PRE-FEASIBILITY STUDY
FOR
THE GOVERNMENT OF CANADA
DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

5,000,000 TONS PER YEAR
COKE PLANT

Submitted by

ARTHUR G. McKEE & COMPANY OF CANADA LTD.

ENGINEERS AND CONSTRUCTORS

21 VOYAGER COURT SOUTH
REXDALE, ONTARIO
CANADA

OCTOBER 1978

CCL-348

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ENGINEERS AND CONSTRUCTORS

October 30/1978

Government of Canada
Department of Regional Economic Expansion
6th Floor
200 rue Principale
Hull, Quebec.
K1A 0M4

Attention: Mr. Suresh Khandelwal
Senior Analyst
Department of Project Assessment

Re: Coke Plant Study
McKee Ref. CCL 348

Dear Mr. Khandelwal:

We are pleased to submit five preliminary copies of our "Pre-Feasibility Study for a 5,000,000 Ton Per Year Coke Plant", based on the McKee-Otto coke oven technology and utilizing approximately 75% DEVCO high volatile coal and 25% imported low volatile coal.

The study is based on the parameters used in the previous two studies covered by the Contract No. 2757. Due to the mail strike we are still awaiting for the addendum to this contract which you have told us has been mailed approximately two weeks ago.

A final report will be issued to you soon, containing a compilation of the three reports.

Yours very truly,

ARTHUR G. McKEE & COMPANY
OF CANADA LTD.

A. Berndl

A. Berndl, Ph.D., P. Eng.
Project Manager

AB/sk

encl.

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PRE FEASIBILITY STUDY OF A 5,000,000 TON PER YEAR COKE PLANT

Prepared for

THE GOVERNMENT OF CANADA
DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

OCTOBER 1978

CONTRACT CCL-348

By

ARTHUR G. McKEE & COMPANY OF CANADA, LTD.
ENGINEERS & CONSTRUCTORS
TORONTO, ONTARIO

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SECTION I

I. INTRODUCTION

This report has been prepared by Arthur G. McKee & Company of Canada, Ltd., for the Minister of Regional Economic Expansion acting for the Government of Canada, in accordance with the understandings in the Terms of Reference attached to the contract dated September 14, 1978. The Terms of Reference are included at the end of this section.

The basic purpose for this study is the definition of two sets of coke plant facilities to produce 1,000,000 tons and 2,000,000 tons of merchant coke per year respectively from indigenous high volatile and imported low volatile coking coals. In addition to metallurgical quality coke, coke oven gas, tar, anhydrous ammonia, elemental sulfur and light oils are to be produced as saleable products. The results of the study, contained herein, will be used by Department of Regional Economic Expansion personnel to determine the opportunities for manufacturing metallurgical coke in Nova Scotia for the world export market.

The scope of work has been extended to include a 5,000,000 ton per year module consisting of two phases. Phase I is to be 3,000,000 tpy and Phase II is to be 2,000,000 tpy, with start-up of Phase II beginning 4 years after completion of construction of the Phase I facilities.

The study has been prepared in a very limited time period and accordingly it has been necessary to maximize the utilization of in-house work developed for prior feasibility and engineering studies. In this regard, Dr. C. Otto & Comp. GmbH of Bochum, West Germany, has provided information based on their proprietary coke ovens and auxiliary equipment. The facility complement described herein reflects the Dr. C. Otto design.

All references to tons in this report mean metric tons of 2205 pounds.

All references to dollars in this report mean Canadian dollars.

Terms of Reference

"The work to be performed by the Contractor is as follows:

1. The study to assume that coke facilities will be a free standing plant, i.e. greenfield site.

2. Soil conditions to be based on those known for Sydney, Nova Scotia.

3. Construction and operating cost estimates will be provided for a conventional type plant, e.g. incorporating wet quenching (for both 1M and 2M metric ton sizes). Based on the above, a differential analysis will be provided assuming dry quenching techniques.

   The differential analysis will, as a minimum, provide the cost differences in percentage terms between the plant incorporating wet quenching (for both 1 and 2M metric ton sizes), however, the contractor will make a best effort to provide the differential analysis in dollar terms as well. The contractor's report will also contain a description of preheating and pipeline charging processes and how they might be applied in the subject plant.

4. Study will be based on approximately 75% DEVCO high volatile coal and approximately 25% low volatile coal from either Virginia, U.S.A. or British Columbia. The coke of specifications of 55 to 60 stability, 0.7% sulfur and 8 to 9% ash, will, in essence, determine the coal blend(s). As far as possible use of DEVCO coal will be maximized.

5. Accuracy of the estimates will be at least ± 35%.

6. For this study, starting point will be a car dumper to receive DEVCO coal in rail cars, and dock side equipment to receive low and medium volatile coal.

7. Coke plant will include coal preparation coke (about 6 meter) ovens, minimal by-product plant, shipping facilities (rail, barge and ships), maintenance shops, offices, storage facilities.

8. Storage facilities will be sufficient to hold 30-day inventory of DEVCO (high volatile) coal, 90-day inventory of low and medium volatile coal as well as of manufactured products, e.g. coke, tar, light oils, ammonia and sulfur.

9. Engineering estimates would include an estimate of equipment which will be required to transfer surplus coke oven gases to a purchaser at battery limits.

10. Capital cost breakdown, among other things, should clearly list equipment and its cost related to pollution abatement requirement. The study should also discuss cost and effectiveness of the various pollution abatement alternatives.

11. Study will incorporate the current U.S. pollution control requirements (OSHA and EPA). A summary of these requirements will be provided.

12. Imported items will be identified, and Canadian/Non-Canadian costs will be shown. (Where possible indicating Customs and Excise duty, federal and Nova Scotia sales tax.)

13. The Study will explicitly state the kind of dollars (nominal, current or otherwise) in its reports.

14. The Study, wherever possible, would indicate prices in both Canadian and U.S. dollars.

15. Real estate cost - land and improvements - should be separately identified for each plant size.

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16. The study data will be arrayed in a manner that can be readily utilized for Departmental economic and financial analysis.

17. Construction labor requirements to be identified by craft and by year, based on Hamilton, Ontario rates and productivity.

18. A factor of 1.35 will be applied to Hamilton manhours to reflect construction efficiency at the proposed site.

19. Contractor will provide a complete description of the nature and size of all infrastructure requirements relating to the two plants. The infrastructure would include, among other things, dock and wharf, water and power to plant site and other facilities viewed as a part of requisite infrastructure for such a facility.

20. Material flow sheets will be prepared but no engineering drawings will be provided."

SECTION II

II. SUMMARY

GENERAL

The basic purpose for this study is to define a coke plant facilities to produce 5,000,000 tons of merchant coke per year from indigenous high volatile and imported low volatile coking coals. The results of the study will be used by Department of Regional Economic Expansion personnel to determine the opportunities for manufacturing metallurgical coke in Nova Scotia for the world export market.

FACILITIES

The facilities required in order to produce 5,000,000 tons of coke will consist of 5 units of 90 ovens of 6.5 meter size with the necessary complement of oven machinery. Phase I, 3,000,000 tpy, will consist of 3 batteries and Phase II, 2,000,000 tpy, will consist of 2 batteries.

Minimal by-product facilities are provided to recover tar, light oil, anhydrous ammonia, sulfur and the coke oven gas. In this case the excess coke oven gas is available for sale to a user such as a power plant.

The description of the facilities is based on a conventional coke plant, if preheating and hot charging are desired the investment costs are of the same order of magnitude.

The coal storage facilities are based on the sizes requested by DREE.

Coal can be received by rail or by sea and handled at the rate of 2,000 tons per hour. The coal will be crushed into separate stock-bins, mixed and conveyed to the coke batteries.

The coke, after quenching is screened to remove the breeze; thereafter the facilities consist of stockpiles to hold three months quantities of coke and of coke breeze. Recovery systems will deliver 2,000 tons per hour to dockside loading of ships or railway cars for export or Canadian use.

At the 5 million ton per year rate, a second system to deliver coke to the dockside is a strong probability and has been included in these costs.

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CAPITAL COSTS

The following table indicates the dispersal of the Capital Cost of approximately $470 million for Phase I and $306 million for Phase II.

	Millions of $			
	Phase I		Phase II	
Materials & Machinery of Canadian manufacture	207.1		131.55	
Construction labour wages	129.0		84.0	
Other field expenses, professional expenses & fee	55.7		38.1	
Land purchase	4.0		-	
Total Canadian $		395.8		253.65
Purchase of foreign refractory bricks & machinery	56.3		37.85	
Other field costs professional expenses & fee	17.9		14.50	
Total C $ required to be spent on foreign resources		74.2		52.35
		470.0		306.0

No allowance has been made for docks and quay side dredging or similar works.

It is estimated that from the date of a contract being awarded approximately three years would be required to complete the assignment. Approximately, 80% of the construction labour hours and 85% of the material costs would be spent in the second and third years of each construction period.

OPERATING COSTS

Operating costs have been provided for the cost of coke in the form of unit quantities and/or dollar values and credits have been alloted for by-products.

The estimated manpower requirements for:

3,000,000 tpy	523 people
5,000,000 tpy	784 people

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III. DESCRIPTION OF FACILITIES

a. INTRODUCTION

The facilities described herein will produce 5,000,000 tons of metallurgical quality coke per year. The facility complement includes coal unloading and handling equipment, stocking and reclaiming facilities, coke oven battery, by-products plant, product storage and shipping facilities. The installation, as conceived, will produce merchant products at a "greenfield" location.

For the purposes of this study, a mix of 75% high volatile and 25% low volatile coals has been assumed. The high volatile requirement will be met by indigenous DEVCO coals from Cape Breton Island. Pocahantas #3, from the state of West Virginia, U.S.A., has been assumed to meet the low volatile requirement. Pocahantas #3 is the world standard for low volatile, by-product, metallurgical coal. Representative analyses for these coals are as follows:

	Devco	Pocahantas #3
Ash	4.1%	4.0%
Volatile Matter	33.9%	17.0%
Fixed Carbon	62.0%	76.0%
Sulfur	1.25%	0.5%
Gross Calorific Value	8190 KCal/kg	8120 KCal/kg

While the 75-25 mix would be adjusted in actual practice to maximize the utilization of the indigenous DEVCO coal so as to minimize the amount of the higher cost low volatile coal to be imported, the assumed mix meets the requirements for reasonability for study purposes.

The coal mix and the selected carbonization facilities will produce a metallurgical grade coke of the following approximate analysis:

Volatile Matter	0.7	-	1.2%
Fixed Carbon	90.0	-	92.0%
Ash	5.0	-	7.0%
Sulfur	0.8	-	0.9%
Moisture	3.0	-	5.0%
Stability	55.0	-	60.0%
Hardness	64.0	-	68.0%

Provisions are made for receiving in-bound coal and shipping coke by rail or by water. Secondary products, i.e. tar, anhydrous ammonia, light oils and elemental sulfur, will be shipped by rail, road or sea. Coke oven gas with a heating value of approximately 4450 kcal/cubic meter is piped to the boundary limits for off-site consumption by others.

The coke oven gas is expected to have the following analysis:

		%, by volume
Hydrogen,	- H_2	55
Methane	- CH_4	28
Carbon Monoxide	- CO	6
Nitrogen	- N_2	4

The facility complement is described on the following pages.

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The coal mix and the selected carbonization facilities will produce a metallurgical grade coke of the following approximate analysis:

Volatile Matter	0.7 - 1.2%
Fixed Carbon	90.0 - 92.0%
Ash	8.0 - 9.0%
Sulfur	0.7%
Moisture	3.0 - 5.0%
Stability	55.0 - 60.0%
Hardness	64.0 - 68.0%

Provisions are made for receiving in-bound coal and shipping coke by rail or by water. Secondary products, i.e. tar, anhydrous ammonia, light oils and elemental sulfur, will be shipped by rail, road or sea. Coke oven gas with a heating value of approximately 4450 kcal/cubic meter is piped to the boundary limits for off-site consumption by others.

The facility complement is described on the following pages.

b. MATERIAL HANDLING

COAL STOCKPILE

Coal will be imported by ships which have their own unloading equipment. Receiving bins at dockside and transfer conveyors will transport this coal at the rate of 2,000 tons per hour to a 192,000 ton stockpile. This is the amount required for 60 days' operations of the coke plant.

Coal can also be received by rail and unloaded with a car dumper capable of handling 100 ton coal cars, as unit trains. This stockpile also for 192,000 tons of local coal is required for 20 days' operations. The radial stacker is shared by the two operations.

Reserve stockpiles have been designated adjacent to the radial stockpiles each capable of holding 96,000 tons of coal. This will increase the stock from 20 to 30 days of local coal and from 2 to 3 months of imported coal.

For the Phase II system, these reserve stockpiles have been increased to 288,000 tons each.

COAL RECOVERY, CRUSHING & MIXING

The coals are recovered from the radial stockpiles by an underground conveyor system to feed coal impactors which have capacities of 800 ton/hour. Recovery from the reserve stockpiles will be with surface equipment as well as by conveyor. The impactors will reduce the coal size to all minus 18 mm and 80% minus 3 mm. Stockbins will be available for the crushed coals with a total capacity of 2,400 tons for Phase I & 3,200 tons for Phase II.

COKE STOCKPILES

The quenched coke is screened to remove minus 20 mm coke breeze. These fines and the coke product are conveyed to a 90 day stockpile.

The coke stockpile will hold 750,000 tons for Phase I and 1,250,000 tons for Phase II. Recovery will be made by conveyor systems in tunnels which supply an inclined conveyor for shipment at 2,000 tons per hour via a shiploader. In Phase II, a second shiploader has been indicated; however from the experience of seasonal supply and demand at 3,000,000 tons per year this may not be necessary.

The shiploader will be partially mobile and the coke will be protected from breakage by adequate retractable feeding downcomers.

BREEZE STOCKPILE

The breeze stockpile will hold 52,500 tons in Phase I and 87,500 tons after Phase II.

The breeze will normally be shipped by rail although recovery conveyors will be linked to the coke shiploader for 2,000 tons per hour loading of breeze to barges or ships.

BY-PRODUCTS

The ammonia, sulfur, light oils and tar products will be sold and transported by road, rail or by sea.

COKE OVEN GAS

Coke oven gas will be transferred by a pipeline for consumption by a local power plant.

c. BATTERIES

GENERAL

The plant will consist of five batteries of 90 nominal 6.5 meter ovens complete with oven machinery and a by-product plant.

The ovens will be designed to produce approximately 5,000,000 metric tons of sized blast furnace coke (+20 mm) per year at 25 mm coking rate. Provisions for future installation of coal preheating will be included.

The three batteries in Phase I will consist of 270 underjet ovens for underfiring with coke oven gas and the two batteries in Phase II contain 180 underjet ovens for a total of 450 ovens.

The general cold dimensions of the ovens are approximately as follows:

Width

Oven Chamber, average	470 mm
Oven Chamber, pusher side	430 mm
Oven Chamber, coke side	500 mm
Center to Center of Ovens	1,350 mm
Oven Taper	75 mm

Length

Inside of Oven Door Lining	14,720 mm
Face to Face of Brickwork	15,480 mm
Inside of Regenerators	14,730 mm

Height

Oven Sole to Oven Roof	6,750 mm
Oven Roof to Top of Battery (Average)	1,390 mm
Oven Pad to Oven Sole	5,280 mm
Oven Pad to Top of Battery	13,450 mm

Capacity Figures

Hot Volume	43.2 m^3
Bulk Density of Coal (Wet)	800 kg/m^3
Metric Tons per Charge	4.6 t

BATTERY FOUNDATIONS AND SUBSTRUCTURE

The battery substructure consisting of the bottom slab, the nozzle decking supports and girders, the nozzle decking and the angular retaining wall. The foundations for pusher machine track and the quench car track.

WASTE GAS FLUE, STACK FLUE, BATTERY STACK

The waste gas flue running along the coke side of the battery and the stack flues will be from heavy-duty reinforced concrete with a 50 mm thick lining inside.

The battery stacks will consist of the outer reinforced concrete column and the full height self-supporting independent brick lining.

REFRACTORY OVEN BLOCK

The refractory oven block rests on the reinforced concrete nozzle decking between the reinforced concrete pinion walls. It consists of the sole flues, the regenerators with the checkers, the heating walls forming the oven chambers, and the oven roof.

The refractory materials used are fireclay for the sole flues, the lower regenerator courses, and the checkers, silica for the upper regenerator courses, high density silica for the heating walls, silica for the lower oven roof courses, and fireclay for the upper oven roof courses.

The oven top is covered with special concrete slabs.

The oven top slopes from the battery axis to both sides.

OVEN BRACINGS

The longitudinal bracing with all necessary connections.

The upper cross bracing consisting of tie rods for each oven wall.

The oven top bracing.

The lower cross bracing consisting of tie rods for each oven wall.

The buckstay girders for fastening the buckstays at the concrete columns on coke and pusher side.

The buckstays for coke and pusher sides of wide flanged beams.

The wall protection plates behind the buckstays.

The regenerator bracing.

The additional bracing under the benches.

The bracing below the oven sole.

BENCHES AND PLATFORMS

The coke and pusher side benches will be structural steel construction. They will be filled with rammed concrete between the top girders and also have a course of hard burned red brick paving.

The end and intermediate platforms will be structural steel construction with reinforced concrete slabs.

OVEN DOORS AND FRAMES

The door frames will be from ductile iron and have a square cross section. The doors will be self-sealing type coke oven doors consisting of the heat-resistant ductile iron box-type door body, the special fused silica door plugs, the two spring-loaded latch gears, the NICUTE sealing strips.

The pusher side doors will be equipped with leveler doors.

HEATING SYSTEM

The coke oven gas supply main from the by-product plant to and within the battery area with the steam heated gas preheaters.

The coke oven gas distribution main along the battery.

The pipe connections between the distribution main and the coke oven gas headers with shut-off cocks and reversing cocks.

The coke oven gas headers, including the riser pipes and the coke oven gas nozzles.

The decarbonizing air system with heavy-duty fans, the air headers and the connection pipes to the reversing cocks.

REVERSING SYSTEM

The hydraulic reversing winch with rods, chains, sprockets, brackets, etc. for operating the waste gas valves, air flaps at the air inlet boxes and the coke oven gas reversing cocks.

GAS COLLECTION SYSTEM

Each battery will be equipped with refractory-lined standpipes on coke and pusher side with elbows and collecting main valves with flushing liquor spray nozzles and steam jet. Each battery of 90 ovens will have two collecting mains with two off-take mains on the pusher side and two collecting mains and two crossover mains on the coke side. The collecting mains will be equipped with liquor sprays and remote controlled liquor sealed bleeders.

The two crossover mains convey the gas from the coke side collecting mains to the pusher side off-take mains.

The off-take mains run across the pusher machine tracks to the suction main.

The suction main runs along the battery and to the primary coolers.

OVEN TRACKS

The tracks for pusher machine, the coal charging car and the coke guide/door machine extended over the battery ends to allow parking of a second machine. The quench car track between quench station and coke wharf, including turnout for parking of a second quench car.

DOOR RACKS

Two electrically operated slewable and winch-tiltable door racks on coke and pusher sides of one end platform will be provided, including hoist for each battery. The door service area will be weather-enclosed, heated and lighted.

Four spare door racks for the recesses at the pinion walls and four steel frames at each end and intermediate platforms will be provided.

RAM AND LEVELER BAR CHANGING STATION

A changing station for ram and leveler bar in each end platform.

QUENCH STATION

The quench towers will be of concrete with brick lining inside. They will include a wooden mist suppressor with flushing system. The quench water tanks will be supported on a steel structure of the settling pond.

The settling plants will be from reinforced concrete.

COKE WHARF

Each battery will have a wharf approximately 70 meters long, inside to inside, and approximately 11 meters from center line quench car track to center line of the wharf conveyor.

The wharf will be of reinforced concrete and the sloping surfaces lined with hard burned brick pavers.

The trenches will extend the length of the wharf and beyond to accommodate the plow maintenance platforms and stairways.

Two plows, each capable of reclaiming 200 tons per hour, will be provided for each battery. One is a standby.

PIPING IN THE BATTERY AREA

The necessary supply piping and connecting piping for flushing liquor, steam, service water and compressed air.

PUSHER MACHINES

Complete pusher machines are provided. This provides for door removal, door replacing, pushing, automatic door and jamb cleaning, etc., which will be performed without respotting. An interlocking system between pusher machine and coke side to ensure proper positioning before pushing is included.

COKE GUIDE/DOOR MACHINES

Complete one-spot coke guide/door machines are provided. This provides for door removal and replacing, automatic door and jamb cleaning, coke guide positioning, etc., which will be performed without respotting.

COAL CHARGING CARS

Complete coal charging cars are provided. This provides for charging hole lid removing and replacing, cleaning goosenecks and standpipes, charging, etc., which will be performed without respotting.

COKE SIDE EMISSION CONTROL SYSTEM

Land-based systems for coke side emission control, complete with hood cars, duct along the battery, up to the quench station and on-ground scrubber station.

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QUENCH CARS

Complete one-spot quench cars of the fixed bottom type are provided.

QUENCH LOCOMOTIVES

Complete quench locomotives about 25 t, standard railroad gauge are provided.

COAL BIN

Concrete coal bins with 2,000 t storage capacity each with 2 bays and 4 outlet hoppers per bay are included.

At lower levels, offices and facilities for personnel and maintenance services will be provided.

Service elevators will be provided with exit landings at various levels and charging car track scales.

SUMMARY OF MAJOR EQUIPMENT

	Phase I	Phase II	Total
Battery (90 ovens)	3	2	5
Pusher Machine	4	3	7
Coke Guide/Door Machine	4	3	7
Coal Charging Car	4	3	7
Quench Car	4	3	7
Quench Locomotive	4	3	7

d. BY-PRODUCTS

PRIMARY COOLERS

Direct spray-type primary coolers are provided to process the coke oven gas derived from each battery.

Each primary cooler is designed for a volumetrical coke oven gas throughput of 75%.

FLUSHING LIQUOR SYSTEM

Flushing liquor decanters are provided which handle the returned flushing liquor from each battery.

Each decanter is designed for a 75% flushing liquor throughput, with a retention time of 25 minutes.

AMMONIA LIQUOR TREATMENT PLANT

Gas condensates and process water, which are collected in several intercepting sumps adjacent to the respective process units, are processed through the ammonia stills. Caustic soda is injected into the stills for proper control of the pH-value of the treated effluent and to release the fixed ammonia compounds.

The vapors derived from the ammonia stills, which include besides ammonia also other strippable organic and inorganic compounds, are recycled for further processing into the coke oven gas.

EXHAUSTER

The exhausters are designed to draw off the gas from the Coke Oven Battery. They provide sufficient positive pressure to deliver the gas through the by-product plant and to transfer the appropriate quantity of cleaned gas for underfiring back to the Coke Oven Batteries.

Exhauster drivers are back pressure steam turbines. The exhaust steam will be utilized in several sections of the by-product plant either for heating and/or stripping purposes.

ELECTROSTATIC TAR PRECIPITATOR

The electrostatic tar precipitators are designed for a tar removal efficiency of 98% under normal operating conditions.

PHOSAM PLANT

The ammonia absorbed from the coke oven gas by an ammonium phosphate solution, with subsequent steam stripping and condensation of the ammonia vapors. The aqua ammonia condensate is then fractionated to yield a high purity anhydrous ammonia.

FINAL GAS COOLER

Process heat generated by the Phosam Plant is removed in the final gas cooler. The gas is cooled to the lowest possible temperature in order to improve the light oil absorption efficiency in the subsequent Light Oil Plant.

LIGHT OIL PLANT

Light oil is removed in an absorption/stripping operation by means of mineral wash oil.

The product of the plant is a light oil mixture comprising mainly of benzene, toluene, xylene and some solvent naphtha fractions.

STRETFORD PLANT

Hydrogen sulfide is selectively absorbed from the coke oven gas by an aqueous sodium carbonate solution with subsequent oxidation to elemental sulfur.

Formation of fixed cyan-sulfur compounds within the Stretford Plant is reduced by processing the coke oven gas through an HCN-Removal Section prior to the Stretford Plant.

The blowdown quantities from the HCN-Removal Section and the Stretford Plant are treated in a Waste Liquor Incineration System. The vapors and the condensates derived from the incineration are recycled to the Stretford Plant.

GAS HOLDER AND FLARE STACK

After being processed through the by-product plant, the gas enters the gas distribution system where it is divided into a stream to the battery for coke oven underfiring and a stream to the consumers.

To avoid surges in the coke gas distribution system, a gas holder is installed serving as a buffer tank.

A gas flare stack is provided to release into the atmosphere and ignite any excess gas from the gas system.

WASTE WATER TREATMENT

Waste water treatment facilities have been provided for each phase.

e. INFRASTRUCTURE

The following facilities or items represent some of the known infrastructure requirements. When a specific location is selected others may exist.

		3,000,000 TPY LEVEL	5,000,000 TPY LEVEL
a)	Dock (meters)	600	800
b)	Water - potable (m^3/day)	125	175
	- industrial (m^3/day)	125,000	210,000
c)	Electric Power (kwh/day)	210,000	350,000

d) Access roads for cars and trucks to the battery limits of the plant

e) Railroad tracks to battery limits

Some of the infrastructure items such as water, power, railroads, etc. may become a part of the rate structure.

f. BUILDINGS - MISCELLANEOUS

Buildings and equipment have been provided for an administrative office, maintenance shops, a labroatory and a warehouse.

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IV CAPITAL COSTS

This section of the report presents the capital cost requirements for the construction of a coke and by-product plant for the production of 5,000,000 tons of coke per year, constructed in two phases. The estimates are based on 3rd quarter 1978 costs. The accuracy of the estimates are at least ± 35 percent.

INCLUSIONS

The estimates include the cost of equipment and material, engineering, purchasing, field supervision, and construction labor, tools and equipment required for construction, and overhead charges incurred during construction.

Moneys have been included for nominal site preparation, land costs and taxes.

The equipment and material costs have been increased by 10% for a 1½% allowance for shipping expenses and an 8½% allowance for possible taxes.

EXCLUSIONS

No provisions have been made for infrastructure items, such as dock, harbor dredging and breakwall, if required, water or power supply to the battery limits, roads or railroads to the battery limits.

Escalation has not been included.

TOTAL CONSTRUCTION COST

The construction cost for Phase I is	$470,000,000.
The construction cost for Phase II is	$306,000,000.
so that the total construction cost is	C $776,000,000.

A breakdown of the estimates are presented in the following tables:

Phase I - 3,000,000 TPY	-	Table IV-1
Phase II - 2,000,000 TPY	-	Table IV-2

Mechanical and electrical spares have been included at a value of C $5,000,000 for Phase I and an additional C $3,000,000 for Phase II.

Approximately $5 million has been calculated for purchases of railway locomotives and rolling stock and for heavy front end loader equipment in Phase I and, this has been increased to $6.5 million for Phase II.

Field costs include all field labour and field indirects, including construction supervision, temporary construction, construction equipment, small tools, consumables and payroll burden.

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TABLE IV-1 - CAPITAL COSTS

PHASE I - INITIAL 3 x 10^6 TON COKE/YEAR

(Thousands of C $ - 3rd Quarter 1978)

	Domestic Supply	Foreign Supply	Total
Battery			
Equipment			
Refractory	-	54,600	54,600
Oven Machinery	17,400	1,600	19,000
Castings	19,800	-	19,800
Other Equipment	5,800	-	5,800
Materials	38,600	-	38,600
Sub-contract Materials	20,000	-	20,000
Field Costs	90,100	3,000	93,100
Professional Services & Fee	8,900	9,300	18,200
Total Battery	200,500	68,500	269,100
By-Products			
Equipment	21,000	-	21,000
Materials	19,500	-	19,500
Sub-contract Materials	27,100	-	27,100
Field Costs	49,200	800	50,000
Professional Services & Fee	4,800	4,800	9,600
Total By-Products	121,600	5,600	127,200
Materials Handling			
Equipment & Materials	33,000	-	33,000
Field Costs	24,700	-	24,700
Professional Services & Fee	6,400	-	6,400
Total Materials Handling	64,100	-	64,100
Land (400 Acres) 160 Hectares	4,000	-	4,000
Heating up of Battery	600	-	600
Mechanical & Electrical Spare Parts	4,900	100	5,000
Total Plant	395,800	74,200	470,000

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TABLE IV-2 - CAPITAL COSTS

PHASE II - FINAL 2 x 10^6 TON COKE/YEAR

(Thousands of C $ - 3rd Quarter 1978)

	Domestic Supply	Foreign Supply	Total
Battery			
Equipment			
Refractory	-	36,600	36,600
Oven Machinery	13,400	1,200	14,600
Castings	13,200	-	13,200
Other Equipment	4,300	-	4,300
Materials	26,600	-	26,600
Sub-contract Materials	13,500	-	13,500
Field Costs	62,700	2,300	65,000
Professional Services & Fee	7,200	7,600	14,800
Total Battery	140,900	47,700	188,600
By-Products			
Equipment	13,500	-	13,500
Materials	12,300	-	12,300
Sub-contract Materials	18,500	-	18,500
Field Costs	35,400	600	36,000
Professional Services & Fee	4,000	4,000	8,000
Total By-Products	83,700	4,600	88,300
Materials Handling			
Equipment & Materials	13,300	-	13,300
Field Costs	10,000	-	10,000
Professional Services & Fee	2,600	-	2,600
Total Materials Handling	25,900	-	25,900
Land	-	-	
Heating up of Battery	200	-	200
Mechanical & Electrical Spare Parts	2,950	50	3,000
Total Plant	253,650	52,350	306,000

Heating-up Of Battery

The drying out and heating-up to temperature of a new coke battery requires approximately 10 weeks (70 days).

The labor required for this procedure is included in the total manhours requirements, but at a greenfield site location oil for the drying and heating functions will have to be purchased. Since, it is assumed that all excess coke oven gas from the plant is sold, a similar expense is estimated for the Phase II start-up.

The cost for the fuel oil and possibly a storage tank, lines, etc., is estimated to be:

Phase I	-	$600,000.
Phase II	-	$200,000.

Spending Schedule

The spending schedules as shown below represents the 3 - year project schedule with a carry over into the 4th year for performance guarantees, field charge, deferred charges, etc., for each Phase. This schedule includes the constructed plant, battery heat-up expense, and spare parts.

	Year	Million Dollars
Phase I		
	1	90.0
	2	220.0
	3	150.0
	4	10.0
Phase II		
	8	44.0
	9	150.0
	10	105.0
	11	7.0

Project Schedule

It is estimated that the construction schedule for this project would cover a period of about 36 months. This begins with the award of the contract through to start of operations. It is anticipated that the major engineering work, site preparation and some civil work would occur in the first year, with the major construction and erection and the heating-up of the batteries taking place in the next 24 months. This schedule is applicable for both phases.

Escalation

The Consultant's reply to DREE's request for a forecast of the escalation rate in the construction industry for the next three years follows:

U.S.A.	-	9 percent per year
Canada	-	8 percent per year

U. S. Pollution Control Requirements

Regulations (EPA and OSHA)

It should be pointed out that the pollution control requirements vary from state to state in the U.S.A., as well as from municipality to municipality. In addition, some of the previously approved processes or equipment are not now acceptable. Nevertheless, the facilities provided for this project meet the generally accepted current U.S. pollution control requirements.

A summary of these regulations follow:

a. Environmental Protection Agency (Federal) Iron and Steel Manufacturing Point Source Category - Effluent Guidelines and Standards, Volume 39, Number 126, dated 6-28-74. Subpart A - By-product Coke Subcategory 420.10 describe, define and establish guidelines.

b. State E.P.A. Regulations: (Typical Example) State of Illinois Pollution Control Board AR Pollution Regulations, Rules 202 and 203(d)(6), Part II.

c. Municipal E.P.A. Regulations: (Typical Example) Environmental Control Ordinance, Chapter 17 of the Municipal Code of the City of Chicago, Section 17-2.3 and 17-2.4.

d. OSHA Regulation (Federal Register): Department of Labor, Occupational Safety and Health Administration, Exposure to Coke Oven Emissions, Part III, Dated 10-22-76 covers:

Charging Emission
Pushing Emission
Employee Exposure
Quenching Emission
Raw Material Handling Emission
Product Handling Emission
Water and Air Pollution
Equipment and Environmental Noise Control

Estimated Costs Related to Pollution Abatement Requirements

Description	Thousands of Dollars	
	Phase I	Phase II
Second Gas Collecting Main	450	300
Larry Car Equipment	300	200
Steam Aspiration	750	500
Door Machine Enclosure	150	100
Coke Side Emission System	13,500	9,000
Quench Tower Baffles	300	200
H_2S Removal	22,000	17,000
Final Effluent Treatment Plant	20,000	16,000
Conveyors-Dust Collection	800	200
Total	58,250	43,500

TRAINING

The consultant recommends that an allowance be provided for the recruiting and training of personnel as this is a greenfield site concept. Furthermore, experienced personnel would require some retraining to effectively operate the proposed modern coke and by-product facilities.

A few selected supervisory personnel as well as key operating and maintenance people should be sent to a coke plant with comparable equipment for training.

For Phase I a training period of approximately three months is envisioned and is estimated to cost $500,000 for salaries, travel, living expenses and training fees.

For Phase II approximately $100,000 should be provided. In this phase all training should take place at the plant site. Existing crews will be broken up to form the nucleus for manning the new facilities. In addition, personnel will be employed prior to start-up and trained on the existing facilities.

TECHNICAL AND OPERATING ASSISTANCE

It is recommended that provisions be made for technical and operating assistance during the first year or so of operations. A selected engineering or operating company can provide this type of service.

Specialists would assist in the initial phase of operations in the analysis and solution of technical and operating problems and in attaining satisfactory levels of quality and efficiency.

An estimated cost for these services including salaries, fee, travel and living expenses in Nova Scotia is $200,000 to $250,000.

CONSTRUCTION LABOR, BY CRAFT, BY YEAR

The total estimated construction manhours by craft and by year are shown in Table IV-3. This includes journeymen helpers, apprentices, labourers, etc.

The manhours required to construct the project reflect an adjustment of 1.35 as an index of the labor efficiency in the Nova Scotia area.

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TABLE IV - 3

ESTIMATED MANHOURS, BY CRAFT, BY YEAR

PHASE I — Thousands of Construction Manhours

	Year 1	Year 2	Year 3	Total
Boilermakers	15	240	145	400
Bricklayers	40	430	60	530
Carpenters	300	320	300	920
Electricians	20	310	400	730
Ironworkers	200	320	400	920
Millwrights	60	200	430	690
Operating Engineer	80	140	110	330
Teamsters	20	20	10	50
Pipefitters	225	500	525	1,250
Labourers	320	480	370	1,170
Misc. Crafts	20	20	20	60
Total	1,300	2,980	2,770	7,050

TABLE IV - 4

ESTIMATED MANHOURS, BY CRAFT, BY YEAR

PHASE II	Thousands of Construction Manhours			
	Year 8	Year 9	Year 10	Total
Boilermakers	10	150	100	260
Bricklayers	10	250	90	350
Carpenters	130	300	160	590
Electricians	10	200	250	460
Ironworkers	110	250	240	600
Millwrights	60	140	200	400
Operating Engineer	55	70	85	210
Teamsters	10	20	10	40
Pipefitters	135	400	365	900
Labourers	160	340	250	750
Misc. Crafts	10	20	10	40
Total	700	2,140	1,760	4,600

TABLE IV - 5

COKE PLANT 5 MILLION TONS (Phase I = 3,000,000 ton/yr.)

BATTERY	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
Equipment					
Refractory	6.0	42.6	6.0	-	54.6
Other Machinery	2.0	10.0	6.0	1.0	19.0
Castings	2.0	11.0	5.8	1.0	19.8
Other Equipment	0.5	1.5	3.8	-	5.8
Materials	17.0	12.4	8.2	1.0	38.6
Subcontract Mat'l.	2.0	9.0	8.0	1.0	20.0
By-Products					
Equipment	2.2	12.0	5.8	1.0	21.0
Materials	2.4	9.1	7.0	1.0	19.5
Subcontract Mat'l.	2.5	11.6	12.0	1.0	27.1
Material Handling					
Equipment & Materials	5.0	18.0	9.0	1.0	33.0
Field Costs					
Labour	23.4	54.4	50.7	0.5	129.0
Other	7.0	16.4	14.9	0.5	38.8
Professional Services & Fee	14.0	12.0	7.2	1.0	34.2
Land	4.0	-	-	-	4.0
Heat Up of Battery	-	-	0.6	-	0.6
Spare Parts	-	-	5.0	-	5.0
Totals	90.0	220.0	150.0	10.0	470.0

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TABLE IV - 6

COKE PLANT 5 MILLION TONS (Phase II = 2,000,000 ton/yr.)

BATTERY	YEAR 8	YEAR 9	YEAR 10	YEAR 11	TOTAL
Equipment					
Refractory	4.0	29.0	3.6	-	36.6
Other Machinery	1.5	8.0	4.3	0.8	14.6
Castings	1.0	6.4	5.0	0.8	13.2
Other Equipment	-	1.0	3.3	-	4.3
Materials	8.0	10.0	7.8	0.8	26.6
Subcontract Mat'l.	-	6.5	6.2	0.8	13.5
By-Products					
Equipment	1.0	9.0	2.7	0.8	13.5
Materials	1.0	6.8	3.7	0.8	12.3
Subcontract Mat'l.	-	7.0	10.7	0.8	18.5
Material Handling					
Equipment & Materials	1.0	6.0	5.9	0.4	13.3
Field Costs					
Labour	12.6	39.1	32.0	0.3	84.0
Other	3.9	12.2	10.6	0.3	27.0
Professional Services & Fee	10.0	9.0	6.0	0.4	25.4
Land			-		.0
Heating Up of Battery	-	-	0.2	-	0.2
Spare Parts	-	-	3.0	-	3.0
Totals	44.0	150.0	105.0	7.0	306.0

TABLE IV-7

CONSTRUCTION PHASE I & PHASE II

ESTIMATED FOREIGN COSTS, BY YEAR

PHASE I

	Yr. 1	Yr. 2	Yr. 3	Yr. 4		Total
External Spending						
Materials	6.1	43.2	6.4	0.1		
Services & Fees	5.5	6.6	5.6	0.2		
	11.6	49.8	12.0	0.3	=	73.7

PHASE II

	Yr. 8	Yr. 9	Yr. 10	Yr. 11		Total
External Spending						
Materials	4.1	29.5	4.15	0.1		
Services & Fees	4.0	4.8	5.5	0.2		
	8.1	34.3	9.65	0.3	=	52.35

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V. OPERATING COSTS

General

This section concerns the development of operating costs for coke. Pertinent data relative to production volumes, yields, unit costs, labor requirements, etc., are presented herein.

Production Volume and Operating Schedule

The Phase I and Phase II facilities are sized to provide capacity for producing approximately 5,000,000 tons of sized coke annually.

The coke plant operations are scheduled to work 365 days per year.

The production rates and yields used in the configuration represent reasonable and attainable operations.

a) Yield:

Coal, as received to sized coke	65%
or, Dry coal to dry sized coke	70%

b) Approximate quantity of by-products recovered per ton of coal charged:

Coke oven gas	340 Nm^3
Tar	35 kg
Light oil	12 kg
Anhydrous ammonia	3 kg
Sulfur	3.5 kg

Material flow charts are shown on the following pages.

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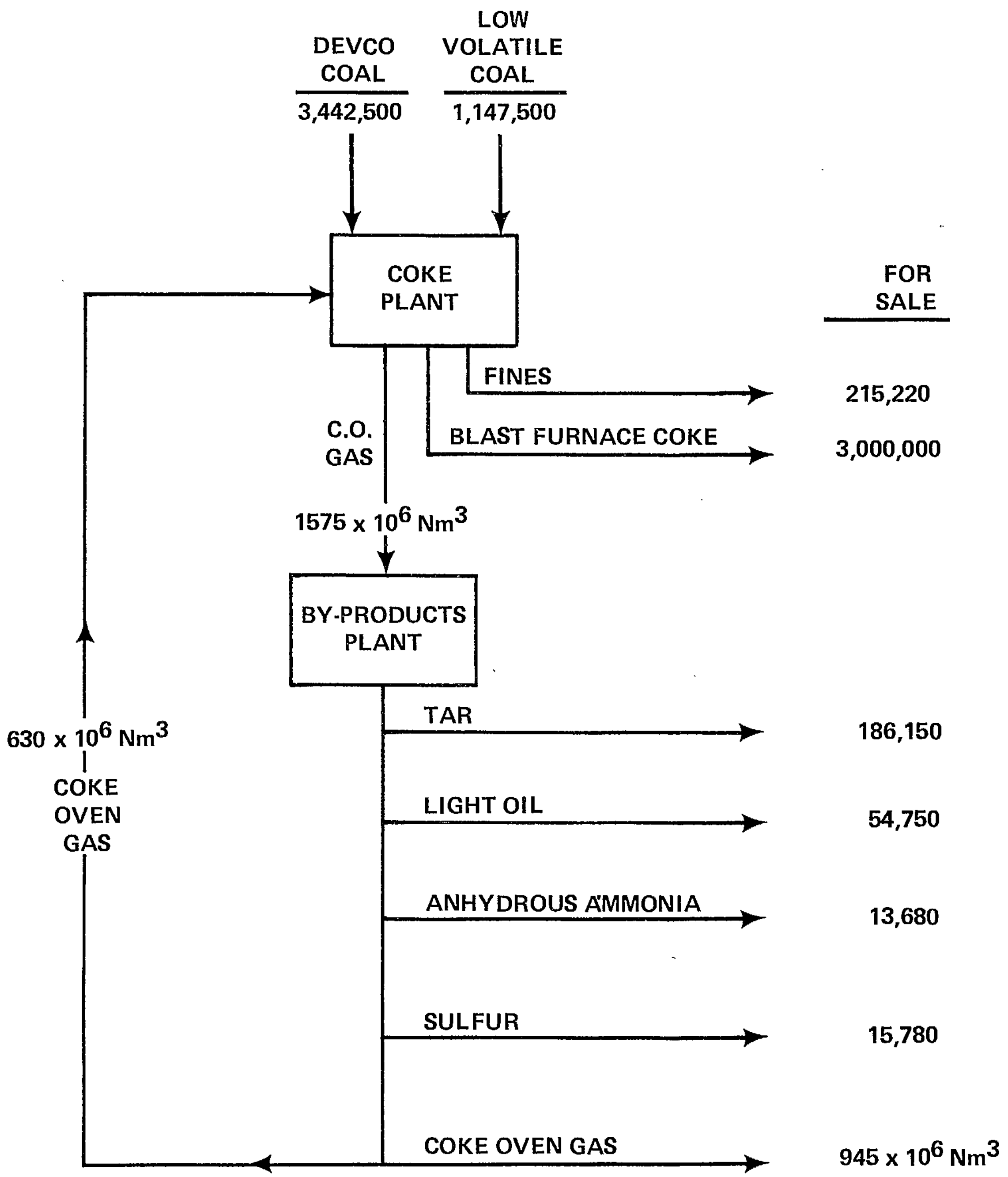
MATERIAL FLOW CHART

(METRIC TONS PER YEAR– EXCEPT AS INDICATED)

PHASE I

3×10^6 t/y



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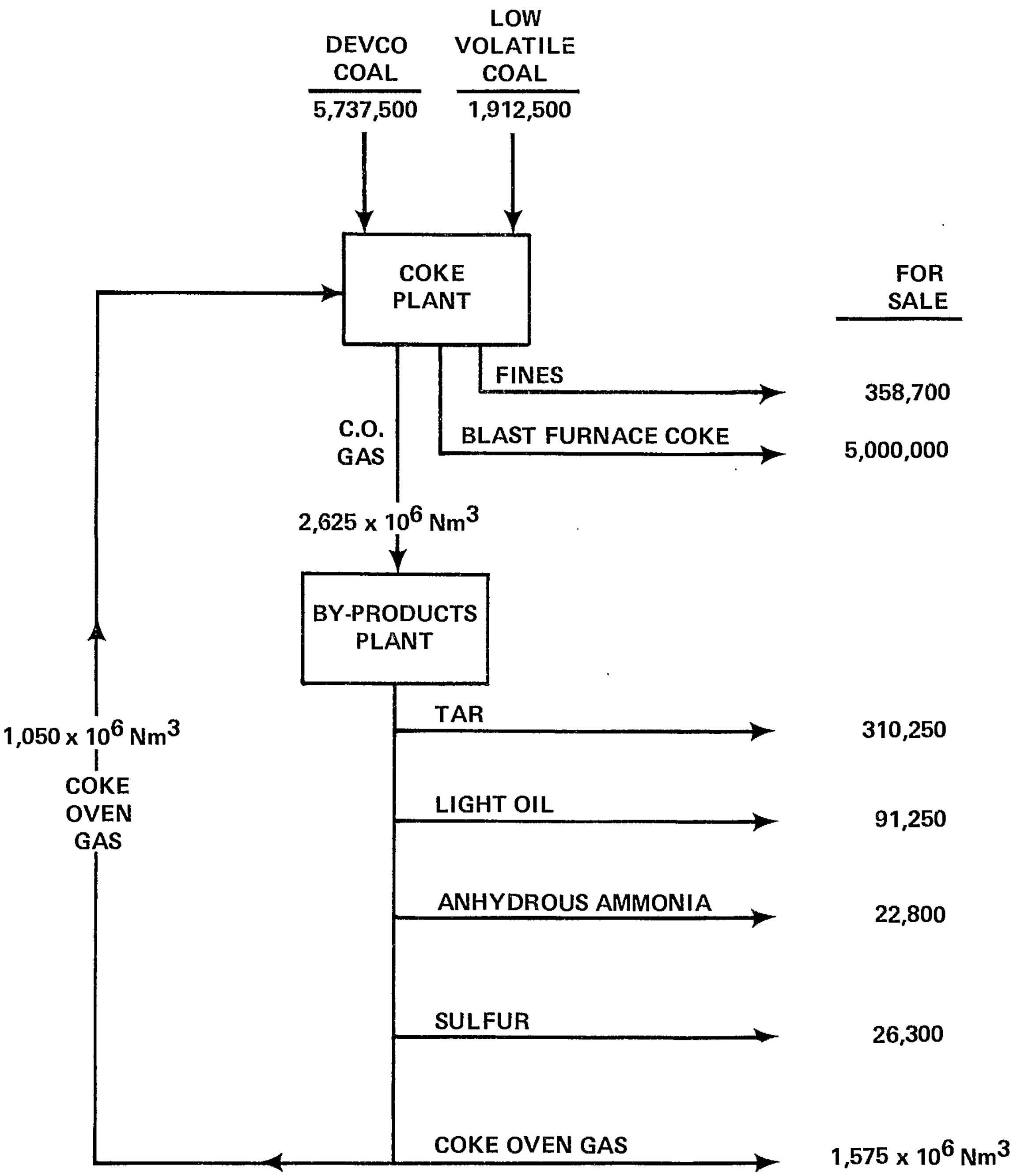
MATERIAL FLOW CHART

(METRIC TONS PER YEAR—EXCEPT AS INDICATED)

PHASE I & II

5 x 10^6 t/y



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For Phase I it is forecast that in the start-up year of operations approximately 80 percent of capacity will be attained. In the second year, production should be at the projected level of 3,000,000 tons of coke.

For Phase II the same percent is applicable for the start-up year, thus resulting in an annual production of 1,600,000 tons or a combined total of 4,600,000 tons. In the second year of Phase II the 5,000,000 ton level should be attained.

Basic Unit Costs

The unit costs shown below represent data provided by DREE and by data developed by McKee. Other unit costs, as required for the economic analysis, will be developed by DREE.

Description	Unit	Dollars Per Unit	Source
Coal - DEVCO (H.V.)	ton		DREE
- Low Volatile	ton		DREE
Coke Fines	ton		DREE
Coke Oven Gas	10^6 Kcal	8.00[2]	McKee
Tar	ton	130.00	McKee
Light Oil	ton	145.00	McKee
Sulfur	ton	25.00	McKee
Anhydrous Ammonia	ton	125.00	McKee
Electric Power	kwh	.04	McKee
Water	m^3	.065	McKee
Labor, average including fringe benefits, etc.[1]	Manhour	9.05	DREE
Salaried, average including fringe benefits, etc.	Manhour	12.50	McKee

Footnotes 1 & 2 continued on following page.

1 Basic Wage Rate (average) \$6.85 x 1.321 = \$9.05

Fringe Benefits

- Unemployment insurance, Canadian pension, Company pension, group insurance, medical	22.0%
- Workmen's Compensation	2.1%
- Vacation and holiday pay	8.0%
Total Fringe	32.1%

2 Based on cost of fuel oil at \$13.00 per barrel.

Estimated Operating Costs

The operating costs include the cost of raw materials (in this case the unit quantities to be provided by McKee) and the other items of expense such as labor, fuel, utilities, maintenance materials, supplies (consumables such as lubricants, by-product chemicals, etc.), and miscellaneous office and sales expense.

Credits are given for the various by-products derived from the coking process.

Start-Up Operating Costs

McKee recommends that the standard operating costs as shown on Table V-1 for Phase I be adjusted by 25 percent in the first year to recognize the impact of the "learning curve" with its lower operating performances, lower yields and higher spending rates during the first year of operations. This is the natural and unavoidable consequence of breaking in new equipment, processing problems, and the learning period for operating personnel in addition to lower productivity.

For the same reasons, the standard operating costs for the 5,000,000 tpy level as shown on Table V-2 should be adjusted by 9 percent in the start-up year of Phase II.

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Manpower Requirements

A summary of the manpower requirements for the 3,000,000 tpy and the 5,000,000 tpy coke plant levels is shown in Table V-3.

The personnel have been classified into the following categories:

	CWS Job Classification
Unskilled	1 - 3
Semi-skilled	4 - 9
Skilled	10 and up
Office & Clerical	
Technical	
Management	

Examples of occupations included in the various classification categories follow:

J.C. 1 - 3	Laborer, Janitor
J.C. 4 - 9	Helpers, Lidman, Coke Loader, Light Oil Operator, Sampler
J.C. 10 and up	Heater, Pusher Operator, Exhauster Engineer, Maintenance Tradesmen
Office & Clerical	Secretaries, Accounting Clerks, Clerk Typists
Technical	Engineer, Draftsman, Computer Operator
Management	Manager, Foreman

Tables V-4 and V-5 present the labor force by classification and by department for the 3,000,000 and 5,000,000 tpy levels respectively.

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TABLE V-1

OPERATING COSTS

(3,000,000 TPY)

Operation: Coke Plant

Product: Screened Coke

Description	Quantity	Unit	Dollars Per Unit	Dollars Per Ton
Materials				
Low Volatile Coal	0.382	ton		
High Volatile Coal	1.148	ton		
Total Material Costs				
Credits				
Coke Fines	0.072	ton		
Coke Oven Gas	2.340	10^6 Kcal	8.00	(18.72)
Tar	0.062	ton	130.00	(8.06)
Light Oil	0.018	ton	145.00	(2.61)
Sulfur	0.005	ton	25.00	(0.13)
Anhydrous Ammonia	0.004	ton	125.00	(0.50)
Total Credits				
Net Material Costs				
Other				
Labor, Supervision, Clerical				3.41
Fuel (coke oven gas)	0.94	10^6 Kcal	8.00	7.52
Utilities				
- Electricity	25.00	kwh	0.04	1.00
- Steam	0.23	ton	8.25	1.90
- Water	15.5	m^3	0.065	1.00
Maintenance Materials				2.00
Supplies (Consumables)				1.00
Miscellaneous Office & Sales Expense				0.50
Total Other				18.33
Total Cost - Screened Coke				

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TABLE V-2

OPERATING COSTS

(5,000,000 TPY)

Operation: Coke Plant

Product: Screened Coke

Description	Quantity	Unit	Dollars Per Unit	Dollars Per Ton
Materials				
Low Volatile Coal	0.382	ton		
High Volatile Coal	1.148	ton		
Total Material Costs				
Credits				
Coke Fines	0.072	ton		
Coke Oven Gas	2.340	10^6 Kcal	8.00	(18.72)
Tar	0.062	ton	130.00	(8.06)
Light Oil	0.018	ton	145.00	(2.61)
Sulfur	0.005	ton	25.00	(0.13)
Anhydrous Ammonia	0.004	ton	125.00	(0.50)
Total Credits				
Net Material Costs				
Other				
Labor, Supervision, Clerical				3.06
Fuel (coke oven gas)	0.94	10^6 Kcal	8.00	7.52
Utilities				
- Electricity	25.00	kwh	0.04	1.00
- Steam	0.23	ton	8.25	1.90
- Water	15.5	m^3	0.065	1.00
Maintenance Materials				2.00
Supplies (Consumables)				1.00
Miscellaneous Office & Sales Expense				0.40
Total Other				17.88
Total Cost - Screened Coke				

TABLE V-3

SUMMARY OF MANPOWER REQUIREMENTS

		10^6 TPY 3.0	10^6 TPY 5.0
1.0	Executive	7	8
2.0	Accounting, Storeroom	39	50
3.0	Engineering	7	11
4.0	Industrial Relations, Plant Protection	26	30
5.0	Quality Control	11	15
6.0	Purchasing, Traffic, Raw Material	5	6
7.0	Marketing (Sales)	15	22
8.0	Coke Plant Management	55	72
9.0	Docks, Storage Yard, Coal and Coke Handling	61	86
10.0	Batteries	125	215
11.0	By-Products	21	41
12.0	Assigned Maintenance	75	120
13.0	Shop Maintenance	50	75
14.0	Services	20	25
15.0	Utilities	6	8
	TOTAL	523	784

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TABLE V-4

MANPOWER REQUIREMENTS BY CLASSIFICATION

(3,000,000 TPY)

Department	Unskilled	Semi-Skilled	Skilled	Clerical	Technical	Management	Total
Executive & Administrative, etc.	7	21	8	34	24	16	110
Plant Management, Production and Maintenance	-	-	-	6	-	49	55
Docks, Storage Yard, Coal and Coke Handling	16	36	9	-	-	-	61
Batteries	26	43	56	-	-	-	125
By-Products	4	8	9	-	-	-	21
Maintenance and Shops	17	40	68	-	-	-	125
Service and Utilities	13	8	5	-	-	-	26
TOTALS	83	156	155	40	24	65	523

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TABLE V-5

MANPOWER REQUIREMENTS BY CLASSIFICATION

(5,000,000 TPY)

Department	Unskilled	Semi-Skilled	Skilled	Clerical	Technical	Management	Total
Executive & Administrative, etc.	12	27	10	40	34	19	142
Plant Management, Production and Maintenance	-	-	-	8	-	64	72
Docks, Storage Yard, Coal and Coke Handling	24	48	14	-	-	-	86
Batteries	48	73	94	-	-	-	215
By-Products	7	17	17	-	-	-	41
Maintenance and Shops	25	67	103	-	-	-	195
Service and Utilities	16	12	5	-	-	-	33
TOTALS	132	244	243	48	34	83	784

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VI. PREHEATING AND CHARGING OF PREHEATED COALS

General

The preheating and hot charging of coking coals into coking ovens is a recent addition to coke plant technology. The basic underlying premise is that when coals are externally heated to a temperature of 260°C, all of the moisture is driven off prior to charging and the time required in the capital intensive coke ovens is significantly reduced. Depending upon the coal used, reductions in coking time and, hence, increases in production rates are reported to be on the order of 35 to 50%.

The removal of the moisture results in a significantly higher bulk density than can be achieved with the conventional untamped method of wet coal charging. The effective result of this factor is that medium volatile coals can be substituted for the low volatile portion or, if the same coals are utilized, a larger percentage of high volatile coals can be charged. The results of existing commercial installations are difficult to assess due to the wide variety of coal mixes charged in different coke plants.

All operators agree, however, that there are advantages to preheating. In addition to those previously mentioned, the higher and more evenly distributed bulk density of the preheated coal produces a more consistent and, in general, a better quality metallurgical coke. Appreciable increases in coke stability have been noted when a given coal mix is subjected to preheating prior to carbonization compared to conventional wet charging. The improvement in coke quality varies according to the rank of coal being carbonized to the extent that the magnitude of improvement is greater for the lower grade coking coals. In general, the abrasion resistance of coke will show improvement. In many cases it is this factor of coke quality improvement which might make the preheating system attractive, especially when lower cost coals could not otherwise be used.

The thermal shock to the oven chamber brickwork is considerably reduced and should, therefore, give a longer battery life expectancy.

The self-leveling nature of preheated coal eliminates the possible pollution source of an open leveler door and reduces the duty cycle of the ram machines.

In general, preheating has little effect on yield or composition of gas and by-products, except predictably, the quantity of ammoniacal liquor is appreciably reduced.

Dry, preheated, pulverized coal tends to flow like water. This characteristic greatly facilitates the charging and, as previously pointed out, the leveling functions. There are two principal methods being used today to transfer the preheated coal mix into the ovens, pipeline and gravity charging. In the former method the coal is conveyed under pressure from a storage bin and through a refractory lined circular conduit which runs the length on the charging side of the oven battery. At the appropriate times, valves are manipulated to permit the coal to flow directly into the oven being charged. There are two principal gravity methods being used: one utilizing a "hot car" which transfers one oven charge of preheated mix from metering bins directly to the coke oven, and one utilizing a "hot car" fed by redler conveyors transferring the mix from a storage bin.

The pipeline system claims certain advantages because the coal mix remains totally enclosed during charging, but because of the nature of its admission through the side of the ovens under pressure, the coal must settle of its own weight and some is carried over into the exhaust gases and tar stream. The "hot car" system must include dust collecting systems at transfer points, but because the charge is released downward into the oven by gravity, the charge is more dense and larger charges are possible. The "hot car" also has the flexibility of being able to charge wet coals should the preheater be out of service for any reason. All of the hot charging methods are "clean" by existing pollution guidelines.

Description of Process

There are many proven commercial processes used for dry coals as well as several methods for charging the preheated coal. The following is a brief description of the Coaltek System.

Wet coal is withdrawn from a storage bin by screw conveyors and screened, crushed and discharged to the preheater feed hopper.

Coal from the hopper is fed to the preheater by variable speed screw. The wet coal is fed into a flash-drying entrainment section where it comes into contact with a stream of hot oxygen-free gas. The gas carries the partly dried coal up to a dilute phase fluidized bed. A rotating swing hammer crusher in the lower part of the fluid bed chamber provides rapid dispersion and agitation of the coal particles in the gas stream and breaks the larger pieces into smaller pieces. All preheated coal goes overhead and is recovered in conventional cyclone separators.

Hot coal from the cyclones is conveyed to a hot coal receiving bin. From the receiving bin, the hot coal is conveyed as needed to an elevated measuring bin for transport to the ovens. The coal is conveyed through a pipeline to the ovens whenever an oven is ready. Coal transport in the pipeline is induced by means of steam jets strategically spaced along the pipeline.

Cost Comparison

At the present time, the capital and operating cost differences between preheating and pipeline charging and conventional wet coals with larry car charging are not discernible within the estimating limits of this study.

Of the capital cost items, the higher cost due to the inclusion of the preheating facilities are offset by the reduced number of coking ovens required to produce the same tonnage as conventional wet charge ovens.

The operating costs are similarly related.

The cost of preheating the coal mix is offset by the reduced heating requirements in the subsequent carbonization stage. Manpower requirements and by-product recovery are reasonably the same for either the preheated or the conventional coking systems.

Dry Coke Quenching vs. Wet Quenching

The major advantages of dry cooled coke expressed by proponents of the process are:

1. Utilization of the sensible heat in coke to produce 0.35 tons of steam at gauge pressure per ton of coke.

2. Improvement in the quality of the coke.

3. Provides coke devoid of moisture, therefore a savings in transportation costs.

Capital Costs

The published quotes for dry coke quenching facilities escalated to current prices, when compared to wet quenching costs appear to require an additional 20 million dollars for the Phase I requirements and 14 million dollars for the Phase II requirements.

Operating Costs

It would appear that the dry quenching process would require one additional man per shift per unit to operate the cooling station vs. no operators in a wet quench tower.

The maintenance costs required in the dry process would be somewhat offset by a reduction in quench car maintenance which is quite high in the wet process.

Both of the above items are relatively small and would increase the operating costs less than 0.4 percent.

The economical justification for the dry quenching process is based on credits derived from savings of fuel, i.e. utilization of the sensible heat of the coke. Dry coke cooling uses practically inert gas, which is recycled through a vertical shaft cooler where the gas is heated and the heat is then transferred via heat exchangers to produce steam or hot pressurized air for hot turbines; or 60 to 70% of the heat can be utilized most economically for coal drying and preheating.

The above credits are only applicable if the steam can be sold or the heat utilized in some manner.

As an example, a current cost for steam is about $8.25 per ton and at 0.35 tons of steam produced per ton of coke a savings in operating costs of about $3.00 could be realized

SECTION VII

[illegible]	DESCRIPTION	CAPACITY
1	COAL DUMPER	100 TONNES
2	RADIAL STACKER ~ 100M RADIUS	2000 TONNES/HR
3	STOCKPILE (HIGH VOLATILE)	192 000 TONNES
4	STOCKPILE (LOW VOLATILE)	192 000 TONNES
5[1]	RECLAIM CONVEYORS (2 SYSTEMS)	800 TONNES/HR
5[2]	RECLAIM CONVEYORS (3 SYSTEMS)	
6[1]	CRUSHERS (3 REQUIRED)	800 TONNES/HR
6[2]	CRUSHERS (4 REQUIRED)	
7[1]	CRUSHED COAL STOCK BINS	2 400 TONNES
7[2]	CRUSHED COAL STOCK BINS	3 200 TONNES
8	MIXING STATION	
9[1]	CONVEYORS TO COAL BINS	
9[2]	CONVEYOR TO COAL BINS	
10[1]	COAL BINS (3 REQUIRED)	3 000 TONNES/EA
10[2]	COAL BINS (5 REQUIRED)	
11[1]	COKE OVENS (3 BATTERIES OF 90)	
11[2]	COKE OVENS (5 BATTERIES OF 90)	
12	BYPRODUCT PIPING (PHASE I & II)	
13	LIGHT OIL STORAGE (PHASE I & II)	90 DAYS
14	TAR STORAGE (PHASE I & II)	90 DAYS
15	ANHYDROUS AMMONIA STORAGE (PHASE I & II)	90 DAYS
16	SULPHUR STORAGE (PHASE I & II)	90 DAYS
17	PIPE RACK FOR DOCKSIDE	
18	COKE WHARF	
19[1]	SCREEN HOUSE (2 SCREENS REQUIRED)	
19[2]	SCREEN HOUSE (3 SCREENS REQUIRED)	
20[1]	COKE BREEZE STOCKPILE	90 DAYS 52,500 TONNES
20[2]	COKE BREEZE STOCKPILE	90 DAYS 87 500 TONNES
21[1]	COKE PRODUCT STOCKPILE	30 DAYS 750 000 TONNES
21[2]	COKE PRODUCT STOCKPILE	30 DAYS 1,250 000 TONNES
22	DOCKSIDE COAL UNLOADING	
23[1]	DOCKSIDE COKE LOADING	
23[2]	DOCKSIDE COKE LOADING	
24	COKE BREEZE SHIPPING	
25	WORKSHOPS	
26	WAREHOUSE	
27	ADMINISTRATION OFFICES	
28	SECURITY FIRST AID & CHANGE ROOMS	
29	WASTE WATER TREATMENT PLANT (PHASE I & II)	
30	THAWING SHED	
31	COKE OVEN GAS MAIN	
32[1]	RESERVE COAL STOCKPILE	96 000 TONNES
32[2]	RESERVE COAL STOCKPILE	288,000 TONNES

NOTES:

1. ITEMS DENOTED THUS O[1] INDICATE PHASE I
2. ITEMS DENOTED THUS O[2] INDICATE PHASE II
3. ITEMS WITHOUT SUFFIX ARE FOR PHASE I & II OR AS INDICATED IN DESCRIPTION.
4. CAPACITIES & QUANTITIES SHOWN FOR PHASE II ITEMS INCLUDE PHASE I

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ARTHUR G. McKEE & CO.

CLIENT
GOVERNMENT OF CANADA
DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

McKee
ENGINEERS AND CONSTRUCTORS
TORONTO, ONTARIO

TITLE
5000 000 TONNE PER YEAR
COKE PLANT ~ PHASES I & II
PLOT PLAN

SCALE 1:2000 B.M. NO.

CCL348A-10-3

REVISION

NO.	DESCRIPTION	BY	CH.	APPROVED	DATE

DESIGNED
DRAWN
CHECKED
APPROVED 1
APPROVED 2
APPROVED 3

McKee

ENGINEERS AND CONSTRUCTORS