

PRODUCT ANALYSIS
OF
HYDRAULIC SYSTEMS FOR
INDUSTRIAL APPLICATIONS

1972

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PLEASE NOTE

This report has been edited, where necessary, to remove comments and data that are classed as confidential. In the interest of efficiency, this has been done by simply removing small sections of the report. As a consequence, there are some blank spots which, we hope, will not interfere with the readability of the report.

Department of Regional Economic Expansion

PRODUCT ANALYSIS OF
HYDRAULIC SYSTEMS FOR INDUSTRIAL APPLICATIONS

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I - SUMMARY

Since hydraulic systems are usually incorporated into machinery or equipment, and Canada imports a great part of its machinery and equipment, it is difficult to measure the total requirement for hydraulic systems in Canadian industry. The market for hydraulic systems (exclusive of those already incorporated in imported machinery and equipment) was approximately \$33,000,000 in 1972 (Table 1). Agricultural equipment, construction equipment, machine tools, logging equipment and aerospace industries represent most of this market. Growth is forecasted at about 7% per year assuming a continuation of existing tendencies.

1) Imports

Imports of components, mostly from the U.S., are valued at approximately \$18 million. The main items are pumps, valves and cylinders.

Canadian Manufacturers

Canadian manufacturers of major components (for 1972 about \$1.0 million), appear to be successful in exploiting specific applications:

- a) Winches;
- b) Farm equipment.

Manufacturing of cylinders (\$4.3 million in 1972) is carried out predominantly on a small job shop basis (more than 200). Many distributors (300) of foreign components assemble in Canada hose assemblies, couplings and power units (\$9.7 million in 1972).

In total, these activities had a value of \$15 million in 1972.

Auxiliary devices such as flexible hoses, filters, couplings, etc. are made by Canadian manufacturers whose main interest lies outside the hydraulic industry.

2) Exports

There are no exports of hydraulic systems or components as such. Certain Canadian manufacturers of industrial equipment, however, export their equipment complete with hydraulic system. The major firm in this category export their hydraulic winches all over the world. United States tariff is approximately 5% on hydraulic components.

Market Segmentation

The industry is highly segmented as far as end-use product, specific application, variety and number of components.

The major components have a very high technological content. Canadian manufacturers will require know-how agreements with the U.S. or European manufacturers to provide them with a continued access to design, technological development, parts, etc.. This will enable them to build a business from partial to full manufacturer over a fairly broad range of major components (pumps, motors, valves).

CANADIAN MARKETHYDRAULIC SYSTEMS (MAJOR INDUSTRIAL APPLICATIONS)

(\$000)

Year	I	II	III	IV
	Canadian imports (1) + (2) + (3) + (4)	Canadian production (5)	Canadian production (6) + (7)	Domestic market (8) I + III
1966	11,001	3,608	9,048	20,049
1967	12,749	4,194	10,702	23,451
1968	11,510	6,420	11,337	22,847
1969	16,546	6,655	12,761	29,307
1970	14,541	6,520	12,725	27,266
1971	15,581	6,400	12,290	27,871
1972	18,030	7,191	13,964	31,994
1973				33,900
1974				36,400
1975				38,900
1976				41,600
1977				44,600

(1) Hydraulic pumps and parts (Cat. 504-85)

(2) Hydraulic valves and parts (Cat. 504-87)

(3) Hydraulic cylinders and parts (Cat. 504-83)

(4) Hydraulic couplings and parts (Cat. 504-81)

(5) Cylinders, air and hydraulic (D.B.S. 42-214)

(6) Estimated at 60% of (5)

(7) Hydraulic power units, hoses assemblies and couplings (D.B.S. 42-214)

(8) Excluding manufacture of pumps, valves and motors estimated at \$1.0 million in 1972 (see text)

N.B. Canadian exports apparently very small and inexistent in export statistics.

II - BACKGROUND

A) DEFINITION

The technology of a hydraulic system is based on the transmission of power by potential energy changes in a fluid circulated at a controlled rate.

This energy-transfer cycle, from the prime mover into the system (by means of the pump) through the system (by means of a fluid) and out of the system to a mechanical load (through the motor) is the essence of fluid power. Intermediate control devices modulate either the energy level (pressure) or the rate of energy transfer (flow rate), but they do not alter the fundamental cycle.

1) Major components

There are three major components: pumps, valves and hydraulic motors.

a) Pumps

- i) vane
- ii) gear
- iii) piston

The range in size is: 0.2 - 1,000 gpm (special units over 1,000). The number of sizes offered by a given manufacturer can vary between 1 and 110.

The range of maximum system pressures is 250 - 10,000 psi (special units over 10,000 psi).

For industrial machinery, pumps are generally driven by electric motors.

Mobile pumps are generally driven from the vehicle engine.

b) Valves

There are three (3) types of valves:

- i) direction-control
- ii) flow-control
- iii) pressure-control

Direction-control valves fall into a pattern similar to that of pumps. Brand differentiation is primarily in the area of refinements, flexibility, and options.

Flow-control valves are of the adjustable-orifice, pressure compensated type.

Pressure-control valves modulate the energy level.

The range in size is $1/8$ - 3 inches.

The range of pressure rating: 10 - 10,000 psi (special valves over 10,000 psi).

The range of flow rating: $1/2$ to 2,000 gpm (special valves over 2,000 gpm).

Interest appears to be increasing in flow-divider valves, combination valves, and remote control of flow settings by servovalves.

c) Hydraulic motors

Hydraulic motors produce mechanical energy output from a fluid energy input. Motors have been developed from their pump counterparts. Motors and pumps from the same manufacturer use many interchangeable parts. Operating data and specifications often are developed from pump data.

2) Basic components

Basic components include major components defined above as well as cylinders, power units and hose assemblies and couplings.

a) Cylinders

Cylinders can either be welded or machined depending on pressure and precision requirements. A variety of steel is used with the nature of finish and the tolerance varying, depending on the application. Sizes vary from quite small (2") to very large (over 48"). Pistons can be either ordinary cast iron, die-casted or made of precision machined steel.

b) Power units

A hydraulic power unit is a combination of basic hydraulic components and auxiliary devices, in such a way that it brings under a single-source command, the performance of one or many operations. Hydraulic power units may then range from simple to very complex and different arrangements.

The characteristics of hydraulic power units are machine contour adaptability, compactness, versatility, a reduction or elimination of auxiliary independent circuit components, maximum

system efficiency, controlability and durability.

We have included under the heading "Canadian Production", the assembly, in Canada, of hoses, couplings and power units which is predominantly done by Canadian distributors representing foreign suppliers of major components, but which may use hoses, couplings and other auxiliary devices of Canadian primary manufacture.

3) Auxiliary devices

Many auxiliary devices are necessary to tie a circuit together and allow it to function: piping, reservoirs, filters, lubricators, manifolds, instrumentation, heat exchangers, and electrical controls. Although these auxiliaries do not play a part in the primary energy transfer function, without them the hydraulic system would not operate.

The manufacturers of these auxiliary devices do not manufacture any major components for hydraulic systems. They belong to industries such as flexible hosing, instrumentation, etc.. Consequently, we have excluded the primary manufacturing of these auxiliary devices from our study.

B) APPLICATIONS

Industrial applications for hydraulic systems in Canada can be found in agricultural equipment, construction equipment, industrial machinery, civil aviation, off-the-road motorized transport, logging equipment and marine equipment.

c) TRENDS

The hydraulic system industry has experienced a decade of very rapid development in components, circuits and controls. For example, pressure levels have been increased from a maximum of 1,000 psi to 5,000 - 6,000 psi, with some components operating at up to 10,000 psi.

Pump delivery capabilities have increased from 60 gpm to the 1,000 gpm range.

Pump and motor power capabilities, a decade ago, were in the 50 hp. range. Today, almost all of the major manufacturers have units in the over 100 hp range, with some up to 1,000 hp.

Control valves and related components have kept pace with these developments, so that today a wide selection is available to the circuit designer.

Packaging of components into subsystems, and manifolding of valves into control subsystems to eliminate external piping, have become popular.

In some instances, the packaging of pumps and valves, or motors and valves, into single units has carried the concept across functional lines.

d) RESEARCH AND DEVELOPMENT

The major areas of research and development are:

- 1) higher speeds for hydraulic pumps;
- 2) increases in system pressure;
- 3) increase of pump capacities;
- 4) increase in performance and output per pound;
- 5) more sophisticated subsystems (electrohydraulic servos).

III - SUPPLY

A) COMMERCIAL PRACTICES1) Buying

In contrast to the American market, where the purchase by original equipment manufacturers, for incorporation in their own product, plays an important role in the sharing of the market, few Canadian buyers are original equipment manufacturers. Canadian purchases are mainly for import replacement or special applications.

2) Selling

Recently, there has been an increasing demand for hydraulic systems in logging machinery, off the road vehicles, farm machinery, etc.. This has brought upon a major change in the selling practices of important distributors: from order takers, they have become specialists who are called upon to design hydraulic systems for specific applications. Their staff must solve hydraulic problems and provide a high degree of service.

To serve the Canadian market, there are five (5) major American manufacturers located in Canada with sales offices, engineering staffs and "systems" assembly plants. They import major components from their U.S. plants.

The majority of smaller distributors possess a general expertise, and will claim to have the capability to design circuits for a

wide range of applications. In actual fact, the bulk of their sales volume is derived from import replacement.

There are more than one hundred (100) manufacturers of hydraulic pumps, motors and valves around the world, and the majority of them are represented across Canada, mainly through distributors (more than 300).

Any realistic marketing plan in this industry must give serious consideration to the role of the distributor.

3) Pricing

Hydraulic pumps range in price from \$50 to \$20,000.

Valves range in price from \$25 to \$3,000.

Complete hydraulic systems, including auxiliary accessories can run to as much as \$100,000.

B) IMPORTS

Imports supply most of the Canadian market for hydraulic motors, pumps and valves because of the following:

- 1) Hydraulic systems are generally incorporated to machinery or equipment, and designed specifically for each application. A wide selection of hydraulic pumps, motors and valves were developed and manufactured by leading industrial nations. Canada, until a few years ago, was importing the bulk of its machinery from the United States, Europe and Japan.

The majority of Canadian machinery manufacturers were small shops who tended to specialize in customizing equipment to individual client specifications. The Canadian original equipment market was too small to justify the manufacture of hydraulic pumps, valves and motors.

- 2) It is quite evident that the leading firms of other industrial nations, who produce highly versatile and technologically advanced pumps, motors and valves, have established outlets in Canada to satisfy after-sales service and to acquire new clients

Imports grew from \$11 million in 1966 to \$18 million in 1972, an annual growth rate of $8\frac{1}{2}\%$ (see Table 1).

Canadian imports are predominantly pumps, valves and cylinders. The following table gives the breakdown of Canadian imports:

BREAKDOWN OF 1972 CANADIAN IMPORTS

BY NATURE OF COMPONENTS

	Million \$	%
Pumps	7.9	43.9
Valves	4.1	22.8
Cylinders	4.9	27.2
Couplings	1.1	6.1
T o t a l	18.0	100.0

There is no duty on parts imported to be used in the assembly of hydraulic pumps, valves and motors, since none are manufactured in

Canada. However, imports of many hydraulic components are dutiable at approximately 15%.

The following table gives an estimate of duties paid and percentage dutiable in 1970:

TARIFF REVENUES ON IMPORTS (1970)

<u>Free</u>	+	<u>Dutiable</u>	=	<u>Total</u>
\$ 5,893,187		\$ 8,648,130		\$ 14,541,317
		<u>Dutiable/Total</u>		59.5%
		<u>Duty Collected</u>		\$ 1,246,016
		<u>Duty Collected/Dutiable</u>		14.4%

To enable Canadian machinery manufacturers to derive maximum relief from the tariff, the Department of Industry, Trade and Commerce offers them (under Tariff items 42,700-1 and 41,100-1) remission of import duty on hydraulic components under the Machinery Program (MACH).

Therefore, tariff revenue statistics (as shown above) give a completely erroneous picture of the relative importance of imports, because importers usually pay the duty (giving rise to statistics), and then recover the amounts through the MACH Program.

Imports of hydraulic components into Canada come predominantly from the United States and the United Kingdom as shown below.

PERCENTAGE BREAKDOWN OF CANADIAN IMPORTSOF HYDRAULIC COMPONENTS

	<u>1972</u>	<u>1970</u>
United States	93.1%	93.6%
United Kingdom	5.0%	4.3%
Others	1.9%	2.1%

Canadian imports of components were predominantly to Ontario as shown below.

BREAKDOWN OF 1971 IMPORTSOF COMPONENTS BY PROVINCE

<u>Province</u>	<u>Couplings</u> <u>504-81</u> \$	<u>Cylinders</u> <u>504-83</u> \$	<u>Pumps</u> <u>504-85</u> \$	<u>Valves</u> <u>504-87</u> \$
Newfoundland	-	8,260	11,406	3,368
Nova Scotia	13,859	41,064	17,061	19,141
New Brunswick		86,397	52,030	4,573
Quebec	110,108	417,987	498,694	363,402
Ontario	727,058	3,026,810	4,441,784	2,626,422
Manitoba	33,775	108,244	294,675	409,628
Saskatchewan	2,320	140,838	39,600	21,845
Alberta	82,637	140,466	211,581	128,976
British Columbia	38,916	252,502	977,456	227,203
TOTAL	<u>1,008,673</u>	<u>4,222,568</u>	<u>6,544,287</u>	<u>3,804,558</u>

c) CANADIAN MANUFACTURERS

There are only two Canadian manufacturers of major components for hydraulic systems. The name and location of these firms appear below.

British Columbia

1. Gearmatic Co. Ltd.
7400, 132nd Street
Surrey, B.C.

Prairies

2. Monarch Machinery Ltd.
889 Erin Street
Winnipeg, Manitoba

Ontario

None

Quebec

None

Maritimes

None

There are more than two hundred (200) manufacturers, usually small machine shops, fabricating cylinders in Canada.

There are more than three hundred (300) distributors of mostly foreign manufactured major components, who fabricate assemblies or systems in Canada.

We estimate at approximately \$1.0 million the value of major components

produced by the above Canadian manufacturers in 1972. Adding this to the Canadian production of cylinders, power units, hose assemblies and couplings as shown on Table 1, we obtain the following breakdown of the estimated total Canadian production in 1972:

1972 CANADIAN PRODUCTION

	Million \$	%
Pumps, valves and motors	1.0	6.6
Cylinders	4.3	28.6
Hose assemblies, couplings and power units	<u>9.7</u>	<u>64.6</u>
T o t a l	<u>15.0</u>	<u>100.0</u>

In recent years, Canadian production has increased at the rate of $7\frac{1}{2}\%$.

Further details on Canadian production is given below.

1) Pumps

The only Canadian manufacturer is Monarch Machinery Ltd., located in Winnipeg. The firm manufactures water pumps and cement mixers, besides a hydraulic pump and valve.

Hydraulic pump: one (1) model only, gear type, 15 gpm capacity, and 1,000 psi pressure.

The main application of their hydraulic pump and valve is for farm machinery.

This firm competes, mainly with U.S. manufacturers, on the basis of manufacturing and selling in the Prairies one model only (15 gpm at 1,000 psi) for farm equipment.

The price is competitive with American sources because they produce on an assembly line basis (they also manufacture water pumps).

Their hydraulic pump has the following characteristics:

- a) mechanically simple;
- b) can be delivered within one week of date of order;
- c) in case of breakdown, parts are from stock.

The major competitors are American because farm equipment requiring hydraulic systems are mainly imported from the United States and the hydraulic pump is already installed on the equipment. The sales of distributors for U.S. pumps in the Prairies are derived from import replacement.

2) Valves

The only Canadian manufacturer is Monarch Machinery Ltd. (see PUMPS). This firm manufactures three control valves: size 3/4", capacity 20 gpm, pressure 2,500 psi.

They are sold mainly for farm equipment on the Prairies. The company has the same competitors in valves as in pumps.

3) Motors

The only Canadian manufacturer is Gearmatic Co. Ltd., located in Surrey, B.C.

This firm, does not market their hydraulic motors as such. The motor they manufacture was designed basically for winches (1,750 to 5,000 psi and 17 to 140 gpm).

However, there are more than sixty-five (65) manufacturers of hydraulic motors in the world. The main competition is from U.S. manufacturers who have distributors throughout Canada.

4) Cylinders

Except for MONARCH MACHINERY, Canadian manufacturers of cylinders do not manufacture major components for hydraulic systems. They are generally small machine shops, manufacturing customized general purpose equipment, and not assembly-line operations.

They are more than two hundred (200) of these manufacturers in Canada.

The raw material they utilize is seamless steel tubing, 2" to 48" in diameter. Canadian manufacturers supply up to 5" in diameter.

The recent growth of the Canadian original equipment market, which requires cylinders in much larger volume than for replacement, may induce some mass-production of cylinders in the future.

5) Systems

Compatible components, supplied by one manufacturer, for a specific hydraulic system, usually provide maximum system efficiency, controllability and durability. They also provide the advantages of a single source responsibility for the performance of the system.

GEARMATIC CO. LTD. is Canadian manufacturer of hydraulic motors for

a specific application. They design the hydraulic system and assemble the major components and auxiliary devices together for an end product called hydraulic winches.

MONARCH MACHINERY LTD. manufacture hydraulic pumps and valves.

They will design a system, but will not necessarily assemble the major components and auxiliary devices in their factory.

Generally, Canadian distributors of hydraulic components do not manufacture auxiliary devices, but they do design and sell complete hydraulic systems. The after-sale service is also given by these distributors.

Major U.S. manufacturers of pumps and valves, who assemble hydraulic systems in Canada are:

- a) Abex Corp.
Montreal, P.Q.
- b) Parker-Hannifin (Canada) Ltd.
Burlington, Ontario
- c) Fluid Power Systems Div.
AMBAC Industries Inc.
Rexdale, Ontario

The hydraulic system industry has experienced a decade of very rapid development in Canada. More than one hundred (100) manufacturers of pumps, from other leading industrial nations, have established distributors in Canada.

IV - PRODUCTION AND COSTS

With regards to major components (pumps, valves, motors) a wide variety of products, and a wide range of models for each product, is offered in Canada by major manufacturers from other industrialized countries. Canadian manufacturers are at a disadvantage in relation to unit costs, because of the relatively small Canadian market, unless they put emphasis on specialty items.

Demand for higher system pressures is increasing, thereby requiring more development. R and D costs can only be spread over a relatively small number of pumps (unless the Canadian manufacturer exports, or imports his know-how from a parent company).

Production methods generally involve the purchase of castings for pumps and valves, and require highly skilled workers to manufacture internal components and machine the castings. Currently, production is taking place in the Vancouver and Winnipeg areas, for specialty items only.

In the assembly of systems and power units, production techniques tend to follow job shop patterns. The major distributors are involved in the production function. Application engineering is a significant part of the system cost, estimated at an average of 10% of the total cost.

Since only major components (pumps, motors and valves) are not assembled locally (in or near the user's plant), transportation is not a significant cost factor.

V - PLANT LOCATION CRITERIA

The two existing component manufacturers are highly specialized, and are located primarily on the basis of their particular markets (tidewater in the case of GEARMATIC and prairie farmland in the case of MONARCH MACHINERY).

The subsidiaries of American component manufacturers, who assemble power units and complete systems, are also located primarily on the basis of original equipment markets (Montreal, Toronto and Hamilton).

Transportation to market is not an important location factor for pump, valve and motor manufacturers. However, a European firm setting up in Canada would likely prefer an Eastern seaboard location to minimize transportation costs of internal components to be assembled in its Canadian plant. In the case of large units, the proximity of a ductile iron foundry would be important.

In the case of assembly operations for power units and/or complete hydraulic systems, proximity to the customer is very important, for service as well as delivery costs.

In all cases, the manufacturer must have a local supply of highly-skilled labour.

VI - OPPORTUNITIES

Opportunities exist in two major fields.

The most deficient sector of the Canadian market appears to be the manufacturing of pumps, valves and motors. We estimate this market at \$13.0 million in value of components, most of which are imported from the United States.

The first opportunity therefore is for the manufacturer of these components in Canada to replace Canadian imports. Because of the diversity of products in this field and the originality of designs, an investor considering such an opportunity should not only consider the relatively limited Canadian major component market, but consider as well:

- the American original equipment market;
- the American after market;
- the specific American original equipment market of industrial products re-exported to Canada.

We feel that securing a basic volume in a few selected component designs to serve anyone of the above markets would be important to provide a base from which production could expand and diversify. The diversity of the Canadian major component market (mostly an after market), would make it extremely difficult to penetrate directly.

The second opportunity is for European manufacturers of patented hydraulic systems and/or industrial pieces of machinery or equipment which include hydraulic systems to set up in Canada to penetrate the Canadian

and the American markets.

Although such an undertaking would initially involve a high proportion of imported components, with only the assembly being done in Canada, it could eventually lead to manufacturing of components in Canada, especially when the patented product finds a market outlet in the United States.

It would appear that Canada would generally be more receptive to a foreign manufacturer of many patented specialized equipment wishing to penetrate the North-American market since, contrary to the U.S., similar products may not yet be available locally. Incentives might thus be provided under existing Canadian programs since an Eastern Seaboard tidewater location would likely be preferred.

