: From Department of Industry, Trade & Commerce

HYDRAULIC EQUIPMENT APPLICATIONS  
INDUSTRIAL

Automatic Door Operators  
Car Hoists  
Coating Machinery  
Drilling Equipment  
Elevator Power Units

Hydraulic Tables  
Materials Handling Systems  
Piercing Machinery  
Presses  
Resistance Welding Machinery

Sign Rotators  
Stage Lifts  
Surface Grinders  
Water Treatment Machinery  
Die Casting Machinery

Antenna Drives  
Power Hose Reel Drives  
Milling Machines  
Manipulators  
Promotion Sound Devices

Automated Machinery  
Clutches  
Dental Chairs  
Elevators  
Gear Hobbers

Can Forming Machines  
Airless Paint Sprayers  
Scrap Balers  
Paper Balers  
Stamping Presses

Machine Tools  
Metal Forming Machinery  
Plastic Forming Presses  
Elevating Tables  
Die Tryout Presses

Pulp Making Machinery  
Sawmill Equipment  
Special Machinery  
Steel Mill Machinery  
Textile Machinery

Woodworking Machinery  
General Paper Machinery  
Lathes  
Paper Slitting Equipment  
Testing Machines

Injection Molding Equipment  
Rubber Molding Presses  
Extrusion Machines  
Cooling Fan Drives  
Industrial Screen Vibrators

Hydraulically Actuated Fly Systems  
Commercial Laundry Machines  
Cross Slide Feeders  
Tire Recapping Equipment  
High Speed Spiral Winders

Marking Machines  
Labelling Machinery  
Packaging Machines  
Platten Presses  
Data Processing Equipment

HYDRAULIC EQUIPMENT APPLICATIONS  
MOBILE

Dump Trailers  
Steel Wheeled Rollers  
Coal Augers  
Concrete Mixers  
Motor Graders

Miscellaneous Hoisting Equipment  
Farm Tractors  
Excavator Cranes  
Miscellaneous Mixer Drives  
Aerial Platforms

Rubber Tired Rollers  
Power Steering Systems  
Ditchers  
Asphalt Plants  
Hydraulic Bridge Cranes

Self-Propelled Joint Sealers  
Trailer Assist Drives  
Pulpwood Harvesters  
Log Skidders  
Crane Wagon Hydrostatic Drives

Irrigation Tractor Drives  
Cable Carriers  
Bean Pickers  
Concrete Spreader Belt Drives  
Hydrostatically Driven Excavators

Remote Compressor Drives  
Ditcher Propel Systems  
Base Spreaders  
Blast Hole Drills  
Articulated Power Steering

Hydraulic Starters  
Truck Cranes  
Snow Plow Equipment  
Fork Lift Trucks  
Radiator Fan Drives

Pile Driver Vibrator Systems  
Hydraulically Driven Rock Crushers  
Asphalt Distributors  
Railway Maintenance Equipment  
Hydraulically Tree Shakers

Rough Terrain Cranes  
Goose Car Propel Systems  
Fogger Drives  
Harvesting Machinery  
Crawler Mounted Bituminous Pavers

Earth Drills  
Vibratory Roller Drives  
Self-Propelled Pavement Breakers  
Locomotive Crane Propel Systems  
Highway Mowers

Belt Tensioning Systems  
Crane Swing Systems  
Remote Alternator Drives  
Marine Winch Drives  
Yard Cranes

Centrifugal Cotton Baling Machines  
Centrifugal Water Pump Drives  
Chip Drives  
Concrete Saw Drives  
Pitch Brace Systems

Bucket Wheel Excavators  
Kelly Hoist Drives  
Overhead Cranes  
Hydraulic Concrete Pump Drives  
Pallet Trucks

Motor Scrapers  
Continuous Miners  
Front End Loaders

HYDRAULIC EQUIPMENT APPLICATIONS  
MARINE

Miscellaneous Loading Devices  
Miscellaneous Marine Transmissions  
Hatch Door Cover Actuators  
Sonar Hoists

Marine Steering Equipment  
Miscellaneous Marine Hoists and Winches  
Sonar and Sound Device Drive Systems  
Vang Winches

Shock Absorber, Carrier Missile Transfer  
System (Fast System)  
Capstan Drives  
Anchor Windlasses

LIST OF CONTACTS

Clark Equipment of Canada  
St. Thomas, Ontario

GM Diesel  
London, Ontario

Galion Manufacturing of Canada Ltd.  
St. Thomas, Ontario

Standard Tube & T.I.  
Woodstock, Ontario

J.I. Case  
Woodstock, Ontario

Caterpillar of Canada Ltd.  
Mississauga, Ontario

International Harvester  
Candiac, Quebec

Lansing Bagnall of Canada Ltd.  
Bramalea, Ontario

Hyster Materials Handling Eqt.  
Malton, Ontario

Production Hydraulic Co.  
Weston, Ontario

Fluidic Systems  
Rexdale, Ontario

Department of Trade and Commerce  
Ottawa, Ontario

International Publishing Company  
Cleveland, Ohio

National Fluid Power Association  
Milwaukee, Wisconsin

B & K Machinery International Ltd.  
Malton, Ontario

John Deere Construction Equipment  
Welland, Ontario

White Trucks (div. of White Motor Corp.)  
Brantford, Ontario

Dominion Engineering Works  
Lachine, Quebec

Rousseau Controls  
Pointe Claire, Quebec

Husky Manufacturing & Tool Works Ltd.  
Bolton, Ontario

CanCar (div of Hawker Siddeley)  
Thunder Bay, Ontario

Timberjack (Eaton)  
Woodstock, Ontario

Koehring-Watrous  
Brantford, Ontario

Alco Equipment Ltd. (div. of Allied Farm Eq.)  
Winnipeg, Manitoba

Fluid Power Limited  
Rexdale, Ontario

Higginson Equipment Sales Ltd.  
Burlington, Ontario

Massey-Ferguson  
Toronto, Ontario

John Spotton Co. Ltd.  
Cooksville, Ontario

Aircraft Appliances and Equipment Ltd.  
Bramalea, Ontario

Dowty Equipment of Canada Ltd.  
Ajax, Ontario

Statistics Canada  
Ottawa, Ontario

Tycos Tool & Die Co. Ltd  
Downsview, Ontario

Dycon Limited  
Mississauga, Ontario

Parker-Hannifin (Canada) Ltd.  
Burlington, Ontario

Vickers Division Sperry Rand Canada Ltd.  
Rexdale, Ontario

Design Engineering  
Toronto, Ontario

Martonair (Canada) Ltd.  
Cooksville, Ontario

Monarch Machinery Ltd.  
Winnipeg, Manitoba

Blue Giant Industrial Trucks  
Brampton, Ontario