# LOCATION AND INVESTMENT OPPORTUNITIES FOR DIESEL ENGINE MANUFACTURE

(Prepared by D.D. Dogherty)

March 27, 1975

GOVERNMENT OF CANADA

DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

QUEBEC REGION

# LOCATION AND INVESTMENT OPPORTUNITIES FOR DIESEL ENGINE MANUFACTURE

"THE VIEWS EXPRESSED IN THIS REPORT ARE NOT NECESSARILY THOSE OF DREE"

"LES OPINIONS EXPRIMÉES DANS CE RAPPORT NE SONT PAS NÉCESSAIREMENT CELLES DU MEER"

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## INTRODUCTION

This report "Location and Investment Opportunity for Diesel Engine Manufacture" March 27, 1974, was commissioned by the Department of Regional Economic Expansion in order to provide data and background information to support discussions with private sector interests both Canadian and Foreign as to possible opportunity for expanding Diesel Engine manufacturing in Canada in general and in the Quebec region in particular.

The report surveys the present status of the industry in Canada, the degree of import to Canada, the source of such imports.

The report deals with five distinct categories of the Diesel Engine market. The categories deal with distinctly different types of Diesel Engines each with differing technology, economic scales of manufacturing, tariff protection and marketing structure.

The report concludes with specific identification of areas of interest that can be pursued by the Department of Regional Economic Expansion together with the logic and support data leading to the identification of these specific opportunities.

LOCATION AND INVESTMENT OPPORTUNITY - DIESEL ENGINE MANUFACTURING

General Market Categories

Market analysis for all sizes and types of Diesel Engines indicates a total Canadian market for 45,300 engines valued at $227,000,000 in 1973. Serving this market, one Canadian Company only, manufactured Diesel Engines - who manufactured 160 engines in 1973 for a value of $11,000,000 approximately. This represents only a 5% manufacturing content in Canada for this industry.

Diesel Engines are imported into Canada from many industrial countries but the dominant share of imports is from the U.S.A. (60%). U.K. supplies 21% of the Canadian market, West Germany 6% and 13% comes from other countries.

Canada imports approximately one half of market of Diesel Engines as loose engines to be added to equipment built in Canada or for use as replacement engines for equipment already in service.

The remaining half of Diesel Engine imports comes integrated with equipment imported to Canada including engines.

The market for Diesel Engines can be broadly classified into five segments:

Large Marine Engines

Large marine slow-speed 2 stroke crosshead engines 10,000 H.P. and up are used in ships of 40,000 tons and over. Large medium-speed 4 stroke Diesel Engines are used in ships of 10,000 to 20,000 tons size and in ships 20,000 to 40,000 tons size.

Medium Speed Diesel Engines

Diesel Engines operating at 500-1500 rpm with a horse-power range of 1000-8000 H.P. either 2 stroke or 4 stroke find application in Canada for locomotive traction engines, stationary power generators, marine engines, emergency generator sets and for special industrial applications such as large pump and compressor units.

High Speed Industrial Engines

Diesel Engines either 2 stroke or 4 stroke with power ratings between 35-1000 H.P. operating at speed ranges of 500-1500 rpm. These engines have a multitude of applications - small marine engines, construction and logging equipment prime movers, agricultural machine prime movers, stationary and emergency power generators, auxiliary power units and generators, mining equipment, welding machines, pumps, etc.

High Speed Transport Engines

Diesel Engines 2 or 4 stroke between 50-400 H.P. operating at speed ranges of 1800 to 3200 rpm for application as prime movers in trucks and buses. These engines are closely allied to the type of engine used in agriculture and construction crawler and wheel tractors.

Small High Speed Diesel Engines

Diesel Engines operating in the range 1-30 H.P. for use on small vehicles, air compressors, welding machines, boats where smaller engines are required for motive power.

Each of the engine classifications have different marketing characteristics, different manufacturing characteristics and different manufacturing economics of scale.

Manufacturing opportunities for each segment of this market will be examined separately.

STATISTICS
MARKET

Market Statistical Information

Perhaps the most authoritative set of data on Diesel Engine Sales in Canada is the special survey "Diesel and Natural Gas Engine Sales Survey 1973" pp. 63-221 published for the Ministry of Industry, Trade and Commerce, October, 1974 by Statistics Canada.

This survey, however, did not include import machines with the engine already built in.

Various other Canadian data was available including two special surveys conducted by the Department of Industry, Trade and Commerce, Import Analysis, I.A. Div. 35-73 and I.A. Div. 85-74.

In addition, Statistics Canada industry surveys for those industries using Diesel Engines, namely:

Ship Building & Repair 42-206
Motor Vehicle Manufacture 42-209
Construction Machinery & Equipment Sales 63-220
Farm Implement & Equipment Sales 63-203

were useful in that information on Diesel Engine usage in the particular industry was available.

All data was consistent for 1973. From these sources the Canadian data for the exhibit "1973 Analysis Diesel Engines - Canada and U.S.A." was prepared.

The Department of Industry, Trade and Commerce together with Statistics Canada examined the format of Diesel Engine statistical information in 1974. As a result, a new industry reporting format was established. Data from the new reporting structure, however, is not yet available.

On the basis of the analysis all data for Canada for 1973 is believed to be valid. One major assumption, however, had to be made. Import of Diesel Engines for farm tractor use was extracted from Farm Implement and Equipment Sales 63-203. Tractor imports are shown by Diesel H.P. category so that the units of Diesel Engines in tractors is known. Note that Diesel Engines for combines and other self-propelled agriculture equipment would appear in the Diesel Engines (NES) category since engines are imported in loose condition for combine manufacture, Versatile tractors, self-propelled swathers, etc.

In order to determine value of engines in tractors a check of spare engine price vs. complete tractor price was made. The ratio of engine cost to total tractor cost varies with tractor size. Based on this limited data the assumption was made that Diesel Engines compose 25% of the value of complete tractors.

In order to cross-check the validity of the data comparison was made to U.S.A. data. This data for 1973 was derived from the most recent U.S. Department of Commerce-Bureau of the Census data on Internal Combustion Engines 1973 - M.A. 35L (73) - 1 and from the most recent 1972 Census of Manufacturers, U.S. Department of Commerce M.C. - 72 (P) 35A - 2, March, 1974.

Comment on the Canadian - U.S. comparison of data whereby industry groupings and H.P. ranges were aligned as closely as possible, is as follows:

"Road Transport" data from the Canadian "Diesel Engine Sales Survey" does not align well with the U.S.A. automotive diesel category, probably because of a difference in definition.

However, data from the Department of Industry, Trade and Commerce analysis 35-73 under Class 588-04 - Motor Vehicle Engines, Diesel for 1972 indicates:

15,934 engines for a value of $37,517,000

This data aligns better with the U.S.A. 1972 data for Automotive Diesel Engines:

180,036 engines for a value of $632,323,000

It can be assumed therefore that the terminology "Road Transport" in the Canadian 1973 survey is not comparable to the terminology "Automotive" in the U.S.A. data.

Furthermore, U.S.A. data for exports for 1973 shows 17,580 automotive engines exported (probably largly to Canada) at a value of $57,887,000 and 28,173 non-automotive engines exported for a value of $166,048,000. This data tends to confirm the validity of the Class 588-04 Canadian automotive data.

The agriculture Diesel Engine data does not align well with U.S.A. data considering population difference between Canada and the U.S.A. The discrepancy could be explained however by the marked growth in the Canadian market for tractors in 1973 relative to U.S.A.

In conclusion, the data contained in "1973 Analysis of Diesel Engines - Canada and U.S.A." will be used in this report as the basis for market analysis taking into account the above stated qualifications, however.

Data for Country of Origin and for breakdown by power range was also extracted from the above mentioned data and used appropriately for analytic purposes.

# 1973 ANALYSIS DIESEL ENGINES CANADA AND U.S.A.

| | CANADA 1973 (1) | | U. S. A. 1973 (4) | | |
|---|---|---|---|---|---|
| | Units | $ | Units | $ | |
| Road Transport | 5,127 | 57,918,806 | 198,636 | 733,180,000 | |
| Construction Mining & Forestry | 8,097 | 48,186,000 | 130,395) | | |
| Marine | 1,743 | 22,307,000 | 9,083) | 773,876,000 | |
| Agriculture (as reported) | 910 | 3,460,000 | ) | | |
| (3) Agriculture (added) | 24,505 | 50,836,000 | 112,068) | | |
| Others | 4,910 | 44,336,000 | 44,676) | | |
| TOTAL | 45,292 | 227,043,000 | 508,185 | 1,507,056,000 | (5) |

NOTES

(1) 1973 Canadian data from Statistics Canada "Diesel Engine Sales Survey 1973" pp. 63-221

Including
1. Importers specializing in the sale of diesel engines
2. Canadian engine manufacturers
3. Canadian OEM manufacturers who build in imported engines
4. Not included were those companies who import machines not already-built-in.

(2) In 1972, 15,695 engines at a value of $29,217,000 were reported as bare engine imports (Industry, Trade and Commerce Import Analysis).

(3) 24,505 agriculture tractors imported to Canada complete with diesels at a value of $203,344,000 assuming engine cost at 25% of tractor-engine value is $50,836,000.

(4) 1973 Internal Combustion Engines MA 35L (73) - 1.
U.S. Dept. of Commerce

(5) Export content of 1973 U.S.A. shipments of Automotive Diesels were 17,580 units valued at $57,887,000 or 9% of U.S. domestic market.

Export content of 1973 U.S.A. shipments of Non-Automotive Diesels were 28,173 units valued at $166,048,000 or 9% of U.S. domestic market.

## 1973 DIESEL ENGINES - ANALYSIS

### ENGINES BY POWER RANGE U.S. & CANADA

| POWER RANGE | CANADA | | | | U.S. | | | |
|---|---|---|---|---|---|---|---|---|
| | Auto. | Agric. | Indus. | Total | Auto. | Agric. | Indus. | Total |
| 6-50 | | 6298 | 2521 | 8,819 | | | 20,732 | 20,732 |
| 51-100 | | 12930 | 4454 | 17,384 | | 112,008* | 85,720* | 85,720 |
| 100-300 | 5127 | 6897 | 4113 | 16,137 | 198,635 | | 66,456* | 365,092 |
| 300-400 | | | 3570 | 3,570 | | | 18,559 | 18,559 |
| 400-500 | | | 367 | 367 | | | 10,518 | 10,518 |
| 600-700 | | | 163 | 163 | | | 2,414 | 2,414 |
| 700 plus | | | 472 | 472 | | | 5,153 | 5,153 |
| TOTALS | 5,127 | 26,125 | 15,660 | 46,912 | 198,635 | | 309,550 | 508,185 |

*U.S. agriculture engines included in Industrial totals.

# DIESEL ENGINES IMPORTED TO CANADA BY SOURCE

(not including engines installed in equipment)

## Class 502-18 (NES) Industrial Engines

| 1973 | Country of Export | Quantity | Value | % by Value |
|---|---|---|---|---|
| | U. K. | 6,025 | 8,080,000 | 21% |
| | West Germany | 870 | 2,172,000 | 6 |
| | Italy | 74 | 71,000 | |
| | Sweden | 3 | 13,000 | |
| | Japan | 52 | 51,000 | |
| | U. S. A. | 10,110 | 27,370,000 | 72 |
| | TOTAL | 17,163 | 38,003,000 | 100% |

## Class 583-04 Automotive Diesels

| 1972 | Country of Export | Quantity | Value | % by Value |
|---|---|---|---|---|
| | U. K. | 7,141 | 8,617,000 | 30% |
| | Denmark | 2 | 2,000 | - |
| | France | 5 | 7,000 | |
| | West Germany | 865 | 889,000 | 3 |
| | Italy | 81 | 71,000 | |
| | Netherlands | 2 | 5,000 | |
| | Sweden | 12 | 29,000 | |
| | Japan | 8 | 4,000 | |
| | U. S. A. | 7,577 | 19,594,000 | 67 |
| | TOTAL | 15,695 | 29,217,000 | 100% |

## Class 592-27 MARINE ENGINES, DIESEL

| 1973 | Country of Export | Quantity | Value | % of Value |
|---|---|---|---|---|
| | U. K. | 383 | 915,000 | 6 |
| | Denmark | 2 | 1,046,000 | 6 |
| | France | 8 | 1,897,000 | 12 |
| | West Germany | 152 | 1,795,000 | 11 |
| | Italy | 2 | 1,000 | |
| | Netherlands | 2 | 4,000 | |
| | Norway | 45 | 40,000 | |
| | Sweden | 349 | 1,554,000 | 10 |
| | Switzerland | 5 | 11,000 | |
| | Japan | 193 | 214,000 | |
| | U. S. | 1,371 | 8,748,000 | 54 |
| | TOTAL | 2,512 | 16,226,000 | 100 |

LARGE MARINE ENGINES

## Large Medium-Speed Marine Engines

The market for Diesel Engines for marine propulsion indicates two classes of engine appropriate to ships built by Canadian shipyards.

Ships up to 20,000 tons use Diesel Engines of the high speed 1000-8000 H.P. type (similar to locomotive traction engines built by M.L.W.) Ships in the 20,000 to 40,000 ton class use large medium-speed marine Diesel Engines in a H.P. range 10,000-20,000 H.P. The very large slow-speed, 2-stroke engines, "Cathedral Engines" are not appropriate for Canadian built ships.

In March, 1975, the new Shipbuilding Assistance Plan was announced. This revised program acts to put subsidies for Canadian Shipyards on a permanent basis. The new program brings former subsidies for domestic and export vessels to the same rate. The new subsidies will be 14% of audited cost reducing to 8% beginning January, 1976, on a phased basis. In addition, grant assistance for an additional 3% when matched by equal capital investment for modernizing shipyards applies.

Canada has five major shipyards able to construct vessels using medium-speed large Diesel Engines.

St. John Shipbuilding & Dry Dock, Saint John, N.B.
Has a capacity of 4 ships per year in the 20,000-40,000 ton range.

Davie Shipbuilding, Levis, Que.
Has a capacity of 4 ships per year in the 20,000-40,000 ton range.

Canadian Shipbuilding & Engineering Ltd., Collingwood, Ont.
Has a capacity of 1 ship per year in the 20,000-40,000 ton range.

Upper Lake Shipping Ltd., Port Weller, Ont.
Has a capacity of 1 ship per year in the 30,000 ton category.

Marine Industries Ltd., Sorel, Que.
Has a capacity of 4 ships per year in the 20,000 ton range.

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The combined useage of the four companies building 20,000-40,000 ton ships totals 10 ships per year. Given common engine usuage, there would be sufficient market to consider licenced manufacture in Canada of this type of engine. Owners, however, specify engines compatible to present fleets and so complete standardization is problematical.

The exhibit, Medium-Speed Diesel Engine Builders, shows an internationally fragmented market with small volume of construction by many ship building nations.

The manufacturing characteristic for building such engines is general purpose large size machine tools generally associated with shipyard equipment. Such engines are constructed by ship yards in conjunction with ships in many countries. The economic scale of production for such an engine with today's technology is 7-10 engines per year -- a market of $10-$15 million. Such a program however requires stability in the industry. If one Canadian shipyard would produce such an engine for all four users who presently use very similar engines but from different European engine builders, then an opportunity for Canadian manufacture would be economic. This can now be considered, given the capital investment incentive in the new S.T.A.P. program.

The Marine Industries ships use smaller high speed Diesel Engines of the type manufactured by M.L.W. for locomotive traction engines.

The supply of engines to the Marine Industry Program could well be a consideration for M.L.W. , particularly for auxilary power application.

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this category of medium-speed marine Diesels except for Colt Industries licenced program using the French Pielstick PC-2 engine. The model tooled for is now somewhat obsolete. De Laval U.S. also produces an engine suitable for this type of ship.

U.S. built ships have traditionally used steam turbine propulsion for 80% of U.S. built ships in the 20,000-40,000 ton category. This is contrary to practice in the rest of the world where 80% of such ships are Diesel propelled. The U.S. shipbuilding program for the same type of ships now made in Canada is about the same scale as the Canadian industry. Each industry presents a marginal size market for the type of engine in question. It would be logical to produce the appropriate modern engine at one location in North America, to serve both U.S. and Canadian markets.

Ships in this category include Great Lakes dry bulk cargo carriers, roll-on - roll-off container ships, small tankers, O.B.O. (ore-bulk-oil) vessels and ferry ships.

The characteristics of the required modern engine would be high horsepower per cylinder (in the order of 1000 H.P./ cylinder), advanced technology power to weight ratios, ability to burn intermediate ~~maritime grade fuel oil and to maximize fuel economy~~ given the new fuel costs. Present day technology clearly indicates the superiority of Diesel power rather than steam turbine power for the class of ships in the 20,000-40,000 ton range.

The size and quality range appropriate would be the Sulzer-MAN 52/55 engine - an engine more than competitive with present U.S. built engines.

The 40/54 series engine is a medium-speed 4-stroke engine. It is suitable for heavy oil and develops 560 H.P. per cylinder at 430 rpm. The newer 52/55 series also using heavy oil develops 1000 H.P. per cylinder. Vee and in-line models 6-18 cylinder arrangements permit good manufacturing variety with standardized components.

The U.S. Alco engine produces 220 H.P./cylinder. The U.S. De Laval engine produces 677 H.P./cylinder. The British Mirrlees engine 514 H.P./cylinder. Second generation engines have developed more power e.g. the Sulzer 52/55 at 1000 H.P./cylinder, the Sulzer 65/65 at 1600 H.P./cylinder, the Fiat 550SS at 1200 H.P./cylinder and the new versions of the Pielstick engine at 1200 to 1250 H.P./cylinder.

Since the U.S. new shipbuilding program is Government subsidized "Buy America" provisions would normally apply. However, given the market logic and Canadian initiative, the basis for a sound stable engine building program now exists for a North America market.

Canadian Tariff Structure - Large Marine Engines & Diesel Traction Engines

Revenue Canada, Customs & Excise Memorandum D51-15, 27/4/70 states that Diesel or semi-diesel engines 500 B.H.P. to 4000 B.H.P. together with piston displacement 600 cu. ins. to 700 cu. ins. per cylinder are considered to be of a class or kind MADE IN CANADA.

Diesel Engines having piston displacement greater than 700 cu.ins. enter Canada free of duty under Tariff Item 44025-1.

These rulings protect M.L.W. Alco engines under 42815-1 with a 15% tariff for General Motors locomotive engines. No tariff protects the Canadian industry under the British Preferential Tariff from U.K. engines.

However, M.L.W. Alco engines can find application for marine usage but without tariff protection since the small piston displacement limitation which applies to locomotive engines does not apply to the generally larger displacement marine engines, for example:

| | | |
|---|---|---|
| RUSTON ENGINES | 942 cu.in. displacement | not dutiable |
| POLAR ATLAS | 900 | |
| MIRRLEES | 691 | |
| DEUTZ | 649 | dutiable at 15% |
| G.M. | 645 | dutiable at 15% |

Should M.L.W. or a Canadian shipyard, however, decide to enter the marine market with a marine type engine - then it would normally follow that the 15% tariff protection would apply and the piston displacement restriction would be suitably amended.

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## ANALYSIS OF ENGINES IN SHIPS COMPLETED IN 1974

(Vessels of 2000 tons d.w. and above)

| Engine make | No. of ships inst. | No. of engines Built by licensor | Built by licensees | Total | BHP | % World total |
|---|---|---|---|---|---|---|
| Sulzer | 287 | 18 | 286 | 304 | 3952 950 | 40 |
| B. and W. | 172 | 20 | 168 | 188 | 2455 220 | 25 |
| M. A. N. | 66 | 17 | 61 | 78 | 1078 490 | 11 |
| Pielstick | 53 | - | 79 | 79 | 595 780 | 6 |
| Mitsubishi | 79 | 37 | 44 | 81 | 482 450 | 5 |
| G. M. T. | 23 | 24 | 14 | 38 | 265 140 | 3 |
| Gotaverken | 9 | 7 | 2 | 9 | 138 750 | 1 |
| SWD | 18 | 19 | 9 | 28 | 132 100 | 1 |
| MaK | 32 | 41 | - | 41 | 129 320 | 1 |
| Hanshin | 25 | 25 | - | 25 | 93 400) | |
| Deutz | 18 | 14 | 9 | 23 | 67 020) | |
| Doxford | 3 | 3 | - | 3 | 50 000) | |
| Nohab | 11 | 16 | 6 | 22 | 48 540) | |
| Smit-Bolnes | 8 | 13 | - | 13 | 40 950) | |
| General Electric | 2 | 1 | 1 | 2 | 39 000) | |
| Ito | 5 | 5 | - | 5 | 33 500) | |
| Normo | 9 | 18 | - | 18 | 29 730) | |
| Daihatsu | 10 | 20 | - | 20 | 29 160) | |
| Akasaka | 6 | 7 | - | 7 | 22 000) | |
| Niigata | 2 | 3 | - | 3 | 20 000) | |
| General Motors | 3 | 6 | - | 6 | 18 760) | |
| Enterprise | 1 | 2 | - | 2 | 18 400) | |
| Ruston | 2 | 5 | - | 5 | 17 000) | |
| MWM | 5 | 6 | - | 6 | 14 300) | |
| Makita | 6 | 6 | - | 6 | 14 300) | 7 |
| Fairbanks-Morse | 2 | 4 | - | 4 | 10 800) | |
| S. A. C. M. | 1 | 2 | - | 2 | 7 000) | |
| Crepelle | 1 | 2 | - | 2 | 6 000) | |
| Ruskij | 1 | 1 | - | 1 | 6 000) | |
| Alco | 1 | 2 | - | 2 | 5 500) | |
| Mirrlees-Blackstone | 2 | 2 | - | 2 | 5 400) | |
| SKL | 3 | 4 | - | 4 | 5 280) | |
| Wartsila | 2 | 9 | - | 9 | 9 750) | |
| English Electric | 1 | 2 | - | 2 | 4 670) | |
| Caterpillar | 2 | 6 | - | 6 | 4 320) | |
| Brons | 3 | 3 | - | 3 | 4 200) | |
| Dvigatelj Revolucii | 2 | 4 | - | 4 | 3 600) | |
| Wichmann | 1 | 2 | - | 2 | 3 500) | |
| Allen | 1 | 1 | - | 1 | 2 800) | |
| TOTALS | 878 | 376 | 678 | 1,054 | 9865 080 | |

Figures as given in "The Motor Ship", January 1975

MEDIUM SPEED

## Medium-Speed Diesel Engines 1000-8000 H.P.

This category of engines finds application in locomotive traction engines, marine engines, including small cargo ships, tug boats, ferries and fishing vessels, off-shore supply ships, oil rigs, government vessels, stationary power plants and large emergency power generating units.

Technological development of this type of engine can be illustrated by the example of the history of the development of the horsepower per cylinder of a typical traction engine with 177 mm. bore and equal piston displacement.

In 1950 naturally aspirated 4 stroke engine compression ratio 6.5 giving 50 H.P. per cylinder.

In 1952 low pressure supercharging of intake air, compression ratio 8.2 giving 62.5 H.P. per cylinder. Degree of supercharging 1.5

In 1960 high pressure supercharging compression ratio 9. giving 68.7 H.P. per cylinder. Degree of supercharging 1.7

Then high pressure supercharging with intercooling compression ratio 10.1 giving 77 H.P. per cylinder. Degree of supercharging 1.9

In 1972 high pressure supercharging, intercooling, piston cooling, heat recovery turbine compression (turbo compressor) ratio 13.1 giving 100 H.P. per cylinder.

Modern traction engines have moved from 50 H.P. per cylinder to 350 H.P. per cylinder in today's most efficient engine.

## Traction Engine Application

There is a steady market for locomotive traction Diesel Engines - 400 per year in Canada. This market is split - 40% M.L.W. and 60% G.M. Diesel. General Motors imports the engine from U.S. and incorporates it in Canadian built locomotives. G.M. import engine value is estimated at $20 million per year and no spares parts business results for Canada with the engine.

has developed a large export market so that present production is at plant capacity at 15 locomotives and engines per month. Present order backlog is at s record high of $100,000,000 representing 1½ years of business.

The result of traction engine technical development is that for the same engine profile (restricted frontal area and length) traction locomotive power has increased from 2000 H.P. in 1960 to 4000 H.P. in 1975 with power output of 19.6 H.P. per litre of piston displacement. Future development points to the feasibility of a 5000 H.P. locomotive.

Concurrent with development in power to weight ratio improvement in thermal efficiency and fuel consumption results in the Diesel Engine having the best thermal efficiency as compared with steam, gasoline or turbine engines.

The Diesel traction engine must, however, compete with electric traction engines. Electric engines are superior in power to weight characteristics in that the motor does not carry its own fuel. One electric locomotive can pull twice the load (2000 tons) as today's Diesel (1000 tons) for the same locomotive profile.

Electric engines in Europe, where high traffic density can support the high fixed cost of the electric distribution infrastructure, are economic to the extent of about 50% of locomotives being Diesel and 50% electric.

In the U.S.A., some 1500 miles of electric railway was installed in the most dense U.S. traffic route structure. The development of diesel economics relative to even the highest density North American routes has resulted in complete displacement of electric locomotives. The Canadian market for Diesel traction locomotives is now only challenged by the limited market for gas turbine engine locomotives for special high speed, high density passenger routes.

Power Generation Diesel Engines

The use of Diesel engines used to drive an electric generator provides electric power either on a continuous basis or for emergency power requirements for hospitals, large public buildings and industrial plants to provide for intermittent failure of the normal electric power distribution grid fed by steam turbine, hydro or nuclear power sources.

For continuous power generating requirements there is a considerable market in Canada for generating stations providing 1000 KW - 6500 KW of power driven by Diesel Engines of 1500 H.P. to 9000 H.P. This requirement results from the large number of towns, mines, factories in remote areas of Canada off the power distribution grid system. This market is growing in Arctic development north of the 60th parallel. Transportation economics and restrictions tend to limit maximum size of an installation unit to 2550 KW or 4000 H.P.

The development, design, fuel usage and thermal efficiency are similar to the traction engine.

For continuous diesel generating units, sophisticated development maximizing thermal efficiency at consequently high initial capital cost is economic.

For emergency service, however, gas turbine technology development results in lower capital cost, smaller space requirement at the expense of thermal efficiency. Old Diesel Engines, such as the Mirrlees J type, with low first cost for diesel equipment but with low thermal efficiency and higher fuel cost, is an alternate consideration to high efficiency, more expensive diesels or gas turbines.

British Columbia Power has some 350 diesel engine generating sets in use. Quebec Hydro recently asked for bids for 20 - 3000 KW or 4000 HP units.

Gas and Oil Pipelines

A further market potential for medium-speed diesels - the market for gas and oil pipeline requirements is considered. Present 30" gas pipelines in Canada use first generation gas turbines 12,500 - 30,000 H.P. fuelled from the gas in the pipeline. Such engines at thermal efficiencies of 23% use up to 10% of pipeline gas for the pumping operation.

Gas turbines are manufactured in Canada by Orenda & Rolls Royce. United Aircraft, Canada, supplies gas turbines for auxiliary use. Gas driven centrifugal compressor units of 30,000 HP are also used, but with no Canadian manufacturing content.

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The market is limited and equipment is not close enough to diesel design to warrent Canadian manufacture.

Second generation gas turbines with improved thermal efficiency (to 30%) and with lower capital cost will be used for future gas pipelines and for replacement. This should result in a reduction to 6% of gas used for pumping purposes. Auxiliary power generators used are of the small high-speed 800 H.P. Diesel type or gas fuelled. Modern Diesel engines operate at 40% Thermal efficiency.

For oil pipelines, north of $60^{\circ}$ latitude there is an application for medium-speed Diesels for generating sets at 40 to 50 mile intervals to supply pumping power and pumping station auxiliary power. Some 100 units can be expected to arise from a 48" Canadian MacKenzie Valley Arctic pipeline (4 units per station). These units would be 2550 KW or 4000 H.P. Oil pipelines south of $60^{\circ}$ latitude will use 12,500 H.P. gas turbines.

Marine Engine Applications

Marine Industries program of four ships per year of the 17,000 ton dry cargo type use diesel engines in the same size range as a traction engine - the SEMT Pielstick.

The M.L.W. Alco engine has been used for an icebreaker for diesel-electric application.

Ferry boats, ocean-going tug boats use traction locomotive sized medium-speed Diesels.

Other Applications - large size compressor units are diesel powered. Usage in Canada is rare, however.

Market Summary - M.L.W. estimate that some 300 such medium-speed engines (over and above traction locomotive requirement) will be required in the Canadian domestic market in the period 1974-1980 or some 50 engines per year.

Tariff - Medium-Speed Engines 1000-8000 B.H.P.

The Revenue Canada, Customs and Excise Memorandum D 51-15, September 20, 1974, rule such engines providing piston displacement lies between 600 and 700 cu. in. per cylinder protects the M.L.W. Alco engine as a class and kind MADE IN CANADA and tariff item 42815-1 applies (see also Tariff - Large Medium-Speed Engines).

Note that the present piston displacement regulation does not provide protection now for many applications of the M.L.W. Alco engine for other than locomotive use e.g. power plant and marine applications.

Revenue Canada
Customs and Excise

Revenu Canada
Douanes et Accise

# MEMORANDUM D51-15

Ottawa, September 20, 1974

## "MADE IN CANADA" RULINGS

Reprinted from D51-15-3, 27/4/70, file 86550 GE41-14

**Diesel or semi-diesel engines** having a continuous rated brake horsepower within the range of 500 BHP to 4000 BHP, inclusive, together with a piston displacement of from 600 cubic inches per cylinder to 700 cubic inches per cylinder, inclusive, are considered to be of a class or kind **made in Canada**, effective 28th May 1970.

**Notes:** 1. Diesel or semi-diesel engines having a continuous rated brake horsepower within the range of 500 BHP to 2720 BHP, inclusive, together with a piston displacement of from 600 cubic inches per cylinder, to 700 cubic inches per cylinder, inclusive, are already ruled to be of a class or kind **made in Canada**, effective 2nd October 1964.

2. Diesel or semi-diesel engines having a piston displacement of less than 600 cubic inches, per cylinder, or more than 700 cubic inches per cylinder, are considered to be of a class or kind **not made in Canada**, effective 27th April 1970.

3. To determine the piston displacement of a cylinder when given the bore and stroke, the following formula may be used:

$$(\frac{\text{Bore}}{2})^2 \times \frac{22}{7} \times \text{stroke} = \text{Piston Displacement}$$

4. The following information is to be shown on the Customs invoices:

*(a)* Continuous rated brake horsepower;

*(b)* Cubic inch displacement per cylinder, or bore and stroke of the piston.

Reprinted from D51MCR89, 20/11/48

**Pyrometer sets**, especially designed for diesel or semi-diesel engines, consisting of a selector switch, temperature dial and one or more thermocouples, have been transferred from the category of a class or kind not made in Canada to that of a class or kind **made in Canada.**

Ottawa, le 20 septembre 1974

## DÉCISIONS RELATIVES AUX "ARTICLES FAITS AU CANADA"

Réimpression du D51-15-3, 27/4/70, dossier 86550 GE41-14

Conformément aux dispositions du *Tarif des douanes*, **les moteurs diesel ou semi-diesel** ayant une puissance nominale continue au frein variant de 500 BHP à 4,000 BHP, inclusivement, ainsi qu'une cylindrée allant de 600 pouces cubes par cylindre à 700 pouces cubes par cylindre, inclusivement, sont considérés comme étant d'une classe ou d'une espèce faite au Canada, à compter du 28 mai 1970.

**Notes:** 1. Les moteurs diesel ou semi-diesel ayant une puissance nominale continue au frein variant de 500 BHP à 2,720 BHP, inclusivement, ainsi qu'une cylindrée allant de 600 pouces cubes par cylindre à 700 pouces cubes par cylindre, inclusivement, ont déjà été jugés être d'une classe ou d'une espèce **faite au Canada**, à compter du 2 octobre 1964.

2. Les moteurs diesel ou semi-diesel ayant une cylindrée de moins de 600 pouces cubes, par cylindre, ou plus de 700 pouces cubes, par cylindre, sont considérés comme étant d'une classe ou d'une espèce **non faite au Canada**, à compter du 27 avril 1970.

3. Pour déterminer la cylindrée d'un cylindre lorsqu'on connaît l'alésage et la course, on peut se servir de la formule suivante:

$$(\frac{\text{Alésage}}{2})^2 \times \frac{22}{7} \times \text{course} = \text{Cylindrée}$$

4. Les renseignements suivants doivent figurer sur les factures douanières:

*a)* Puissance nominale continue au frein;

*b)* Cylindrée en pouces cubes par cylindre, ou alésage et course du piston.

Réimpression du D51MCR89, 20/11/48

Les **pyromètres** destinés surtout aux moteurs Diesel ou semi-Diesel et comprenant un commutateur à plusieurs positions, un cadran pour la température et un thermo-couple ou plus, sont transférés de la catégorie des articles d'une classe ou d'une espèce non faite au Canada à celle des articles d'une classe ou d'une espèce **faite au Canada.**

. . .2

Reprinted from D51MCR100, 10/11/49

Diesel electric switching locomotives weighing over 95 tons have been transferred from the category of a class or kind not made in Canada to that of a class or kind made in Canada.

Reprinted from D51-15-1, 3/2/60, file 86550 GL 96-4

Diesel Mechanical, diesel electric and diesel hydraulic locomotives, weighing from 15 tons to 95 tons, inclusive, have been transferred from the category of a class or kind not made in Canada to that of a class or kind made in Canada.

Note: Diesel electric switching locomotives weighing over 95 tons have previously been ruled of a class or kind made in Canada.

Reprinted from D51-15, 11/5/60, file 86550 GL 96-5

Flameproof diesel underground mining locomotives, weighing up to and including 17 tons (34,000 pounds), are considered to be of a class or kind not made in Canada, effective 11th May 1960.

Note: This ruling supersedes, in part, the ruling contained in Memorandum D51-15-1, 3/2/60, file 86550-GL-96-4.

Reprinted from D51-42, 31/12/58, file 86550 GS 286

Locomotive stokers, type BK were transferred from the category of a class or kind made in Canada to that of a class or kind not made in Canada, effective 31st December 1958.

Note: All other types of locomotive stokers are presently ruled as a class or kind not made in Canada.

Reprinted from D51MCR115, 15/2/51, file 180386, Decision of the Tariff Board, at the Sitting on the 20th September 1933 Appeal 18

In the matter of the appeal by Bret. Pliske, Toronto, that the aircraft known as "Aeronca C-3" be held to be of a class or kind not made in Canada.

Ruling on the 30th October 1933: "Appeal dismissed".

Réimpression du D51MCR100, 10/11/49

Les locomotives de manoeuvre électriques Diesel pesant plus de 95 tonnes sont transférées de la catégorie des articles d'une classe ou d'une espèce non faite au Canada à celle des articles d'une classe ou d'une espèce faite au Canada.

Réimpression du D51-15-1, 3/2/60, dossier 86550 GL 96-4

Les locomotives Diesel mécaniques, électriques et hydrauliques, pesant de 15 tonnes à 95 tonnes inclusivement, sont transférées de la catégorie des articles d'une classe ou d'une espèce non faite au Canada à celle des articles d'une classe ou d'une espèce faite au Canada.

Note: Les locomotives de manoeuvre électriques Diesel pesant plus de 95 tonnes ont déjà été jugées être des articles d'une classe ou d'une espèce faite au Canada.

Réimpression du D51-15, 11/5/60, dossier 86550 GL 96-5

Les locomotives Diesel antidéflagrantes pour chantiers souterrains, pesant jusqu'à 17 tonnes (34,000 livres) inclusivement, sont considérées comme étant des articles d'une classe ou d'une espèce non faite au Canada, à compter du 11 mai 1960.

Note: La présente décision remplace en partie la décision contenue dans le mémorandum D51-15-1, 3/2/60, dossier 86550 GL 96-4.

Réimpression du D51-42, 31/12/58, dossier 86550 GS 286

Les foyers mécaniques pour locomotives, du type BK, sont transférés de la catégorie des articles d'une classe ou d'une espèce faite au Canada à celle des articles d'une classe ou d'une espèce non faite au Canada, depuis le 31 décembre 1958.

Note: Tous les autres types de foyers mécaniques pour locomotives sont actuellement jugés être des articles d'une classe ou d'une espèce non faite au Canada.

Réimpression du D51MCR115, 15/2/51, dossier 180386, décision de la Commission du tarif, séance du 20 septembre 1933, appel 18

Appel interjeté par la Bret. Pliske, de Toronto, portant que l'avion connu sous le nom de "Aeronca C-3" devrait être considéré comme étant d'une classe ou d'une espèce non faite au Canada.

Décision du 30 octobre 1933: "Appel rejeté".

Reprinted from D51-15-1, 12/9/67, file 86550 GA 27-5

Fixed high wing fixed undercarriage single engine aircraft having a gross weight of from 2701 pounds to 3300 pounds, inclusive, as covered by the Certificate of Airworthiness issued by the Department of Transport, have been transferred from the category of types and sizes made in Canada to that of types or sizes **not made in Canada**, effective 12th September, 1967.

Reprinted from D51-15-1, 18/12/68, file 86550 GA27-5

Single engine fixed wing aircraft, for civilian use, having a gross weight of from 5501 pounds to 8000 pounds, inclusive, as covered by the Certificate of Airworthiness issued by the Department of Transport, have been transferred from the category of types and sizes made in Canada to that of types or sizes **not made in Canada**, effective 18th December 1968.

Reprinted from D51-15-2, 25/8/69, file 86550 GA27-5

Single engine fixed wing aircraft, for civilian use, having a gross weight of from 4500 pounds to 5500 pounds, inclusive, as covered by the Certificate of Airworthiness issued by the Department of Transport, are being transferred from the category of types and sizes made in Canada to that of types or sizes **not made in Canada**, effective 25th August 1969.

**Note:** The effect of this Ruling is that all aircraft are presently ruled of types or sizes not made in Canada.

Réimpression du D51-15-1, 12/9/67, dossier 86550 GA 27-5

Les aéronefs monomoteurs à ailes surélevées fixes et à train d'atterrissage fixe, ayant un poids brut de 2701 à 3300 livres inclusivement et visés par le certificat de navigabilité délivré par le ministère des Transports, sont transférés de la catégorie des modèles et formats faits au Canada à celle des modèles et formats **non faits au Canada**, à compter du 12 septembre 1967.

Réimpression du D51-15-1, 18/12/68, dossier 86550 GA 27-5

Conformément aux dispositions du Tarif des douanes, les aéronefs monomoteurs à ailes fixes, à l'usage des civils, ayant un poids brut de 5,501 à 8,000 livres incluses, visés par le Certificat de navigabilité délivré par le ministère des Transports, sont transférés de la catégorie des modèles et formats faits au Canada à celle des modèles et formats **non faits au Canada**, à compter du 18 décembre 1968.

Réimpression du D51-15-2, 25/8/69, dossier 86550 GA 27-5

Conformément aux dispositions du Tarif des douanes, les aéronefs monomoteurs à ailes fixes, à l'usage des civils, ayant un poids brut de 4,500 à 5,500 livres incluses, visés par le Certificat de navigabilité délivré par le ministère des Transports, sont transférés de la catégorie des modèles et formats faits au Canada à celle des modèles et formats **non faits au Canada**, à compter du 25 août 1969.

**Note:** Par suite à cette décision, tous les aéronefs sont présentement réputés être des aéronefs de modèles et formats non faits au Canada.

*Le Sous-ministre du Revenu national,*
*Douanes et Accise.*

G.L. Bennett,
*Deputy Minister of National Revenue,*
*Customs and Excise.*

* Memoranda D51-15, May 24, 1968; D51-15-1, December 18, 1968; D51-15-2, August 25, 1969 and D51-15-3, April 27, 1970 are consolidated.

Codification des mémorandums D51-15, 24 mai 1968, D51-15-1, 18 décembre 1968, D51-15-2, 25 août 1969 et D51-15-3, 27 avril 1970.



INFORMATION CANADA, 1974.

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| 42777-1 | Engines, axles, torque converters, differentials, transmissions, and parts thereof, for use in the manufacture of self-propelled machines commonly known as compactors, street or road rollers, vibratory rollers and pneumatic tired rollers ..... *(Expires February 28, 1977)* | Free | Free | 10 p.c. | | O.C. 13/7/71, D47-515,515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42800-1 | Traction engines and complete parts thereof, n.o.p. ..... | Free | 15 p.c. | 25 p.c. | | 17/9/30, 352-A |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42805-1 ■ | Engines or boilers and complete parts thereof, n.o.p. ..... | 15 p.c. | 15 p.c. | 30 p.c. | | 4/6/69, D47-492 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | 10 p.c. | 1/7/74, D47-518-1 |
| 42810-1 ■ | Magnetos and complete parts thereof, when imported by manufacturers of internal combustion engines, for use exclusively in the manufacture of such internal combustion engines, in their own factories ..... | Free | 10 p.c. | 15 p.c. | | 22/3/33, 631-B |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42815-1 ■ | Diesel and semi-diesel engines, and complete parts thereof, n.o.p. ..... | Free | 15 p.c. | 30 p.c. | | 4/6/69, D47-492 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |

SCHEDULE "A"

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| 42817-1 | Diesel and semi-diesel engines of 500 horsepower or less, and complete parts thereof, n.o.p. | Free | 15 p.c. | 30 p.c. | | 4/6/69, D47-492 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 42820-1 ■ | Air-cooled internal combustion engines of not greater than 1½ h.p. rating, and complete parts thereof | Free | 15 p.c. | 30 p.c. | | 4/6/69, D47-492 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 42825-1 ■ | Starter cartridges, fuel injection pumps and nozzles, and parts thereof, for diesel and semi-diesel engines | Free | Free | Free | | 21/3/56, D47-395(R) |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 42830-1 ■ | Diesel and semi-diesel engines, torque converters and hydraulic couplings, and parts thereof, for use in the manufacture of rotary air compressors, power shovels, power cranes, backhoes, graders or scrapers and snowblowers *(Expires February 28, 1977)* | Free | Free | 30 p.c. | | O.C. 13/7/71, D47-515,515-10 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 42835-1 | Governors, n.o.p., and parts thereof, for use in the manufacture or repair of diesel locomotives | Free | 7½ p.c. | 30 p.c. | | 4/6/69, D47-492 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| • 42840-1 | Reciprocating natural gas engines, of a class or kind not made in Canada, for use in the manufacture of self-contained compressors *(Expires October 31, 1977)* | Free | Free | 30 p.c. | | O.C. 13/7/71, D47-515,515-26 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |

• Revised October 22, 1974

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| • 42845-1 | Gasoline internal combustion engines with a displacement of more than 500 cubic inches and air-cooled gasoline internal combustion engines with a displacement of less than 200 cubic inches, for use in the manufacture of snowblowers ..... *(Expires October 31, 1976)* | Free | Free | 30 p.c. | | O.C.13/7/71, D47-515,515-26 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42855-1 | Diesel engines and gasoline internal combustion engines with a displacement of 400 cubic inches or more, for use in the manufacture of airport sweepers..... *(Expires February 28, 1976)* | Free | Free | 30 p.c. | | O.C. 26/2/74, D47-515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42860-1 | Diesel engines and parts thereof for use in the manufacture of asphalt road finishing machines ..... *(Expires February 28, 1976)* | Free | Free | 30 p.c. | | O.C. 13/7/71, D47-515,515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42865-1 | Diesel and semi-diesel engines;<br>Diesel dual fuel engines;<br>L.P.G. engines;<br>Gasoline internal combustion engines;<br>Reciprocating natural gas engines;<br>When of a class or kind not made in Canada; parts thereof; all of the foregoing for use in the manufacture of electricity generating sets consisting essentially of an internal combustion engine and one or more generators mounted on a common base ..... *(Expires February 28, 1977)* | Free | Free | 30 p.c. | | O.C. 26/2/74, D47-515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| 42870-1 | Gas turbines of 1500 horsepower or less, for use in the manufacture of electricity generating sets consisting essentially of an internal combustion engine and one or more generators mounted on a common base ..... *(Expires June 30, 1975)* | Free | Free | 30 p.c. | | O.C. 13/7/71, D47-515,515-23 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42875-1 | Gasoline internal combustion, water-cooled engines, of types or sizes not made in Canada, for use in the manufacture of portable air compressors and transit concrete mixers ..... *(Expires October 31, 1975)* | Free | Free | 30 p.c. | | O.C. 13/7/71, D47-515,515-19 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42880-1 | Diesel engines, of a class or kind not made in Canada; Gasoline internal combustion engines, air-cooled, four cycle, not greater than nine horsepower; For use in the manufacture of plate type vibratory compactors ..... *(Expires February 28, 1976)* | Free | Free | 30 p.c. | | O.C. 30/1/73, D47-515-11,515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |
| 42885-1 | Diesel engines, of a class or kind not made in Canada, for use in the manufacture of portable crushing plants, portable screening plants or combinations thereof ..... *(Expires February 28, 1976)* | Free | Free | 30 p.c. | | O.C. 30/1/73, D47-515-11,515-21 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | --- | | | Free | 1/7/74, D47-518-1 |
| 42890-1 | Gasoline internal combustion engines, air-cooled, four cycle, not greater than thirty horsepower, for use in the manufacture of air compressor sets ..... *(Expires June 30, 1976)* | Free | Free | 30 p.c. | | O.C. 29/5/73, D47-515-13,515-23 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* ..... | | | | Free | 1/7/74, D47-518-1 |

* Amended July 2, 1974

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| 44022-1 | Manufactures of iron, brass or other metal, of a class or kind not made in Canada, for use exclusively in the construction or equipment of ships or vessels, under regulations prescribed by the Minister | Free | Free | Free | | 1/6/50, D47-302(R) |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 44025-1 | Diesel and semi-diesel engines, of a class or kind not made in Canada, and complete parts thereof, for use exclusively in the construction or equipment of ships or vessels | Free | Free | Free | | 1/6/50, D47-302(R) |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 44028-1 | Chronometers and compasses, and parts thereof, including cards therefor, of a class or kind not made in Canada, for ships or aircraft | Free | Free | Free | | 2/5/30, 310-B |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 44031-1 | The following articles and materials when imported for use only in the manufacture, maintenance or repair of buoys and beacons for the Government of Canada, viz.: Flanged and dished steel boiler plate heads over five feet in diameter; lanterns and electric flashing lights; fog horn and other warning equipment; marine radio beacon timing equipment; actuating equipment, including low discharge storage batteries and motors; parts of all the foregoing | Free | Free | Free | | 7/4/54, D47-376(R) |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |

| Tariff Items | Goods Subject to Duty and Free Goods | British Preferential Tariff | Most-Favoured-Nation Tariff | General Tariff | General Preferential Tariff | Effective Date No. of Memo |
|---|---|---|---|---|---|---|
| 44200-1 ■ | Articles and materials which enter into the cost of manufacture of the goods enumerated in tariff items 40900-1, 40902-1, 40904-1, 40906-1, 40908-1, 40910-1, 40912-1, 40914-1, 40916-1, 40918-1, 40920-1, 40922-1, 40924-1, 40926-1, 40928-1, 40930-1, 40932-1, 40934-1, 40936-1, 40938-1, 40940-1, 40942-1, 40944-1, 40948-1, 40950-1, 40956-1, 42723-1, 43915-1 and 61810-1, when imported for use in the manufacture of the goods enumerated in the aforesaid tariff items, or in the manufacture of parts therefor, under such regulations as the Minister may prescribe | Free | Free | Free | | 21/3/56, D47-395(R) |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 44205-1 | Materials, including all parts, wholly or in chief part of metal, of a class or kind not made in Canada, when imported for use in the manufacture of goods entitled to entry under tariff items 41100-1, 41105-1, 41110-1, 42723-1, 42726-1, 42729-1, 42732-1, 42733-1, 42741-1, 42805-1, 42815-1, 42817-1, 44037-1, 44040-1, and 44705-1, under such regulations as the Minister may prescribe | Free | Free | 10 p.c. | | 1/1/68, D47-482 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |
| 44210-1 | Rotors, blade diaphragms, spindle discs, shafts and blades, wholly or in chief part of metal, of a class or kind not made in Canada, when imported for use by turbine manufacturers in the repair or remanufacture of gas or steam turbines and parts thereof entitled to entry under tariff item 42805-1 | Free | Free | Free | | 19/6/71, D47-513 |
| | *G.P.T. rate from 1/7/74 to 30/6/84* | | | | Free | 1/7/74, D47-518-1 |

| Item | Stat. Suf-fix | Articles | Units of Quantity | Rates of Duty 1 | Rates of Duty 2 |
|---|---|---|---|---|---|
| 660.15 | 00 | Economizers, superheaters, soot removers, gas recoverers, and auxiliary plants for use with steam and other vapor generating boilers; condensers for vapor engines and power units; all of the foregoing and parts thereof | X | 7% ad val. | 45% ad val. |
| | | Producer gas and water gas generators, with or without purifiers; acetylene gas generators (water process) and other gas generators, with or without purifiers; all the foregoing and parts thereof: | | | |
| 660.20 | 00 | Apparatus for the generation of acetylene gas from calcium carbide, and parts thereof | X | 4% ad val. | 20% ad val. |
| 660.22 | 00 | Other | X | 7% ad val. | 45% ad val. |
| | | Steam engines, steam turbines, and other vapor power units, and parts thereof: | | | |
| 660.25 | 00 | Steam engines and parts thereof | X | 4% ad val. | 15% ad val. |
| 660.30 | | Steam turbines and parts thereof | | 7.5% ad val. | 20% ad val. |
| | 20 | *Steam turbines* | *No.* | | |
| | 40 | *Parts* | *X* | | |
| 660.35 | 00 | Other | X | 4.5% ad val. | 27.5% ad val. |
| | | Internal combustion engines and parts thereof: | | | |
| | | Piston-type engines: | | | |
| 660.40 | 00 | To be installed in tractors of a type provided for in item 692.30 or in agricultural or horticultural machinery or implements provided for in item 666.00 | No | Free | Free |
| | | Other: | | | |
| 660.42 | 00 | Compression-ignition engines | No | 5% ad val. | 35% ad val. |
| 660.43 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | No | Free | |
| 660.44 | | Engines other than compression-ignition engines | | 4% ad val. | 35% ad val. |
| | | *Specially designed for:* | | | |
| | 15 | *Aircraft* | *No.* | | |
| | 30 | *Automobile (including truck and bus)* | *No.* | | |
| | | *Other:* | | | |
| | 40 | *Outboard motors for marine craft* | *No.* | | |
| | 60 | *Other* | *No.* | | |
| 660.45 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | No | Free | |
| 660.46 | | Non-piston type engines | | 5% ad val. | 35% ad val. |
| | | *Aircraft:* | | | |
| | 20 | *Turbo-jet and gas turbine, new* | *No.* | | |
| | 40 | *Other* | *No.* | | |
| | 60 | *Other* | *No.* | | |
| 660.47 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | No | Free | |
| | | Parts: | | | |
| 660.50 | 00 | Cast-iron (except malleable cast-iron) parts, not alloyed and not advanced beyond cleaning, and machined only for the removal of fins, gates, sprues, and risers or to permit location in finishing machinery | Lb | Free | 10% ad val. |
| 660.51 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | Lb | Free | |

| Item | Stat. Suffix | Articles | Units of Quantity | Rates of Duty 1 | Rates of Duty 2 |
|---|---|---|---|---|---|
| | | Internal combustion engines and parts thereof (con.): | | | |
| | | Parts (con.): | | | |
| | | Other parts: | | | |
| 660.52 | 00 | Parts of piston-type engines other than compression-ignition engines | X | 4% ad val. | 35% ad val. |
| 660.53 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |
| 660.54 | 00 | Other | X | 5% ad val. | 35% ad val. |
| 660.55 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |
| | | Water wheels, water turbines, and other water engines, and parts including governors therefor: | | | |
| 660.65 | 00 | Governors | No | $1.12 each + 17.5% ad val. | $4.50 each + 65% ad val. |
| 660.70 | | Other | | 7.5% ad val. | 27.5% ad val. |
| | 20 | *Water wheels, water turbines, and other water engines* | No. | | |
| | 40 | *Parts* | X | | |
| | | Non-electric engines and motors not specially provided for, and parts thereof: | | | |
| 660.75 | 00 | Hydrojet engines for motor boats, and parts thereof | X | 6% ad val. | 30% ad val. |
| 660.80 | 00 | Spring-operated and weight-operated motors | No | 10% ad val. | 35% ad val. |
| 660.85 | 00 | Other | X | 4.5% ad val. | 27.5% ad val. |
| 660.86 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |
| | | Pumps for liquids, whether or not fitted with measuring devices; liquid elevators of bucket, chain, screw, band, and similar types; all the foregoing whether operated by hand or by any kind of power unit, and parts thereof: | | | |
| 660.92 | 00 | Fuel injection pumps for compression-ignition engines, and parts thereof | X | 3% ad val. | 35% ad val. |
| 660.93 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |
| 660.94 | | Other | | 5% ad val. | 35% ad val. |
| | 20 | *Submersible pumps* | No. | | |
| | 40 | *Other (except parts)* | No. | | |
| | 60 | *Parts* | X | | |
| 660.95 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |
| | | Air pumps, vacuum pumps and air or gas compressors (including free-piston compressors for gas turbines); fans and blowers; all the foregoing, whether operated by hand or by any kind of power unit, and parts thereof: | | | |
| | | Fans and blowers, and parts thereof: | | | |
| 661.09 | 00 | Blowers for pipe organs | No | 5% ad val. | 35% ad val. |
| 661.10 | | Other | | 7% ad val. | 35% ad val. |
| | 10 | *Electric fans, other than for permanent installation* | No. | | |
| | 50 | *Other, including parts of the foregoing* | X | | |
| 661.11 | 00 | If Canadian article and original motor-vehicle equipment (see headnote 2, part 6B, schedule 6) | X | Free | |

Manufacturing Technology

Plant required for medium-speed Diesel Engine manufacturing is indicated by examples of present day plant size and product output.

M.L.W. devotes some 250,000 Sq. Ft. of floor space for a capacity of 15 Alco engines per month or 180 per year. White Motors, Auburn, N.Y. also builds the Alco engine in a 730,000 Sq. Ft. plant.

The Alco engine was first manufactured in Canada at Dominion Engineering Works for the conversion of Canadian locomotives from steam to diesel power. In the late 50's, the program reached a peak of 200 engines per year. After the conversion program was completed and requirements fell to 50 engines per year it was no longer economic to continue manufacturing.

In 1962 M.L.W. undertook to rebuild the Alco engine to support the after-market from the Dominion Engineering program. Since that time expansion of Canadian railways and the replacement market together with a vigorous export program, M.L.W. had reached a manufacturing volume of 180 engines per year. Due to M.L.W.'s development of the Alco engine (the Canadian engine has progressed beyond the state of development of the Alco engine still manufactured in U.S.A.) The future market appears assured for years to come.

In the past two years, M.L.W. has been successful in marketing the Alco engine for generating units and marine usage as well.

The Sulzer Company developed a Diesel traction engine, 12LVA24, 2700 H.P. The engine was manufactured in U.K. initially at a rate of 300 per year. Market requirements, however, dropped below 50 engines per year and the program was no longer economic and so was abandoned.

It would appear that 50 engines per year is the break-even point for economic manufacture of such an engine.

The Canadian market alone is large enough to sustain M.L.W. operations economically. As well, it would appear that G.M. Diesel has market enough in Canada to manufacture economically.

M.L.W. has developed the crankcase as a steel weldment avoiding the need for special steel foundry operations and significantly reducing the economic scale of production.

Today, M.L.W. sources some 65% engine materials in Canada. There is a well developed structure in Canada and North America for components such as injection units, fuel pumps, crankshafts. Canadian forge shops supply a portion of components.

M.L.W. is most interested in widening Canadian content. For example, the 250 lb. cylinder head castings are purchased outside of Canada. The volume is not such that present Canadian foundries equipped with cupola process can economically manufacture. However, should a foundry equip with a modern small electric induction furnace (perhaps with DREE assistance) then manufacture would be economic. M.L.W. has other similar programs in mind in their attempt to expand Canadian content economically.

M.L.W.'s present circumstance is that locomotive production is expected to expand. Export programs are successful, The Canadian domestic market is stable, and the new L.R.C. (Light, Rapid, Comfortable) locomotive developed by M.L.W. for passenger service, is in operation in prototype form (with PAIT support). This program or an equivalent, will require manufacturing space.

There are now some 6,000 Canadian Alco engines in operation. 150 new Canadian Alco engines are being added each year. Alco U.S.A. has produced some 7500 engines. Present repair parts business has reached $1,700,000 per year on obsolete 539 and 244 engines and will continue to grow. Model 251 engines (now in production) parts business is at a rate of $7,000,000 per year. Manufacturing repair parts and rebuilding engines is now a production control problem when this work must be mixed in with new production running at capacity.

Given a new specialized repair parts shop, perhaps an arrangement for obsolete parts could be worked out with the U.S. Company for specialized low volume repair and rebuild manufacturing. This concept is similar to the successful pattern established by United Aircraft in Canada to supply obsolete piston engine spare parts world-wide for the parent U.S. Company.

# DIESEL ENGINES

Medium Speed - Traction, Marine, Generator, Industrial Application

| COUNTRY | MANUFACTURER | POWER RANGE | STROKE | ENGINE SPEED RANGE |
|---|---|---|---|---|
| CANADA | Mtl. Loco. Works (Alco) | 875-4500 | 4 | 400-1200 |
| U.S.A. | General Motors | 800-3900 | 2 | 720-900 |
| | Colt-Peilstick & Fairbanks Morse | 5000-9000 | 4 | 520 |
| | Cooper-Bessemer | 1870-7157 | 4 | 360-600 |
| | Rexnord Nordberg | 1620-7000 | 4 | 514 |
| | White Motor | 700-1800 | 4 | 360-1000 |
| | Enterprise-DeLaval | 2900-5800 | 4 | 630 |
| SWITZERLAND | Sulzer | 3900-10400 | 4 | 500-530 |
| W. GERMANY | Klockner-Humboldt Deutz | 470-2940 | 4 | 720-1000 |
| | Motoren-Und-Turbinen-Union | 400-4500 | 4 | 1500-2100 |
| | Maschinenfabrik Augsburg Nurnberg | 5400-10800 | 2 | 225 |
| | Maschinenbau GMBH Kiel | 2500-10000 | 4 | 275-425 |
| | Motoren-Werke Mannheim | 975-3000 | 4 | 375-514 |
| | Rheinstahl Henschel | 300-3000 | 4 | 1500 |
| E. GERMANY | Techno Commerz | 6000 | 4 | 500 |
| SWEDEN | Nohab Polar | 600-4500 | 2 | 175-335 |
| JAPAN | Daihatsu Diesel | 400-4000 | 4 | 720-900 |
| | Niiagata | 420-16000 | 4 | 400-1450 |
| | Yanmar | 820-1100 | 4 | 750-820 |
| FRANCE | Semt-Pielstick | 900-17100 | 4 | 470-1500 |
| | SACM Mulhouse | 400-6600 | 4 | 1200-1600 |
| | Crepille & Cie SA | 300-3750 | 4 | 600-1000 |

## DIESEL ENGINES

Medium Speed - Traction, Marine, Generator, Industrial Application

| COUNTRY | MANUFACTURER | POWER RANGE | STROKE | ENGINE SPEED RANGE |
|---|---|---|---|---|
| U. K. | Ruston Paxman | 300-8000 | 2 | 450 |
| | | 1000-5000 | 4 | 600-900 |
| | Mirrlees | 1500-10000 | | 514-600 |
| CZECHOSLO-VAKIA | CKD Skoda Pragoinvest | 1000-3500 | 4 | 375 |
| POLAND | Cegielski | 3500-7000 | 2 | |
| BELGIUM | Cockerill | 1950-7800 | 2 | 300-375 |
| ITALY | Grandi Motori Trieste (Fiat) | 1500-12000 | 4 | 500-1500 |
| AUSTRIA | Jenbacher Werke | 350-3375 | 2 | 330-600 |
| | | 1000-2000 | 4 | 1000 |
| HOLLAND | Smit & Bolnes | 1625-9700 | 2 | 250-375 |
| | Stork-Werkspoor Diesel | 225-13000 | 4 | 550-1500 |
| FINLAND | Wartsila | 400-1330 | 4 | 600-750 |
| HUNGARY | Ganz-Mavag | 300-2700 | 4 | 1250-1500 |

## High-Speed Industrial and Transport Diesel Engines - 50 - 1000 H.P.

This category of Diesel Engines produces the largest volume of Diesel Engines. The size range considered is 50-1000 H.P. generally 4 stroke engines with speed of 1000 to 4000 rpm.

This category has three major components - engines for highway trucks and busses, engines for agricultural machines and then industrial and construction machinery of many varieties.

Automotive application, engines between 50 H.P. and 400 H.P. comprise approximately one half the market. U.S.A. and Canadian usage in 1973 was approximately 200,000 engines at a value of $750,000,000

The remaining half of the market, some 310,000 engines at a value in 1973 of approximately $800,000,000 was split 44% construction and forestry machine application, 38% agricultural machine application and 3% marine application. Other miscellaneous uses account for 15% of the North American market.

Canada used some 40,000 of this type of engine in 1973. Since the economic scale of manufacture in this segment of the industry is so large and since the Canadian domestic market alone probably would not support a new viable entry to this market, this discussion will approach the market from a "North American" point of view.

Present North American suppliers to this market are, with only one exception, very large industrial concerns.

These concerns can be classified as follows:

A) AUTOMOTIVE BASED MANUFACTURING CONCERNS

Manufacturing engines for their own vehicles, with outside OEM (Original Equipment Market)

1. Detroit Diesel & GMC Truck & Coach Division

General Motors vehicles, however, Detroit Diesel develops considerable OEM business.

2. Ford Power Products

Supplies to Ford trucks and Ford farm tractors limited OEM markets.

B) AUTOMOTIVE BASED, INDEPENDENT OF VEHICLE MANUFACTURING

1. Cummins Engine Co.

Supplies mainly to automotive truck and bus industry. Some other OEM applications.

C) AGRICULTURE MACHINE COMPANIES BUILDING DIESEL ENGINES

1. John Deere

Supplies engines for John Deere farm equipment, limited other OEM supply.

2. Allis Chalmers

Supplies engines to Allis Chalmers farm machine division, construction machinery division and to lift truck division. Limited OEM supply to other companies.

3. Massey Ferguson - Perkins Engine Division (From U.K.)

Supplies engines to the company's farm machinery divisions and construction machinery divisions. Large scale OEM business developed particularly for marine use.

4. J.I. Case Division of Tenneco Inc.

Supplies mainly to Case Div. farm, construction and lift truck divisions.

5. White Motor Corporation - Minneapolis-Moline Division

Supplies engines to the farm equipment companies in the White Motor Group. Limited OEM supply. In addition, White Motor Corporation with Perkins Engine Division of Massey Ferguson has a new joint-venture under way to supply engines to both Massey Ferguson agriculture and construction divisions and to White Motor truck divisions.

6. International Harvester Corporation

Supplies engines to both International Harveater ferm equipment division and I. H. truck division.

D) INDUSTRIAL EQUIPMENT COMPANIES BUILDING DIESEL ENGINES

1. Caterpillar Tractor Co.

Supplies engines to equip Caterpillar construction and earth moving machinery. Large OEM business also developed.

2. Chicago Pneumatic

Supplies engines to own air compressor business.

3. Ingersoll Rand

Supplies engines to own air compressor business.

E) INDEPENDENT INDUSTRIAL

Murphy Diesel, Milwaukee, Wis., is the only independent engine supplier to the industrial market. This company is a small privately owned one and builds a rather obsolete line of engines tailored to special requirements in the marine, crusher, pump oil field, sawmill, generation set market.

OEM MARKET

Many large industrial companies are heavy users of Diesel Engines but do not manufacture engines - among such large users are Gardner-Denver; Koehring; Joy Mfg. Co.; Rohr Industries; Signal Company Inc.; Mack & Brokway Truck Div.; Jaeger, FMC; Sperry Rand and Clark Equipment Co.

There are many smaller manufacturing companies incorporating OEM Diesel Engines in their products.

Perhaps a good test of the extent of the "non-captive" vs. "captive" market for Diesel Engines results from an analysis of Canadian engine usage in 1973. Since Canada imports this category of Diesel Engine completely and since all the above listed U.S. companies have Canadian branch manufacturing operations using the parent U.S. engine, the data should be approximately valid for North America as a whole.

The analysis indicates 45% of the market captive in number of engines and in 51% in value.

This would indicate a North American market of some 300,000 engines with a value of $800,000,000 per year subject to penetration by a new entry into this North American market.

It should be noted that the Canadian market imports engines from U.S. to the extent of 66%. The Canadian market has demonstrated that it is more receptive to foreign built engines than the U.S. market.

An examination of the relative profitability of companies manufacturing Diesel Engines in U.S.A. shows a pattern of profitability greater than the average of industrial companies.

In 1974 U.S. capacity to manufacture Diesel Engines was strained with the result that large backlogs developed. For example, today delivery time for a Detroit Diesel Engine is 7 months. Each Annual Report for 1974 pointed out this shortage of manufacturing and parts supply as a restraint on potential business. The next North American economic cycle upturn will again result in shortage. There are strong indications that expansion of North American manufacturing capacity is now required, even taking into account the White Motors-Perkins new large Diesel Engine plant.

The U.S. non-automotive market for High-Speed Diesels has been growing from 42.6 million H.P. per year in 1967 to 53.5 million H.P. per year in 1972 -- 26% in 5 years. More operations are being mechanized resulting in strong growth paterns in the construction equipment and the agriculture component of the market. Industrial equipment use of Diesels parallels GNP.

The Diesel engine continues to displace the gasoline engine in trucks and busses. The Diesel automotive sales with the diesel advantage in fuel economy control will probably grow very strongly in the next few years.

## TOTAL CANADIAN MARKET 1973

(% Non-Captive Engines)

Total Market 45,292 Engines at $227,043,000

Total Engines Imported Loose 1973

| | | | |
|---|---|---|---|
| Class 502-18 (NES) Industrial Engines | 17,163 | at | 38,003,000 |
| Class 583-04 Automotive Diesels | 5,127 | | 57,918,000 |
| Class 592-27 Marine Engines | 2,512 | | 16,226,000 |
| Total loose engines | 24,802 | | $112,147,000 |

| For 1973 | Units | Value |
|---|---|---|
| Therefore % "captive" imported engines | 45% | 51% |
| % loose-imported engines | 55% | 49% |

1973 "Non-Captive" North American Market

| | | | |
|---|---|---|---|
| 1973 | U.S. Engines Shipped | 500,000 units | $1,500,000,000 value |
| 1973 | Other than U.S. Engines Imported to Canada | 18,000 units | 110,000,000 " |
| | Total North America | 518,000 units | $1,610,000,000 " |

At 50% "non-captive" market opportunity is:

259,000 units $640,000,000 value

Technology Developments - High-Speed Diesel Engines

High speed engines covering the power range 50-1000 H.P. typically follow a pattern such as demonstrated by Detroit Diesel Industrial engines. Model 53 naturally aspirated engine extends from 78 to 216 H.P. with common companents in 2 to 6 cylinder in-line and V arrangements. Model 71 extends from 68 H.P. to 1700 H.P. with common components in 2 to 16 cylinder arrangements both in-line and V arrangements. Turbo charging applies at 250 H.P. and above. Model 149 naturally aspirated and turbo charged versions extends 800 H.P. to 1600 H.P. in 12 to 20 cylinder V arrangements. Model 92 extends from 276 H.P. to 1200 H.P. in naturally aspirated and turbo charged versions.

These four basic designs with variations are used for industrial engines, power units, standby electric sets, marine models and truck models.

The 4-53 sells for $4,240 × weighs 1110 lbs. and produces 123 H.P. 8.9 lb./HP $34.50/H.P. $3.82/lb. of engine weight.

The 8V-7IT sells for $10,980 × weighs 2495 lbs. and produces 350 H.P. 7.1 lbs./H.P. $31.37/H.P. $4.40/lb. of engine weight.

The 16V-149 sells for $38,000 × weighs 10,630 lbs. and produces 1060 H.P. 10 lb./H.P. $35.85/H.P. $3.57/lb. of engine weight.

Notice that turbo charging reduces cost per horsepower and engine weight per horsepower but because of added complexity increases cost per lb. of engine weight.

These engines, because of high volume production economics and two-stroke operation, are the low price engines in the industry.

The Detroit Diesels evolved over a period of 30 years. The 71 series is now thirty years old. The 53 series was introduced in 1955 and resulted in a major re-tooling program. The 149 series was introduced in 1960 and again major re-tooling was required.

× List prices shown - "OEM" prices - $18 - $20 /HP

A new 92 series to comply with new clean air emission control and noise regulations was introduced in 1972-1973. This change-over significantly restricted production and engine availability.

Development has evolved improving reliability and maintenance, power per weight ratios, turbo charging, fuel injection and two stage combustion techniques and more recently emission and noise control.

With the drastic change in fuel costs the industry in North America is now more concerned with fuel cost per unit of power output. Engineering development in Europe has generally been more concerned with fuel economics than North American engines.

The 4 cycle principle is used generally. Detroit Diesel is the exception. The two stroke advantage is less complex and therefore costs less per H.P. The two stroke engine can burn lower grade and cheaper fuel. Engines are heavier and larger. Two stroke engines are noisy.

The four stroke advantages are generally greater thermal efficiency and lower operating costs but have higher first costs per horsepower and added complexity.

U.S. built high-speed engines are generally water cooled (96% of engines). In Germany, the Deutz Diesel Engine division of Klockner-Humboldt-Deutz AG has developed a series of air-cooled high-speed diesels. In 1970, 80% of engines in the high-speed class used in construction machinery, were of the air-cooled type.

In the late fifties two technical developments resulted which created pre-requisites for a high performance air-cooled engine; an aluminum alloy with sufficient high-temperature strength and the advent of direct injection fuel system which reduced heat stress on the cylinder head.

Output per unit of displacement could then be equal to the water cooled engine with output for both engine types, limited by smoke emission limitations rather than cylinder temperature.

The Deutz engine has been developed to be competitive in output per cylinder, high reliability in service life and long service life, low maintenance requirements, superior fuel economics, low noise level, good cold start characteristics, and good operation in very cold or very hot ambient conditions.

Of great importance, the two-stage combustion process results in superior emission performance to the point that the engine has found a special market in underground mining equipment.

Weight ratios are superior. Compare the Deutz naturally aspirated engine at 7.5 lbs./H.P. and the turbo powered unit at 6.6 lbs./H.P. with the best water cooled engines at 8 lbs./H.P.

The engine is about 30% more expensive than the water cooled conventional high-speed engine.× Fuel, operating economy and reliability, however, more than offset higher initial cost.

The Caterpillar engines also have used the pre-combustion chamber concept and as a result have had relatively clean emission engines since inception.

Considerable engineering and production problems resulted in the industry to quickly modify and improve emission performance to conform to emission standards. Shipments were restricted in 1973 and 1974 as necessary modifications were made.

× The Deutz 160 H.P. BF6L913 burns .349 lbs./H.P. hr. This compares to U.S. engines of equal power at .370 to .380 lbs./H.P. hrs.

Economics of Deutz vs. Allis Chalmers - Detroit Diesel - Cummins

U.S. 135 HP - 192 HP use fuel at .370 - .380 lb./ HP/ hr.

Deutz 160 HP BF6L912 use fuel at .349 lb. /HP./hr.
Least difference .021 lb. HP / hr.

For Trucks

Average usage 100,000 miles/year - 2500 hrs./year
40 miles/hr.

NOTE: Tractor engine - 350-500 hrs/year

Annual savings using Deutz Engine March 1975

- 2500 hours at 160 HP at .021 lbs./ HP hr. = 8400 lbs. fuel

Cost of #2 Diesel fuel plus Fed & prov. Tax = 7.75¢/ lb.

Annual Fuel Savings

8400 lbs. at 7.75¢ lb. = $651/ year

Assuming engine cost at $20/HP Engine cost = 3,200

Deutz Engine premium at 30% = $1,000 or 4,200

Break even from fuel savings = 1.53 years

However, May 1, 1975 Fuel price increase to 8.13¢/lb.

Fuel savings, therefore, $683/year and break even 1.46 years

Manufacturing Technology and Economic Scale of Production

Plants building highspeed Diesel Engines run to the following sizes:

Perkins Engines, Peterborough, Eng. - 1,250,000 sq.ft. 210,000 engines per year

International Harvester - $20,000,000 plant 40,000 engines per year

Fiat - 1,500,000 sq. ft.

Caterpillar - 1,300,000 sq. ft.

Lombardini Engines - 100,000 units per year

Cummins Engine Co. - 1,750,000 sq. ft.

Allis Chalmers, Harvey, Ill. - 1,000,000 sq. ft.

Deutz Diesel - Cologne - 125,000 Engines/year Total 200,000/year

Such plants are equipped with special purpose transfer line type tooling designed for high volume production. The plant layouts are relatively inflexible An engine once tooled is difficult to change. There is a good deal of stability in engine production once an engine is designed and developed. For example, Detroit Diesel has had only three major tooling changes in thirty years of operation. Caterpillar engines have evolved slowly with no abrupt retooling cycles in the history of the Caterpillar engine.

High-speed engines are characterized by a great deal of interchangeability of common components to produce a variety of engines in line and Vee configurations. For example, with Caterpillar, parts interchangeability for the 5.4 inch bore engines is 75% and for family of 6.25 in. bore engines interchangeability is 90%.

Foundry technology is an important consideration. Different companies follow different practices for steel, iron and aluminum cast components. For example, John Deere has a foundry operation integrated with engine production. Perkins, however, buys castings.

Deutz, because of the special importance of the aluminum cylinder castings, has a modern foundry integrated with engine machinery and fitting operations.

Forgings are generally purchased from forge shops.

It would appear that the minimum-sized plant to economically produce a family of high-speed engines would require an investment of $50,000,000 plus to produce 50,000 engines per year with 50% of the components made internally and 50% of the value of the engine components purchased from specialist supplier firms. A fully integrated manufacturing operation could cost up to $100,000,000.

Marketing and Distribution Practice

The high-speed Diesel business requires a complex high technology sales and service organization.

Technical service of a high order is required to assist OEM customers to select and modify standard engines for special requirements including assistance with mounting, configuration and noise control problems.

Distribution is direct to large OEM users. The break point is about 300 engines per year to qualify as an OEM customer.

Engine requirements of less than 300 per year are handled by local, generally exclusive, distributors. These distributors provide spare parts, rebuild service after and market technical service.

Users expect quick response replacement part service of the order of quality found in the automobile industry - stock or 48 hour service.

Most engine manufacturers have developed replacement parts reconditioning systems.

A good example of a competitive distribution system is that of Caterpillar engines. Caterpillar serves 250 OEM customers directly. Caterpillar has 900 dealer outlets worldwide, 25 parts depots in 11 countries.

Deutz has 300 representatives in 135 countries with major stocking points in Hamburg, Rotterdam, Montreal and Signapore.

Diesel Engines generally carry warranty. After-market technical service is required both to support OEM customers and dealers.

Generator Sets Manufactured in Canada

In 1974, self-contained electric generating sets imported into Canada as complete units were:

| | |
|---|---|
| U.K. | 552 |
| France | 4512 |
| Germany | 1 |
| Switzerland | 1 |
| Japan | 1381 |
| U.S.A. | 10801 |
| | 17250 sets for a value of $13,115,000 |

In this same period 915 Diesel units valued at $3,738,000 were made in Canada.

The imported sets were powered both with gasoline engines and Diesel Engines.

The Diesel Engine sets manufactured in Canada are protected by a 15% tariff from U.S.A. and 2½% from U.K. Engines are imported duty free under tariff item 42865-1.

As a result of this Canadian tariff structure a sizeable industry has been extablished. Deutz, Mussens, Hewitt, Dorval Diesels in Montreal all have sizeable manufacturing operations. Canadian-built generators, Canron and CGE, are used and assembled to imported Diesel Engines. Control panels, radiators, base plates, specially fitted mobile trailer units etc. are manufactured in Canada and assembled in these shops. Hewitt employs some 60 people in this operation.

The Canadian industry has recently formed a branch of the U.S. E.G.S.M.A. (Electric Generating Systems Marketing Association). Mr. W. Loevinsohn, president Deutz Canada, is the first Canadian Association President.

This Association will seek to improve Canadian content. The present tariff ruling to provide for the 15% Canadian tariff does not specify Canadian content. Some Association mambers feel that if specific Canadian content (say 50%) was specified then more Canadian content would result. A larger proportion of this market could be supplied by Canadian manufactured, given this stronger incentive.

High-Speed Engines - Tariff Structure - Canada & U.S.

Tariff on high-speed Diesel Engines is essentially duty free since they are now of a class and kind not Made in Canada. The exception is generator sets previously discussed.

Should a new manufacturer be set up in Canada with intention to export to U.S. then U.S. tariff items 660-42 would apply with a 5% tariff.

Since a large percentage of component parts would be sourced in U.S., duty draw-back would apply on U.S. export content. The net tariff rate would be less than 5%.

In the case of automotive truck engines no duty would apply under the Auto Pact, Item 660-55.

The net Tariff impact of a manufacturing operation in Canada to supply both automotive and non-automotive units to both the Canadian and U.S. market would be minimal and not a significant deterrent to a Canadian location.

# DIESEL ENGINES

High Speed - Transportation and Industrial Usage

| COUNTRY | MANUFACTURER | POWER RANGE | ENGINE SPEED |
|---|---|---|---|
| U. S. A. | Allis-Chalmers Eng. | 49-900 | 1200-2600 |
| | J. I. Case Co. | 40-200 | 1200-2400 |
| | Caterpillar Tractor Co. | 85-1550 | 1200-3200 |
| | Chicago Pneumatic | 220-2500 | 300-1000 |
| | Cummins Engine Co. | 100-800 | 1750-3300 |
| | John Deere OEM | 44-212 | 1500-2500 |
| | Detroit Diesel Allison | 67-1600 | 1500-2800 |
| | Ford Power Products | 47-167 | 2200-4500 |
| | G.M. Bedford Diesel | 60-146 | 1500-2800 |
| | G.M.C. Truck & Coach Div. | 155-220 | 1800-3200 |
| | International Engines | 71-420 | 1800-3000 |
| | Minneapolis Moline | 47-118 | 800-2000 |
| | Murphy Diesel Co. | 147-524 | 1200-1800 |
| W. GERMANY | Daimler-Benz A.G. | 10-320 | 1000-4200 |
| | Deutz Diesel Engines (K. H. D.) | 10-8000 | 230-3000 |
| SWEDEN | Scania Diesel | 110-350 | 1500-2400 |
| | Volvo Penta | 10-356 | 1500-4500 |
| JAPAN | Isuzu Motors Ltd. | 16.5-285 | 1500-3600 |
| | Kubota Limited | 6-1500 | 600-2400 |
| | Mitsubishi Motors Corp. | 57-280 | 1500-3600 |
| | Nissan Diesel Motor Co. | 70-350 | 1500-4000 |
| FRANCE | Societe Des Moteurs Baudouin | 72-1000 | 1250-3000 |
| | Societe Surgerienne de Const. Mecaniques | 46-1200 | 1000-2700 |

# DIESEL ENGINES

## High Speed - Transportation and Industrial Usage

| COUNTRY | MANUFACTURER | POWER RANGE | ENGINE SPEED |
|---|---|---|---|
| FRANCE (Cont.) | Renault Marine Couach | 5-320 | 1500-4800 |
| U. K. | Perkins Engines | 18-225 | 1200-4000 |
| | Br. Leyland UK Ltd. | 37-254 | 2000-4000 |
| | Dorman Diesels Ltd. | 5-950 | 800-2600 |
| | Blackstone | 180-2500 | 600-1000 |
| | Lister | 10-170 | 650-2600 |
| | Rolls Royce Motors | 100-750 | 1500-2200 |
| ITALY | Applicazioni Indus. Fiat - OM | 30-800 | 1500-3500 |
| | CRM, Fabbrica Motori Marini | 70-1350 | 1600-2200 |
| | Isotta Fraschini Breda | 147-1200 | 1500-1800 |
| | Stabilimenti Meccanici VM | 15-360 | 1500-2600 |
| POLAND | Pezetel | 7-550 | 1500-2400 |
| AUSTRIA | Steyr Daimlet Puch AG | 10-200 | 1000-4800 |
| SPAIN | Pegaso, Empresa Nacional de Autocamiones, S.A. | 40-352 | 1500-3400 |

# INDUSTRIAL DIESEL ENGINE APPLICATIONS

## Construction & Indus.

Air-compressors
Asphalt plant
Cable spinning mach.
Compactor vibrator
Conveyors
Crane carriers
Cranes floating
Cranes locomotive
Crushers - rock & gravel
Ditchers
Dredges, dredgepumps
Drills - blast holes
Excavators, shovels, cranes
Draglines
Graders
Highway wideners
Hoists
Lift trucks
Loaders
Loader-belts
Pavers - bituminous
concrete
Pile driving mach.
Pumps, centrifugal
Road resurfacing
Road rollers
Scrapers
Soil stabilizers &
compactors
Tractors
Off-highway trucks
Welders

## Trucks & Buses

Coaches
Fire trucks
Highway trucks

## Marine

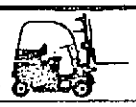
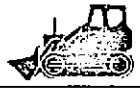
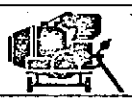
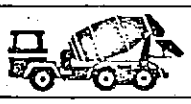
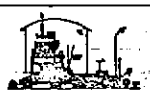
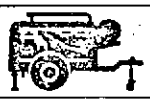
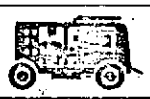
Boats & yachts

## Petroleum

Drilling & services
Pumps - pipeline

## Miscellaneous

Agricultural equipment
Aircraft services
Distillation plants
Drill coal recovery
Water drill
Earth boring
Locomotives
Logging machinery and lumbering
Pumps - well
Fire pumps
Saw mills
Ski cable lifts
Snow-removers
Street sweepers
Trash disposers

| Speed Range RPM | Output (bhp) 10 20 30 50 100 200 300 500 | |
|---|---|---|
| 1500 – 3000 | | FL 410D |
| 1500 – 2800 | | FL 912 |
| 1500 – 2800 | | BF6L 913 |
| 1500 – 2650 | | B/FL 413 |
|  | | Fork lift trucks |
|  | | Rear dumpers |
|  | | Wheeled loaders |
|  | | Excavators |
|  | | Front dumpers |
|  | | Crawler tractors |
|  | | Graders |
|  | | Soil stabilizers |
|  | | Road rollers |
|  | | Stationary concrete mixers |
|  | | Plastering equipment |
|  | | Mobile concrete mixers |
|  | | Road finishers |
|  | | Air compressors |
|  | | Generating and pumping sets |

**Standardized DEUTZ Diesel Power**

55A

Economics of Deutz vs. Allis Chalmers
Detroit Diesel
Cummins

U.S. 135 H.P.-192 H.P. use fuel at .370 - .380 lb./H.P./hr.

Deutz 160 H.P. BF6L912 use fuel at .349 lb./H.P./hr.

Least difference .021 lb./H.P./hr.

For Trucks

Average usage $\frac{125{,}000 \text{ miles/year}}{50 \text{ miles/hr.}}$ = 2500 hrs./year

Annual Savings using Deutz Engine March 1975

= 2500 hours @ 160 H.P. @ .021 lbs./H.P. hr.

= 8400 lbs. fuel

Cost of #2 Diesel fuel plus Fed. & Prov. Tax = 7.75¢/lb.

Annual Fuel Savings

8400 lbs. @ 7.75¢/lb. = $651/year

Assuming engine cost @ $35/H.P. Engine cost = $5,600

Deutz Engine premium @ 30% = $1,680 or $7,280

Break even from fuel savings = 3 years

However, May 1, 1975 Fuel price increase to 8.13¢/lb.

Fuel savings, therefore, $683/year and break even 2½ years.

SMALL HIGH SPEED ENGINES

## Small High-Speed - 0-50 H.P. Diesel Engines

Small high-speed Diesel Engines in the range 0-50 H.P. with speeds of 1200-3600 rpm are a distinct class of Diesel Engines.

These engines are 4-stroke air cooled engines. Application is small generator sets, pump sets, drill units, welding sets, boats, battery chargers, marine electric sets, mobile refrigeration units.

In 1973 in Canada
1,573 units were sold for a value of $2,211,327

In 1973 in U.S.A.

20,732 units were sold for a value of $27,000,000

These engines are often manufactured in conjunction with the same size of gasoline engines.

The gasoline engine market in this size range is much larger than the Diesel market. In U.S.A. in 1973 - 1,768,000 gasoline engines were shipped.

The Diesel Engine is higher priced for the same power output. The The Diesel Engine, however, is easier to start and uses less fuel.

Scale of manufacture varies from a high volume producer - Lombardini, Italy - 200,000 gasoline and Diesel Engines of the same general configuration a year to relatively small U.S. companies such as Wills Industries; Witte Engine Corp. and Universal Multifuel Eng.

It is interesting to note that Deutz is the only Company manufacturing small engines who also manufacture the larger high-speed engine.

Deutz has applied new technology to the small engine with the result that Deutz has engines with the best weight to power ratio in the industry.

| | | | | | |
|---|---|---|---|---|---|
| Honda | 10 | H.P. | - 195 lbs. | 19.5 | lbs./H.P. |
| Lombardini | 10 | " | - 130 " | 13 | " |
| Lombardini | 17 | " | - 200 " | 11.76 | " |
| Teledyne | 30 | " | - 335 " | 11.16 | " |
| Deutz | 25 | " | - 242 " | 9.7 | " |

The Deutz components for small engines have commonality with the larger engines.

Tariff structure both with respect to Canada and U.S. is as per the larger high-speed engines.

Marketing and distribution structure is similar to high-speed engines except that OEM accounts would tend to be to different companies.

# DIESEL ENGINES

Small High Speed - Vehicles, Pumps, Compressors

| COUNTRY | MANUFACTURER | POWER RANGE | ENGINE SPEED |
|---|---|---|---|
| U. S. A. | Avco Lycoming Indus. Prods. Operation | 4-40 | 2000-3600 |
| | Dieselec Div. Wills Indus. | 5-36 | 1200-3000 |
| | Onan Corporation | 7-27 | 1200-3600 |
| | Teledyne Wis. Motor | 3.5-80 | 1500-3600 |
| | Univ. Multifuel Eng. | 15-30 | 800-1800 |
| | Waukesha Motor Co. | 10-1776 | 900-2400 |
| | Witte Eng. Corp. | 4-40 | 800-2400 |
| FRANCE | Bernard Moteurs | 4-40 | up to 3000 |
| | Peugeot Diesel Eng. | 25-106 | 2000-5500 |
| JAPAN | Honda Motor Co. Ltd. | 10 | 2000-6000 |
| ITALY | Lombardini Motori | 3-70 | 1800-3000 |
| | Ruggerini Motori | 3-45 | 2000-3600 |
| | Slanzi Motori | 7.5-64 | 2400-3000 |
| U. K. | Petters | 1.5-50 | 2000-3000 |
| | Lister | 3.9-76 | 2500 |
| W. GERMANY | Deutz | 10-30 | 3000 |

RECOMMENDATIONS

| HD 9710 C23D6 Author/*Auteur* | Dogherty, D. D. | | |
|---|---|---|---|
| Title/*Titre* | Location and investment opportunities for diesel engine manufacture: Quebec region. 1975 | | |
| Date | Borrower *Emprunteur* | Room *Pièce* | Telephone *Téléphone* |
| Jun 10/82 | G. Emond | 57/2 | 2-4446 |
| | | | |
| | | | |

0133-34.3 (10/70) 7530-21-029-4581