(3) Do you have the field map of the above field?

(a) Yes (b) No

If you have the map, please give us a copy of the map.

(a) Yes (b) No

(4) Do you have the analysis data of the Orinoco heavy crude for this F/S?

(a) Yes (b) No

If you have the analysis data, please give us a copy of the analysis data as basis of study.

(a) OK (b) No

(5) What do you suppose the price of Orinoco heavy crude at the up-grading plant fence?

US$ [ ] /BBL.
on [ ] (year)

☆ 5. SYNTHETIC CRUDE

(1) Is the synthetic crude a main product?

(a) Yes (b) No

(2) Is the properties of the synthetic crude fixed or not?

(a) fixed by by-pass of up-grading process

(a) Yes (b) No

(b) maximum up-grading

(a) Yes (b) No

(3) What are the properties of synthetic crude?
And do you have variation of the properties?

(a) API Gravity

(a) 20°API min.
(b) 22°API min.
(c) 25°API min.
(d) 27°API min.
(e) 30°API min.

(b) Sulfur Content

(a) 1 wt% max.
(b) 0.5 wt% max.
(c) 0.3 wt% max.

(c) Other

( )

(4) What do you suppose the price of synthetic crude at plant fence?

US$ [ ] /BBL.
on the condition of
[ ] °API
[ ] wt% S
[ ] year base

Syn. Crude

API	Sulfur (wt%)
22	1.0
24	1.0
26	1.0
28	1.0
30	1.0
32	1.0

Sulfur premium

Est. Price US$/BBL.

at [ ] years

[ ]

[ ] US$/0.1wt% S

☆ 6. SULFUR

→ Refer Fig.6, 7 & 8.

(1) Is it necessary to recover sulfur product from the sour gas of hydrodesulfurization units.

(a) Yes (b) No

(2) Is it necessary to recover sulfur product from flue gas of furnaces and boilers in the refinery.

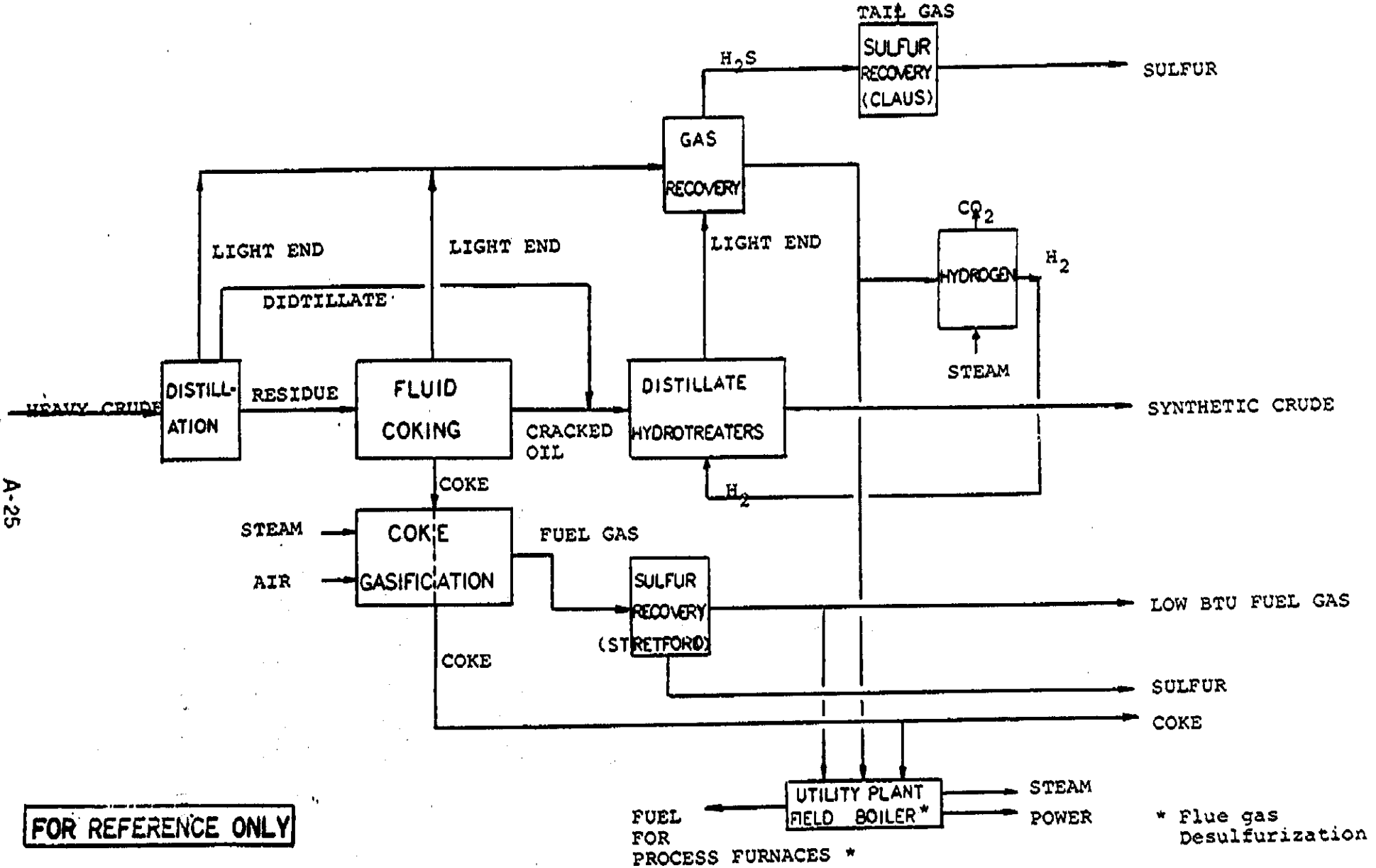
(a) Yes (b) No

(3) Is it necessary to recover sulfur product from the flue gas of boiler plant using by-products fuel?

(a) Yes (b) No

(4) What type of sulfur shall be produced?

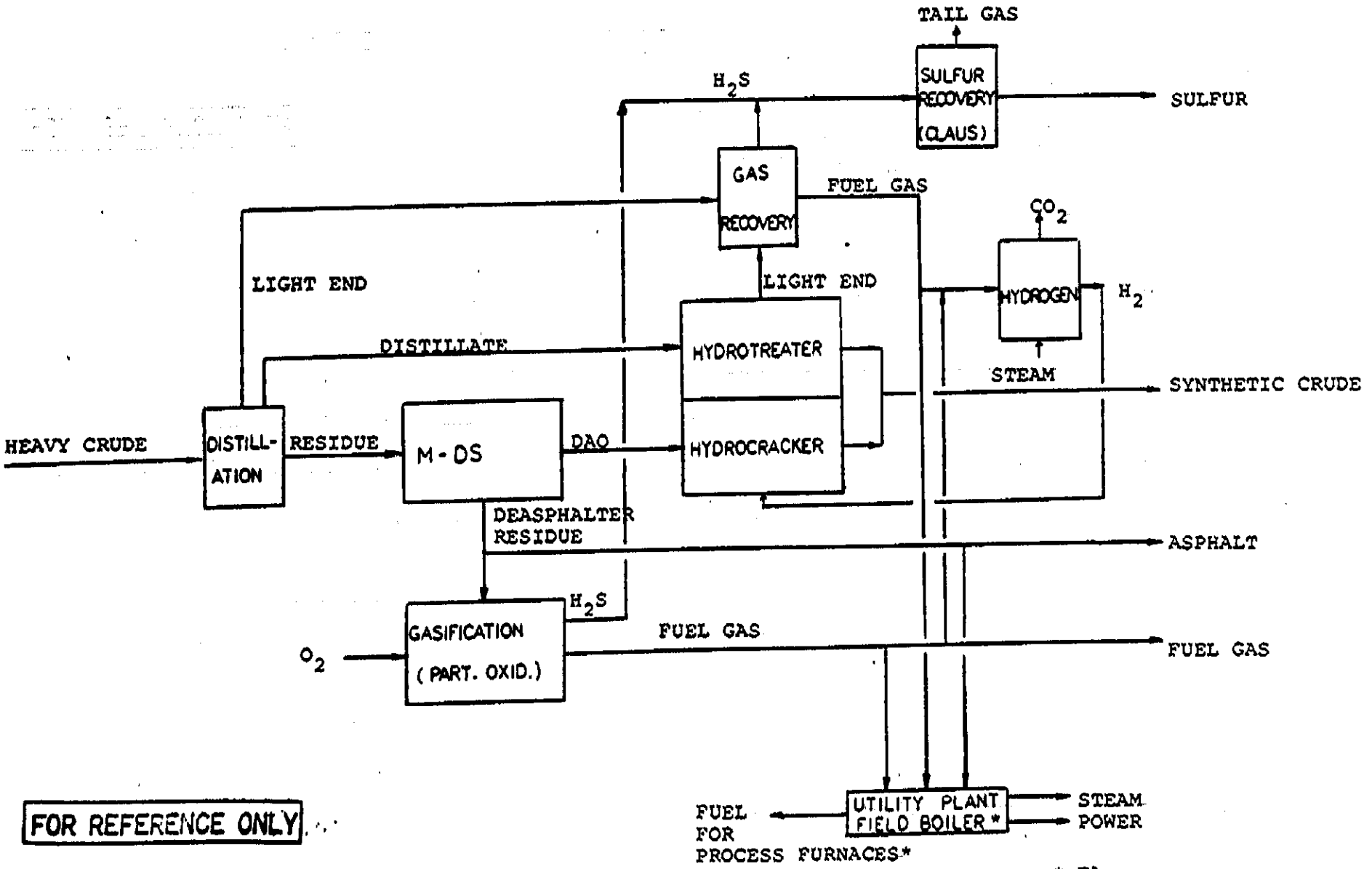
(a) Molten
(b) Solid



FOR REFERENCE ONLY

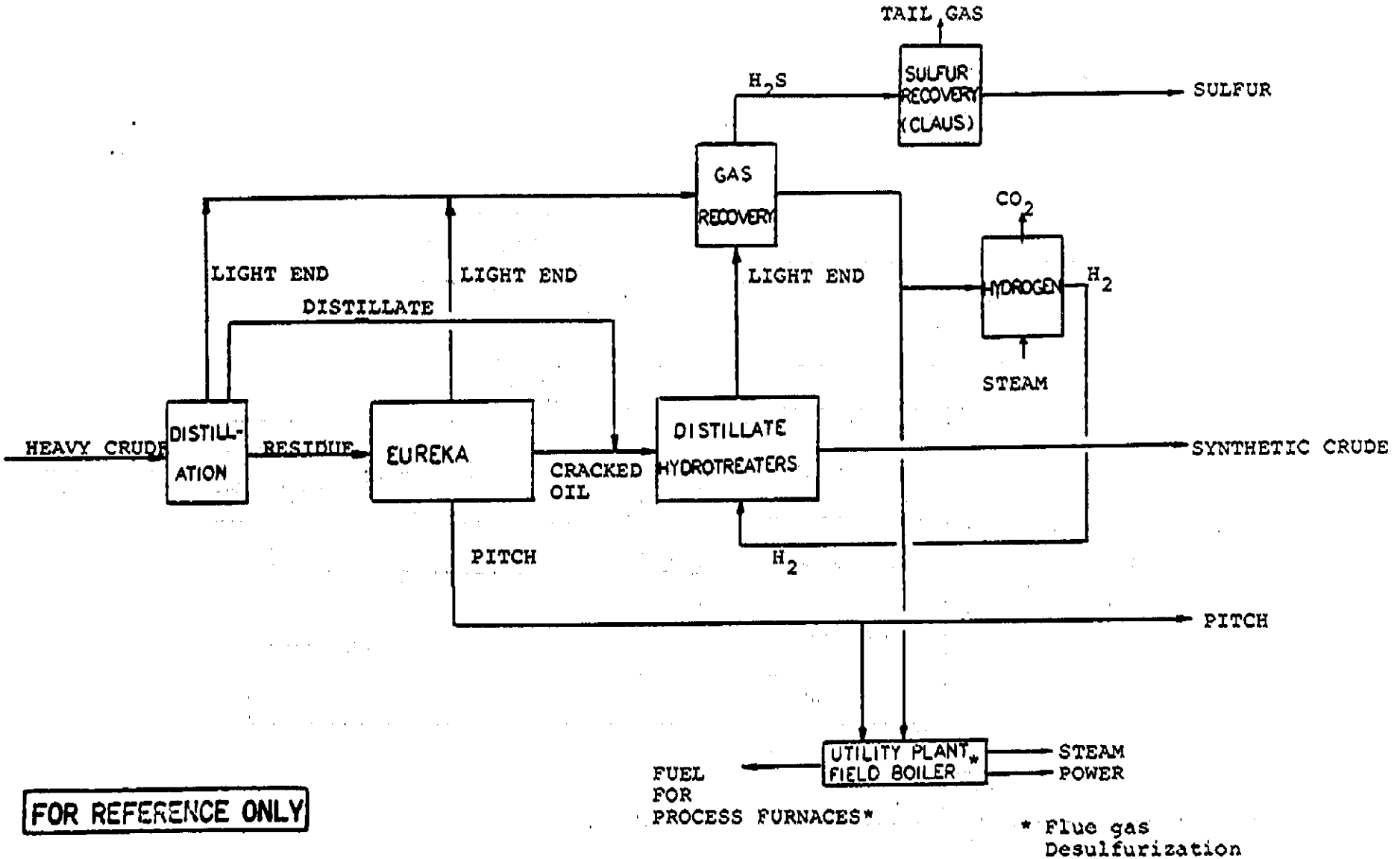
FIG 6

FLUID COKER & FLEXI COKER CASE



FOR REFERENCE ONLY

FIG 7 M-DS CASE



FOR REFERENCE ONLY

FIG. 8 EUREKA CASE

(5) What is the price of Sulfur product at plant site?

US$ [ ] /Ton

(6) Where is the destination of the sulfur product?

[ ]

(7) What is the purpose of utilization of sulfur?

[ ]

(8) How much tonnage is consumed for the above purpose of utilization?

[ ] Ton/D.

☆ 7. BY-PRODUCT (LOW GRADE FUEL)

(1) What is the use of the by-product?

(a) Fuel
(b) Other industries

(2) How many places are required for boiler plant sites?

[ ] sites.

(3) How far is it from the up-grading plant site to the each boiler sites?

[ ] Km (min)
[ ] Km (max)
[ ] Km (average)

(4) What is the price of by-product at the up-grading plant site or the boiler plant site?

US$ [ ] /MMBTU
at [ ] site

(5) Is it necessary to store the by-products for boiler fuel.

(a) Yes (b) No

(6) Is it necessary to use dual fuel?

(a) for operation of boiler during shutdown of refinery

(a) Yes (b) No

(b) for burning technology of by-product

(a) Yes (b) No

(7) How to relate to operation of field boiler and refinery for fuel supply?

(a) Shutdown of boiler
(b) Dual fuel
(c) Other

(8) When burning or transportation of by-products is difficult, is by-product processed in the refinery?

(a) Yes (b) No

☆ 8. STEAM

(1) How much heavy crude shall be produced by injection of steam used by-products fuel?

[ ] BPSD

(2) How much steam is required for production of the above crude or unit rate of steam and crude?

[ ] Ton/D.

[ ] Ton Steam/ BBL Crude

(3) What are the required specifications of injection steam at well head?

Pressure [ ] Kg/cm^2 G
Temperature [ ] °C

(4) What is the price of steam at the boiler plant site?

US$ [ ] /Ton
on [ ] Year

(5) What kind of steam supply method is applied for steam injection?

(a) Constant Continuous
(b) Not Constant Continuous
(c) Constant Intermittent
(d) Not Constant Intermittent

(6) In case of the "Not-Constant Steam" supply, what percent of boiler capacity to total average operating capacity is required normally?

[ ] %

(7) In the case of intermittent steam supply, what is the utilization of steam?

(a) Boiler stop
(b) Steam supply to other wells
(c) Steam loss

9. SITE DATA

Please give us the following data on the conditions of the selected site.
And please plot the oil wells, proposed up-grading plant site, boiler plant sites, utility sources, etc on the map.

(1) Can you give us the maps?

(a) General map of the area

(a) Yes (b) No

(b) Detailed map of the area showing highways, railroads and sidings, streams, surrounding communities, neighboring industries, harbours, airports, and so forth, together with future development plan.

(a) Yes (b) No

(c) Topographic map of the area showing commediate adjoining areas and indicating use of property, that is, residential, commercial, agricultural and so forth, together with future development plan.

(a) Yes (b) No

(d) An enlarged section map of the site showing contours and defining area and boundaries in relation to North.

(a) Yes (b) No

(e) Aerial and ground photographs of the entire site.

(a) Yes (b) No

10. UTILITY SUPPLY

(1) Water

(a) What kind of water source in the plant site is available for the plants?

(a) River water
(b) Lake
(c) Wells

(b) Where is the supply point and the route?

Please plot on the map.

(c) What do you suppose the supply cost at the plant?

US$ [ ] /Ton
on [ ] year

(d) How is the reliability of water supply as to quality and quantity?

Quality
(a) Good (b) Bad

Quantity
(a) Good (b) Bad

(e) Are there any restrictions or regulations on taking water or installing water intake, including right-of-way?

(a) Yes (b) No

(f) Please give us daily temperature records for the past several years.

		Time
	°C at	
	°C at	
	°C at	

(g) Please give us the analysis report and data of water.

(a) OK (b) No

(h) Is the water supply outside the scope of this study?

(a) Yes (b) No

(2) Electric Power Supply

(a) Can we expect the outside source of electrical power available for the plants in the area?

(a) Yes (b) No

(b) Please give us details of the outside power source.
Where is it?
How is the power capacity supplied?
Where is the supply point and the route?
What are voltage, phase and frequency.

[ ]
[ ] KW

[ ] V
[ ] Phase
[ ] Hz

(c) If the power source is under planning or construction, when will the power be available?

[ ] (Year)

(d) What is the supply cost?

US$ [ ] /KW
on [ ] (Year)

(e) If the power is not available from the outsite source, own power generation shall be planned?

(a) Yes (b) No

(f) What is used as fuel for power generation?

(a) by-product
(b) Synthetic Crude
(c) Natural gas

(g) Is the electric supply from the outside out of scope of this study?

(a) Yes (b) No

(h) What are the valtage and phase of electric power in the plant.

- Motor
- Lighting
- Instrument

V	Phase

(3) Fuel Supply

(a) May we understand the natural gas to be available for fuel and/or hydrogen resourse?

(a) Yes (b) No

(b) Where is the supply point and route?

What is the transmission method?

What is supply temperature and pressure at the supply point?

[ ] °C
[ ] Kg/cm^2G

(c) When the gas will be available?

(a) Now
(b) Future [ ] (Year)

(d) What is the supply cost at plant site?

US$ [ ] /SCF

(e) How reliable will it be?

(a) good (b) bad

(f) Please inform us of the heating value, pressure, composition?

[ ] BTU/SCF
[ ] Kg/cm^2G

C_1	[ ]	mol%
C_2	[ ]	
C_3	[ ]	
C_{4+}	[ ]	
N_2	[ ]	
CO_2	[ ]	
H_2S	[ ]	

(g) If the natural gas is not available, shall own fuel be used for the sources?

(a) Yes (b) No

What is own fuel?

(a) Offgas, LPG & by-product
(b) Offgas, LPG & Distillates

(h) Is the fuel supply from the outside covered by the scope of this study?

(a) Yes (b) No

11. GENERAL FACILITY

(1) Communication System

(a) Can we expect the following public communication system available in the area?

Telephon	(a) Yes (b) No
Cable	(a) Yes (b) No
Telex	(a) Yes (b) No
Mail	(a) Yes (b) No

(b) Should the plant have its own communication system?

(a) Yes (b) No

What is the system?

Telephon	(a) Yes (b) No
Cable	(a) Yes (b) No
Telex	(a) Yes (b) No

(c) If the public system is under or construction, when will it be available?

[ ] (Year)

(d) Are there any regulations and restrictions?

(a) Yes (b) No

Please give us its summary.

(a) OK (b) No

(2) Maintenance Facility

(a) Are there local shops and subcontractors who will support the maintenance work for the plant?

Mechanical workshops	(a) Yes (b) No
Electrical workshops	(a) Yes (b) No
Garages for automobiles	(a) Yes (b) No
Service shops for construction equipment	(a) Yes (b) No

(b) Please describe the status of the area industries in present and future.
Can you describe it?

(a) Yes (b) No

(c) Should the plant have its own maintenance facility?

(a) Yes (b) No

(3) Safety Facility

(a) Are there municipal fire fighting facilities in the area?

(a) Yes (b) No

(b) Are there any regulations and ordinances on fire fighting facility and plant layout?

(a) Yes (b) No

(c) Are there any medical facilities in the area?

(a) Yes (b) No

(d) Should the plant have its own fire fighting facility and medical facility?

(a) Yes (b) No

(4) Product Shipping

(a) Is it correct to understand that products (synthetic crude & sulfur) shipping is outside the scope of this study and battery limits of the study is the area inside the fence of the plant?

(a) Yes (b) No

(b) How many days shall be assumed as storage of products in the plant area before transmission to the port?

(a) 1 week
(b) 2 weeks
(c) [ ] days

(5) Waste Treatment and Disposal

(a) Please give us laws or regulations on the waste treatment and disposal in the existing refineries.

(a) OK (b) No

(b) Do you have any regulations for air pollution?

(a) Yes (b) No

(c) Do you have any regulations for water pollution?

(a) Yes (b) No

(6) Plant Building

If the general practices for the buildings are available, please give us a copy of the following from the existing refinery and oil production station.

(a) OK (b) No

Customary Office Requirements
Workers area
Parking areas
Locker room
Cafeteria
Sanitary facilities
Prevailing type of architecture

ATTACHMENT TO JICA-2

PRELIMINARY

TERMS OF REFERENCE

THE STUDY ON UP-GRANDING OF ORINOCO HEAVY OIL

OCTOBER, 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

PRELIMINARY

TERMS OF PEFERENCE

FOR

THE STUDY ON UP-GRADING OF ORINOCO HEAVY OIL

The study will be conducted on the following major investigation items, and the subsequent sections present the study outline.

1. Analysis of sample oil.

2. Site survey.

3. Review of the various process features of the four processes (Flexicoking, Fluidcoking, the M-DS process and the Eureka process.)

4. Plant planning and plant definition.

5. Investment and operating costs estimation.

6. Economic analysis.

7. Utilization of by-products.

8. Evaluation of Processes.

I. OBJECTIVES OF STUDY

1. General

In consideration of the world demand for petroleum products which will continually increase, it is necessary to evaluate not only the conventional reaserves but also the future alternatives.

In the presence of large reserves of the Orinoco heavy oil and the decline of reserves of Conventional crudes in Venezuela, it is meaningful to study the route of upgrading the heavy oil.

For these purposes, JICA intends to develop a plan relating to up-grading of the Orinoco oil, which will lead to the production of a synthetic crude oil.

2. Purpose of the study

The study intends to supply informations required for process selection that is used for evaluation of construction plan of commercial plant for up-grading of Orinoco heavy oil.

An object of process for the study is limitted to four schemes using the four processes (Flexicoking, Fluidcoking, the M-DS process and Eureka process).

II. BASIS OF THE STUDY AND INFORMATION TO BE FURNISHED BY MEM

1. Orinoco Heavy Oil.

   (1) Official name of the crude oil for the study.

   (2) Analysis of the crude oil.

   (3) Supply Conditions.
   Available at the plant fence at the pressure of _____ psig. (kg/cm^2g)

2. Through-put Capacity.

   100,000 BPSD

3. Main Product.

   A synthetic crude that has no more than 22°API specific gravity, no more than 1% sulfur content. The synthetic crude is defined as the product oil excluding gas and LPG.

4. By-products

   (1) By-products are to be used to generate steam that is used for production of raw crude and for other purposes at onsite and offsite facilities.

   (2) Sulfur recovery units are installed for a hydro-desulfurization unit and for a by-product combustion furnace.
   Recovered sulfur is solidified in particle form to premit sale or storage.

5. Site

General information on the site is based on a map of the project area showing the following:

(1) Anticipated up-grading site.

(2) Crude oil wells.

(3) Anticipated site of steam generation for injection.

(4) Supply point of water for utilities and boiler feed.

(5) Supply point of electric power, if available.

6. Steam Generation for Raw Oil Production.

(1) Boiler capacity.

(2) Average operating ratio.

(3) Steam temperature and pressure.

(4) Boiler plant location.

III. SCOPE OF WORK

1. Analysis of Sample Oil.

   (1) To prepare the uniform sample for analysis by blending crude sample of five drums.

   (2) To analyze the uniform sample to obtain the basic data for the up-grading process.

2. Confirmation of Basis of the Study. (by 1st Survey Team)

   Items to be confirmed are as per described in II.

3. Site Survey. (by 2nd Survey Team)

   (1) To explain the results of preliminary study on the four processes (Flexicoking, Fluidcoking, the M-DS process and the Eureka process)

   (2) To collect data and information for planning of the up-grading plant.

      (a) Geographical data.
      (b) Utilities supply conditions.
      (c) Infrastructure conditions.
      (d) Conditions related construction works.
      (e) Basis of Economic Analysis.

4. Review of the Technology of the Processes.

   (1) Features.

   (2) Process development.

   (3) Feedstock and yield.

   (4) Process description.

   (5) Process flow diagram.

   (6) Utility requirements.

   (7) By-product utilization.

5. Plant Planning and Plant Definition.

   (1) Process scheme for synthetic crude production.

   (2) Overall material balance.

   (3) Product quality.

   (4) Utility facilities.

   (5) Oil handling facilities.

   (6) Offsite facilities.

   (7) Utilities requirements.

   (8) Operating requirements.

   (9) General plot plan.

6. Investment and Operating Costs.

   (1) Capital Requirements.

   (2) Operating Cost.

   (3) Costs of Production.

7. Economic Analysis.

   (1) Basis and procedure.

   (2) Profit & loss.

   (3) Cash flow analysis.

   (4) Internal rate of return.

8. Utilization of By-product.

   (1) By-product.

   (2) Transmission system.

   (3) Combustion characteristics and performance of boiler.

9. Evaluation.

(1) Technical.

(2) Economics.

(3) By-product.

IV. REPORTING

1. All documents shall be prepared in English.

2. Metric system shall be used for units, except for the conventional ones broadly used in the petroleum industry.

ATTACHMENT-2

Caracas, October 10, 1979

Record of Discussions

The Venezuelan authorities concerning with Orinoco Oil development, which are Ministerio de Energía y Minas, Petróleos de Venezuela S.A., Lagoven, S.A. and Instituto Tecnológico Venezolano del Petróleo, and the Japanese First Survey Team for the Up-Grading Project of Orinoco Heavy Oil in the Republic of Venezuela, sent by Japan International Cooperation Agency (hereinafter referred to as "JICA"), had discussions based on the attached paper JICA-1 and JICA-2.

The schedule of discussions and persons who participated in the discussions are listed in the attached sheets annex-1 and annex-2.

Both parties confirmed the paper JICA-1 and exchanged views based on the paper JICA-2.

The following is a summary of the result of discussions.

1.- Supply of the Orinoco Heavy Oil.

The Venezuelan authorities concerned will make every possible effort to supply 5 drums (200 l/drum), completely sealed, of the raw Orinoco heavy oil sample to JICA.

2.- Basic Conditions for the Study

2.1 Feed Oil of the Up-Grading Refinery

(1) Name of the Raw Orinoco Heavy Oil
Cerro Negro crude oil

(2) Feed Oil to the Up-Grading Refinery
Mixture of Cerro Negro crude oil and diluent for the oil productions.

(3) Diluent for the Oil Profuction
Distillate, mainly gas oil of the up-grading refinery is recycled.

(4) Rate of Diluent

Diluent/Cerro Negro crude oil = 0.3/1 on volume basis.

(5) Analysis Data of Raw Orinoco Heavy Oil for the preliminary study use.

As per the attached analysis data

(6) Capacity of the Up-Grading Refinery

To produce 125,000 BPSD of product oil

2.2 Product of the Up-Grading Refinery

(1) Kind of Product (Synthetic crude)

Improved crude oil including maximum middle distillate

(2) Properties of Product

Gravity : About 25°API – 28°API (42.6)

Sulfur : 1 Wt% max.

(3) Residual Oil

Residual oil of the raw crude oil shall not be included in the product.

2.3 By-Products of the Up-Grading Refinery

(1) Use of By-Product

Fuel for the generation of steam and electric power for the oil production and the up-grading refinery.

(2) Boiler Plant Site

One centralized boiler plant in the up-grading refinery

2.4 Sulfur Recovery

(1) Recovery Sources

Sour gas of hydrodesulfurization units and flue gas of furnaces and boilers

(2) Type of Sulfur

Molten Sulfur for export

2.5 Steam and Electrical Power Requirements for Oil Production

(1) Steam

.../...

1.5-3.0 Barrel crude oil/Ton steam at continuous injection stage.

Pressure of steam is 1400-~~2500~~ 2500 psig at the outlet of boiler

(2) Electrical Power

50-60 MW at continuous injection stage for the production of the crude oil to be fed to the up-grading refinery of which capacity is per item 2.1(6).

3.- Scope of Work

The feasibility study excludes the survey on financing, the marketing of the synthetic crude, the infrastructure and site selection of the plant and is limited to the plant facilities for the up-grading of the crude.

The detailed scope of the work is shown in the attached annex 2.

4.- Reporting

4.1 All documents shall be prepared in English.

4.2 Metric system shall be used for units, except for the conventional ones broadly used in the petroleum industry.

Dr. Arévalo Guzman Reyes
Director General Sectorial
Ministerio de Energía y Minas

Senichi Hirose
Chief of the Japanese First Survey Team for the Up-Grading Project of Orinoco Heavy oil in the Republic of Venezuela

c.c.: Petroleos de Venezuela S.A.
c.c.: Lagoven S.A.
c.c.: Instituto Tecnológico Venezolano de Petróleo.

S C H E D U L E O F V I S I T

DATE	TIME	PLACE	ATTENDANT
October 3, 1979	10:10 - 12:10	Ministerio de Energía y Minas	Attached MEM's members list, the Japanese first survey team's members list and Mr. Katsuhiko TSUNODA Councilor, Embassy of Japan, Caracas Mr. Hiroshi MITSUKAWA First Secretary, Embassy of Japan, Caracas
October 3, 1979	15:00 - 17:00	Petróleos de Venezuela S.A.	Attached PETROVEN's members list, the Japanese first survey team's members list and Mr. Katsuhiko TSUNODA Councilor, Embassy of Japan, Caracas Mr. Hiroshi MITSUKAWA First Secretary, Embassy of Japan, Caracas

October 4, 1979	10:00 - 12:00	Petróleos de Venezuela S.A.	Attached PETROVEN's members list and the Japanese first survey team's members list
October 4, 1979	14:45 - 16:10	Lagoven, S.A.	Attached LAGOVEN's members list, the Japanese first survey team's members list and Mr. Terukazu KATAOKA Director, C.Itoh & Co. de Venezuela S.A.
October 5, 1979	9:00 - 12:00	Instituto Tecnológico Venezolano del Petróleo	Attached INTEVEP's members list and the Japanese first survey team's members list
October 8, 1979	9:15 - 14:30	Cerro Negro, Morichal and Jobo fields	Attached LAGOVEN's field members list, the Japanese first survey teams members list and Dr. Edison Perozo, Petróleos de VenezuelaSA Mr. Minoru NAGATA, Japan National Oil Corporation
October 10, 1979	14:00 -	Ministorio de Energía y Minas	Attached MEM/ PETROVEN's members list and the Japanese first survey team's members list and Mr. Katsuhiko TSUNODA Councilor, Embassy of Japan, Caracas Mr. Hiroshi MITSUKAWA First Secretary, Embassy of Japan, Caracas

MINISTERIO DE ENERGIA Y MINAS

Dr. Arévalo Guzmán Reyes	Director General Sectorial de Hidrocarburos
Dr. Ernesto Agostini	Jefe de la División de Conservación
Dr. José Manuel Tineo	Director de Planificación Económica de Hidrocarburos
Lic. Rene Arreaza	Asistente del Ministro
Dra. Mariella Ricardo	Jefe del Dpto. de Refinación
Dr. José G. Mendez Z.	Asesor de Exploración
Dr. Ricardo Nuñez	Jefe Dpto. de la División de Refinación

PETROLEOS DE VENEZUELA, S.A.

Dr. Luis Plaz Bruzual	Director de PDVSA
Dr. Edison Perozo	Petroleum Engineering Manager Orinoco Oil Belt - PDVSA
Dr. Carlos Borregales	Orinoco Oil Belt Coordinator - PDVSA
Dr. José Prats	Planning Manager. Refinery Coordinatio: PDVSA
Dr. Angel Behrends	Refinery Coordinator - PDVSA
Dr. Carlos de Castro	International Affairs

INSTITUTO TECNOLOGICO VENEZOLANO DEL PETROLEO

Dr. Néstor Berroeta	Gerente, Grupo de Refinación y Petroquímica
Dr. Paulino Andreu	Gerente, Grupo de Ingeniería de Procesos
Dr. José Luis Calderón	Gerente, Grupo de Análisis y Evaluación
Lic. José Rafael Malpica	Gerente de Información y Relaciones
Dra. Carmen Alvarez	INTEVEP (Project evaluation) Chemical Engineer
Dra. Adelina Ayerbe	Chemical , Catalyst Characterization
Dr. Domingo Rodriguez P.	Process Design, Combustion Engineer
Dr. Franzo Marruffo	Manager, Process Eval., Head Combustion Process, Ch. Eng.
Dr. Jacinto Pachano	Process Development, Deasphalting
Sra. Marina de Canejo	Coordinación de Eventos

LAGOVEN, S.A.

Dr. R.V. Mandini	Central Division MNAR	PROD. DEPT.
Dr. M.J. Treviño	Plan. Coor. Dept.	DSM Production team
Dr. A. Sosa	Prod. Ing. de Petroleo	Ing. de Proyectos
Dr. M. Vasquez	Prod. Planificación DSM	Ing. de Prod.
Dr. J.R. Luengo	Pet. Engineer	Heavey Oil Projects Production Department
Dr. Forest Lighty	Coordination Team	DSM Project
Dr. A. Santos	Jefe Ep. Exploración Faja Department	Prod. Dept.

L A G O V E N S. A. (FIELD)

Ing. L. J. Rengel V.	Oper. Superintendente
Ing. Luis Izarra	Superintendente de Producción
Ing. Gesoniel Zambrano	Special Projects Superviser
Dr. Alfredo Vasquez B.	Sup. Relaciones Públicas

SCOPE OF WORK

1. Analysis of Sample Oil

   (1) To prepare the uniform sample for analysis by blending crude sample of five drums

   (2) To analyze the uniform sample to obtain the basic data for the up-grading process

2. Confirmation of Basis of the Study (by 1st Survey Team)

3. Site Survey (by 2nd Survey Team)

   (1) To explain the results of preliminary study on the four processes (Flexicoking, Fluidcoking, the M-DS process and the Eureka process)

   (2) To collect data and information for planning of the up-grading plant

      (a) Geographical data

      (b) Utilities supply conditions

      (c) Infrastructure conditions

      (d) Conditions related construction works

      (e) Basis of Economic Analysis

4. Review of the Technology of the Processes

   (1) Features

   (2) Process development

   (3) Feedstock and yield

   (4) Process description

   (5) Process flow diagram

   (6) Utility requirements

   (7) By-product utilization

../..

5. Plant Planning and Plant Definition
   (1) Process scheme for synthetic crude production
   (2) Overall material balance
   (3) Product Quality
   (4) Utility facilities
   (5) Oil handling facilities
   (6) Offsite facilities
   (7) Utilities requirements
   (8) Operating requirements
   (9) General plot plan

6. Investment and Operating Costs
   (1) Capital Requirements
   (2) Operating Cost
   (3) Costs of Production

7. Economic Analysis
   (1) Basis and procedure
   (2) Profit & loss
   (3) Cash flow analysis
   (4) Internal rate of return

8. Utilization of By-product
   (1) By-product
   (2) Transmission system
   (3) Combustion characteristics and performance of boiler

9. Evaluation
   (1) Technical
   (2) Economics
   (3) By-product

THE MEMBERS OF THE FIRST SURVEY TEAM

FOR

THE UP-GRADING PROJECT

OF

ORINOCO HEAVY OIL IN THE REPUBLIC OF VENEZUELA

Name	Function	Title
Mr. Sen'ichi HIROSE	Project Manager (Chief of the Team)	Consultant to JICA
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ATTACHMENT-3

LAGOVEN, S. A.

(Filial de PETROLEOS DE VENEZUELA)
Refinería de Amuay-Judibana

12 de junio de 1979

LAB-79-0093

LAGOVEN - CARACAS
Departamento de Planificación
Atención: Sr. Humberto Vidal/Sr. Karl Mazeica

Ref: Ensayo de Productos Combustibles de crudo Cogollar IX - Cerro Negro Nº LV.5C-PC.79

Con la presente les hacemos llegar el ensayo de crudo COGOLLAR IX - CERRO NEGRO efectuado en muestra de 8.5 °API representativa de la mezcla 50/50 % de los crudos Cogollar IX y Cerro Negro, según su cable COP 023 del 6/4/79.

Observaciones:

Fracción lubricante:

a) Naturaleza: Nafténica.
b) Rendimiento: 17.8% Vol. Comparable con crudos convencionales.
c) Indice Viscosidad: Menos 115

Asfaltos:

a) AC-10 y AC-20: Altas pérdidas por calentamiento y baja ductilidad. No cumplen especificaciones AASHTO M226-761. Tabla 2.

En caso de necesitar mayor información, sírvanse comunicárnoslo.

Atentamente,

LAGOVEN-AMUAY
Luis Urdaneta Y.

Rodolfo E. Parra

Orig. y 10 copias

cc: Depto. de Comercio y Suministro-Caracas
Atn.: Sr. L. Díaz

Depto. de Producción-Caracas
Atn.: Sr. J. Roger

Amuay:

Gerente Técnico
Gerente de Operaciones
Planif. e Ing. de Proceso
Contraloría
Coordinación
CIRA
Archivo Central (2)
Laboratorio (3)

CRUDE: COGOLLAR IX - CERRO NEGRO

COUNTRY: VENEZUELA

REPRESENTATIVE OF: 50/50% COGOLLAR IX AND CERRO NEGRO

REPORT Nº LV.SC-PC.79

REPORT DATE: JUNE, 1979

REPORT BY: RODOLFO E. PARRA B.

DATE RECEIVED: MARCH 29, 1979

DATE DISTILLED: APRIL 27, 1979

ASSAY RUN BY: LAGOVEN, S. A.
LABORATORY - AMUAY REFINERY
JUDIBANA - FALCON, VENEZUELA

SPONSORED BY: LAGOVEN, S. A.
PLANIFICATION DEPARTMENT
CARACAS, VENEZUELA, S. A.

TABLE 1

CRUDE	GOGOLLAR EE - CERRO NEGRO	LT.SC-PC.19

WHOLE CRUDE DATA

GRAVITY	°API		8.5
SPECIFIC GRAVITY	60/60		1.011
SULFUR	Wt. %		3.67
MERCAPTAN SULFUR	Wt. PPM		NIL
POUR POINT	°F		+50
NITROGEN	Wt. %		0.57
WATER AND SEDIMENT	Vol. %		1.0
SALT CONTENT, NaCl	PTB Lb/1000 Bbl.		230
Con Carbon	Wt. %		13.3
H_2S DISSOLVED	Wt. PPM		84
NEUT. NO. (BOM)	mg KOH/gm		1.39
VISCOSITIES	KINEMATIC *	130°F, cSt	10517
		140°F, cSt	5544
		150°F, cSt	831
	SAYBOLT UNIVERSAL *	140°F, SEC	27503
		180°F, SEC	4191
Metals	Iron	Wt. ppm	9
	Vanadium	Wt. ppm	332
	Nickel	Wt. ppm	84

LIGHT HYDROCARBONS		
% OF CRUDE	WEIGHT	VOLUME
ETHANE AND LIGHTER	0.01	0.01
PROPANE	0.01	0.03
ISO BUTANE	0.02	0.04
NORMAL BUTANE	0.04	0.07
ISO PENTANE	0.32	0.03
NORMAL PENTANE	0.01	0.02

TABLE 3

CRUDE: CIUDAD BX - CERRO NEGRO

LAGOVEN

PERCENT DISTILLED VS ISIS ASSAY STILL TEMPERATURE (FAHRENHEIT)

ISIS CUT POINT °F	TOTAL DISTILLED - % VOLUME ON CRUDE									
	0	10	25	30	40	50	60	75	80	90
100										
200										
300										
400		1.1	1.4	1.7	2.1	2.5	2.9	3.3	3.7	4.2
500	4.8	5.2	5.8	6.4	6.9	7.5	8.2	8.9	9.5	10.2
600	11.0	11.7	12.5	13.2	14.0	14.8	15.8	16.5	17.4	18.1
700	19.0	19.8	20.5	21.3	22.0	22.6	23.5	24.3	25.0	25.9
800	25.6	27.4	28.2	29.1	29.9	30.6	31.5	32.3	33.1	34.0
900	34.8	35.6	36.4	37.4	38.1	39.0	39.9	40.6	41.5	42.5
1000										

T A B L A 3

COGOLLAR-C.NEGRO DATOS INTRODUCIDOS Y CALCULADOS 8.5 GDS API

TEMPERATURA GDS F	GDS C	% VOL NORM. REN CRUDO	ACUM	MEDIO	GRAVEDAD GDS API	ESPECIFICA	SUMA DE GRAV ESPEC. X % VOL	IN A 67 GDS C	PTO ANIL GDS F	SUMA DE % VOL TX PTO A	TX VOL (LTAROM.)	SUMA DE % VOL X AROM.	NAFT. % VOL	% X NAFT.
0	0.0	0.01	0.01	0.00	246.8	0.3740	0.00374							
0	0.0	0.07	0.09	0.04	147.1	0.5074	0.03929							
0	0.0	0.05	0.13	0.10	119.8	0.5631	0.06745							
68	20.0	0.07	0.20	0.16	110.8	0.5840	0.10835							
0	0.0	0.03	0.23	0.21	94.9	0.6250	0.12704							
0	0.0	0.02	0.25	0.24	92.7	0.6311	0.13970							
401	205.0	0.72	0.97	0.61	36.9	0.8403	0.74469	1.4370	118	85.0	57.3	26.9	0.0	0.0
428	220.0	0.74	1.71	1.34	34.1	0.8545	1.37649	1.4445	119	173.0	62.7	73.3	0.0	0.0
455	235.0	1.03	2.74	2.22	32.3	0.8639	2.26077	1.4510	118	294.6	69.2	144.5	0.0	0.0
482	250.0	1.18	3.92	3.33	30.5	0.8735	3.29744	1.4570	118	433.8	76.9	235.3	0.0	0.0
509	265.0	1.22	5.14	4.53	28.9	0.8822	4.37369	1.4625	116	575.3	87.1	341.5	0.0	0.0
536	280.0	1.60	6.74	5.94	26.9	0.8933	5.80298	1.4686	114	757.7	88.5	482.8	0.0	0.0
563	295.0	1.60	8.34	7.54	25.5	0.9013	7.24502	1.4745	112	936.9				
590	310.0	1.90	10.24	9.29	23.8	0.9111	8.97619	1.4805	110	1145.9				
617	325.0	2.17	12.41	11.32	22.1	0.9212	10.97524	1.4870	108	1380.3				
650	343.3	2.73	15.14	13.77	20.0	0.9340	13.52504	1.4942	105	1666.9				
671	355.0	1.30	16.44	15.79	18.7	0.9421	14.74973	1.5016	106	1804.7				
698	370.0	2.20	18.64	17.54	17.1	0.9522	16.84462	1.5084	108	2042.3				
725	385.0	2.01	20.65	19.64	16.4	0.9567	18.76762	1.5112	111	2265.4				
752	400.0	2.09	22.74	21.69	16.1	0.9587	20.77124	1.5135	116	2507.9				
779	415.0	2.32	25.06	23.90	15.5	0.9626	23.00444	1.5158	118	2781.6				
806	430.0	1.97	27.03	26.04	14.7	0.9679	24.91110	1.5174	119	3016.1				
833	445.0	2.21	29.24	28.13	14.3	0.9705	27.05591	1.5200	121	3283.5				
851	455.0	1.39	30.63	29.93	14.0	0.9725	28.40768	1.5218	124	3455.8				
887	475.0	2.99	33.62	32.12	13.3	0.9772	31.32954	1.5240	126	3832.6				
914	490.0	2.16	35.78	34.70	13.0	0.9792	33.44470	1.5260	127	4106.9				
950	510.0	3.19	38.97	37.37	12.6	0.9820	36.57712	1.5284	128	4515.2				
995	535.0	3.82	42.79	40.88	12.2	0.9847	40.33864	1.5304	132	5019.4				
995+	535.0+	57.21	100.00	71.39	1.8	1.0615	101.06790							

T A B L A 3 A

COGOLLAR-C.NEGRO DATOS INTRODUCIDOS Y CALCULADOS 8.5 GDS API

TEMPERATURA GDS F	GDS C	% PESO CALC CRUDO	% PESO NORM. EN CRUDO	% PESO NORM. ACUM	% PESO NORM. MEDIO	SUMA % PESO AZUFRE X % PESO NORM	% PESO AZUFRE	% PESO CON CARBON	SUMA % PESO CON CARBON X % PESO NORM	% PESO NITROGENO	SUMA % PESO NITROGENO X % PESO NORM
0	0.0	0.00	0.00	0.00	0.00						
0	0.0	0.04	0.04	0.04	0.02						
0	0.0	0.03	0.03	0.07	0.05						
68	20.0	0.04	0.04	0.11	0.09	0.0	0.0				
0	0.0	0.02	0.02	0.13	0.12	0.0	0.0				
0	0.0	0.01	0.01	0.14	0.13	0.0	0.0				
401	205.0	0.60	0.60	0.74	0.44	0.399	0.6510				
420	220.0	0.63	0.63	1.36	1.05	0.928	0.6600				
455	235.0	0.88	0.88	2.24	1.80	1.860	1.0650				
482	250.0	1.02	1.02	3.26	2.75	3.218	1.3280				
509	265.0	1.06	1.06	4.33	3.80	4.912	1.5910				
536	280.0	1.41	1.41	5.74	5.03	7.578	1.8850				
563	295.0	1.43	1.43	7.17	6.46	10.617	2.1500			0.0009	0.0013
590	310.0	1.71	1.71	8.88	8.02	14.632	2.3400			0.0015	0.0039
617	325.0	1.98	1.98	10.86	9.87	19.424	2.6270			0.0030	0.0098
650	343.3	2.52	2.52	13.38	12.12	27.215	2.9240	0.0	0.0	0.0070	0.0274
671	355.0	1.21	1.21	14.59	13.99	31.118	3.2210	0.07	0.0808	0.0140	0.0444
698	370.0	2.07	2.07	16.67	15.63	37.858	3.2620	0.07	0.2209	0.0240	0.0942
725	385.0	1.90	1.90	18.57	17.62	44.097	3.2790	0.07	0.3631	0.0400	0.1779
752	400.0	1.98	1.98	20.55	19.56	50.604	3.2920	0.08	0.5217	0.0600	0.3127
779	415.0	2.21	2.21	22.76	21.66	57.858	3.2830	0.10	0.7427	0.1040	0.5425
806	430.0	1.89	1.89	24.65	23.70	64.455	3.2850	0.13	0.9879	0.1430	0.9125
833	445.0	2.12	2.12	26.77	25.71	71.057	3.2900	0.17	1.3487	0.1700	1.1900
851	455.0	1.34	1.34	28.11	27.44	75.440	3.2920	0.23	1.6563	0.0200	1.2107
887	475.0	2.89	2.89	31.00	29.55	84.963	3.2940	0.32	2.5814	0.0220	1.2803
914	490.0	2.09	2.09	33.09	32.04	91.863	3.2970	0.53	3.6906	0.0240	1.3306
950	510.0	3.10	3.10	36.19	34.64	102.044	3.2990	0.80	6.3560	0.0260	1.4112
995	535.0	3.72	3.72	39.91	38.05	114.593	3.3600	1.70	12.6831	0.0270	1.5116
995+	535.0+	60.09	60.09	100.00	69.96	373.210	4.3040			0.8250	51.0439
		------- 100.00									

T A B L A 3 -

CUGOLLAR--C. (...) MEZCLAS CALCULADAS   8.5 GDS API

RANGO, TEMP. F		% VOL INIC	% VOL FINAL	RENDIMIENTO % VOLUMEN	% VOL MEDIO	GDS API	GRAVEDAD ESPECIFICA	% PESO	% PESO AZUFRE	IND. A GDS C	% CON. CARBON	NITROGENO % PESO	PTO. ANILINA	PARAFINAS % VOL	NAFTENOS % VOL
401	509	0.97	5.14	4.17	3.06	31.09	0.8735	3.50	1.2595	1.4509			118	75.5	0.0
401	650	0.97	15.14	14.17	8.05	25.80	0.9010	12.65	2.1213	1.4788			112	0.0	0.0
428	536	1.71	6.74	5.03	4.22	29.31	0.8790	4.36	1.5185	1.4808			110	61.4	0.0
509	590	5.14	10.24	5.10	7.69	25.30	0.9025	4.55	2.1544	1.4784		0.0008	112	0.0	0.0
536	650	6.74	15.14	8.40	10.94	22.82	0.9165	7.66	2.5701	1.4855		0.0036	104	0.0	0.0
590	650	10.24	15.14	4.90	12.69	20.92	0.9283	4.60	2.7957	1.4910		0.0052	106	0.0	0.0
590	698	10.24	18.64	8.40	14.44	19.50	0.9367	7.79	2.9434	1.4972		0.0116	107	0.0	0.0
550	752	15.14	22.74	7.60	18.94	16.91	0.9535	7.17	3.2622	1.5094	0.07	0.0394	111	0.0	0.0
650	851	15.14	30.63	15.49	22.88	15.77	0.9608	14.73	3.2759	1.5140	0.11	0.0608	115	0.0	0.0
650	995	15.14	42.79	27.65	28.96	14.41	0.9698	26.53	3.2935	1.5199	0.48	0.0559	121	0.0	0.0
752	851	22.74	30.63	7.89	26.68	14.70	0.9679	7.50	3.2871	1.5184	0.15	0.1197	120	0.0	0.0
779	995	25.06	42.79	17.73	33.92	13.23	0.9777	17.15	3.3079	1.5250	0.70	0.0565	126	0.0	0.0
851	950	30.63	38.97	8.34	34.80	12.95	0.9796	8.06	3.2967	1.5262	0.58	0.0241	127	0.0	0.0
851	995	30.63	42.79	12.16	36.71	12.72	0.9812	11.60	3.3166	1.5275	0.93	0.0250	129	0.0	0.0
950	995	38.97	42.79	3.82	40.88	12.20	0.9847	3.72	3.3500	1.5304	1.70	0.0270	132	0.0	0.0

RESIDUOS

GDS F TEMP.	REND. % VOL.	GDS API	GRAVEDAD ESPECIFICA	REND. % PESO	AZUFRE % PESO	CON. CARBON % PESO	NITROGENO % PESO
995+	57.21	1.8	1.0615	60.09	4.56	25.68	0.82
950+	61.03	2.4	1.0567	63.91	4.25	24.28	0.79
851+	69.37	3.0	1.0471	71.89	4.14	21.62	0.69
752+	77.20	4.6	1.0393	79.45	4.06	19.58	0.64
698+	81.35	5.2	1.0352	83.33	4.02	18.67	0.61
650+	84.86	5.7	1.0310	86.62	3.94	17.98	0.58
563+	91.69	6.7	1.0236	92.83	3.91	16.76	0.55
428+	98.29	8.0	1.0143	98.64	3.77	15.77	0.52

INICIAL F	401	509	590	650	752	851	950	428	536	650	851
FINAL F	509	590	650	752	851	950	995	536	650	851	995
AR =	8.34	11.31	14.05	16.01	14.09	15.08	18.04	9.10	13.35	14.23	18.06
NR =	42.75	46.57	51.06	55.35	56.20	57.88	59.15	43.79	44.90	55.91	58.17

TABLE [illegible]

CRUDE	
COGOLLAR II - CERRO NEGRO	LV.5C-PC.79

HYDROCARBON COMPONENT ANALYSIS

15/5 CUT POINT	°F VT	GAS TO 38	
15/5 CUT POINT	°C VT	GAS TO 3	
YIELD CUT RANGE	VOL %	0 - 0.25	
YIELD ON CRUDE	VOL %	0.25	

	GAS CHROM MOL % OF GAS	LIQ. VOL % ON CRUDE		
ETHANE	5.7	0.01		
PROPANE	32.4	0.07		
iso BUTANE	15.5	0.05		
n-BUTANE	28.5	0.07		
iso PENTANE	10.4	0.03		
n-PENTANE	5.8	0.02		
2,2-DIMETHYLBUTANE				
2,3-DIMETHYLBUTANE				
2-METHYLPENTANE				
3-METHYLPENTANE				
CYCLOPENTANE				
n-HEXANE				
2,2-DIMETHYLPENTANE				
2,4-DIMETHYLPENTANE				
METHYLCYCLOPENTANE				
2-METHYLHEXANE				
2,3-DIMETHYLPENTANE				
3-METHYLHEXANE				
CYCLOHEXANE				
BENZENE				

SUMMARY:		
PARAFFINS	VOL %	
NAPHTHENES	VOL %	
AROMATICS	VOL %	

ACTUAL YIELDS AND INSPECTIONS ON FRACTIONS SHOWN IN TABLES [illegible] TO [illegible] ARE THOSE AS CUT FROM THE [illegible] STILL. VALUES SHOWN IN TABLE [illegible] MAY DIFFER AS THEY HAVE BEEN ADJUSTED TO REFLECT CALCULATED PERFECT SPLIT BETWEEN C_4 AND C_5

TABLE 5

CRUDE: COCOLLAR EX - CERRO NEGRO

LY.SC-PC.79

LIGHT DISTILLATES

IBP	°F	68-401	401-455	491-509	401-432	491-536
IBP	°C	20-205	205-235	205-265	205-250	205-280
YIELD CUT RANGE	VOL %	0.2 - 1.0	1.0 - 2.8	1.0 - 5.1	1.0 - 3.3	1.0 - 5.7
YIELD ON CRUDE	VOL %	0.3	1.8	4.1	2.9	5.7
MIDPOINT	VOL %	0.5	1.9	3.1	2.5	3.9
GRAVITY	°API	35.9	33.3	31.0	32.3	29.9
SPECIFIC GRAVITY	60/60	0.840	0.859	0.871	0.864	0.877
TOTAL SULFUR	WT. %	0.55	1.00	1.25	1.12	1.45
MERCAPTAN SULFUR	WT. PPM	7				
SMOKE POINT	mm	25	23	22	23	21
ASTM NO.		64	62	61	62	61
FREEZING POINT	°F	< -100	<-100	<-100	<-100	<-100
CLOUD POINT	°F	N/C	N/C	N/C	N/C	N/C
POUR POINT	°F	<-100	<-100	<-100	<-100	<-100
ANILINE POINT	°F	118	118	119	119	117
DIESEL INDEX		44	39	37	38	35
REFRACTIVE INDEX - 67°C		1.4370	1.4490	1.4560	1.4525	1.4600
AROMATICS, FIA	VOL %	37.3	56.5	75.5	70.7	78.9
VISCOSITIES:						
- KINEMATIC - 20°F	cSt	9.0	18.0	32.0	24.0	49.9
- 100°F	cSt	1.39	1.92	2.40	2.20	2.85
- 210°F	cSt	0.72	0.89	1.03	0.97	1.15

TABLE 6

CRUDE: COGOLLAR 1X - CERRO NEGRO

LV.SC-PC.79

MIDDLE DISTILLATES

15 % CUT POINT F VT	401-650	509-590	590-650	590-698	401-698	509-650
15/5 CUT POINT C VT	205-343	265-310	310-343	310-370	205-370	265-343
YIELD CUT RANGE VOL %	1.0 - 15.1	5.1 - 10.2	10.2 - 15.1	10.2 - 18.6	1.0 - 18.6	5.1 - 15.1
YIELD ON CRUDE VOL %	14.1	5.1	4.9	8.4	17.6	10.0
MID-POINT VOL %	8.1	7.7	12.7	14.4	9.8	10.1
GRAVITY API	24.9	25.2	20.8	19.7	23.1	23.0
SPECIFIC GRAVITY 60 60	0.905	0.903	0.929	0.936	0.915	0.916
TOTAL SULFUR WT %	2.17	2.15	2.80	3.00	2.41	2.43
ANILINE POINT F	111	112	106	105	109	109
DIESEL INDEX	28	28	22	21	25	25
CETANE INDEX	31	35	35	36	31	35
CLOUD POINT F	N/C	N/C	N/C	N/C	N/C	N/C
POUR POINT F	-90	-90	-60	-50	-75	-75
REFRACTIVE INDEX - 67°C	1.4770	1.4757	1.4919	1.4970	1.4828	1.4840
NEUT NO. (D-974) mg KOH gm						4.01
VISCOSITIES,						
KINEMATIC - 100°F cSt	5.65	5.30	12.90	18.50	7.70	8.00
- 150°F cSt	2.91	2.00	5.40	6.90	3.70	3.80
- 175°F cSt	2.27	2.18	3.90	4.85	2.79	2.85
- 210°F cSt	1.70	1.63	2.70	3.20	2.00	2.05
A.N.		11.31	14.05			
B.N.		46.57	51.06			
NITROGEN WT. PPM	10	9	43	195	19	20

TABLE 7

CA.04 COGOLLAR IX - CERRO NEGRO

LV.SC-PC.79

GAS OILS

IB.P. CUT POINT	F	650-752	752-851	851-950	950-994	650-851	650-995	851-995	
IB.P. CUT POINT	C	343-400	400-455	455-510	510-535	343-455	343-535	455-535	
YIELD CUT RANGE	VOL. %	15.1 - 22.7	22.7 - 30.6	30.6 - 39.0	39.0 - 42.8	15.1 - 30.6	15.1 - 42.8	30.6 - 42.8	
YIELD ON CRUDE	VOL. %	7.6	7.9	8.4	3.8	15.5	27.7	12.2	
MID-POINT	VOL. %	18.9	26.7	34.8	40.9	22.9	29.0	36.7	
GRAVITY	API	16.6	14.6	13.0	12.2	15.8	14.2	12.8	
SPECIFIC GRAVITY	60 60	0.955	0.969	0.979	0.985	0.961	0.971	0.981	
TOTAL SULFUR	WT. %	3.25	3.28	3.29	3.35	3.27	3.28	3.29	
ANILINE POINT	F	110	120	127	133	117	123	128	
CON CARBON	WT. %	0.08	0.14	0.53	1.20	0.09	0.20	0.74	
POUR POINT	F	+25	10	35	50	+5	20	40	
REFRACTIVE INDEX @ 67C		1.5105	1.5185	1.5262	1.5304	1.5145	1.5209	1.5278	
NEUT. NO.	MG KOH/GM					5.98			
NITROGEN	WT. %	0.03	0.15	0.24	0.27	0.09	0.19	0.25	
VISCOSITIES									
KINEMATIC @ 100 F	CS	48.0	270.0	1000.0		117.0	485.0		
@ 150F	CS	13.5	65.5	160.0	480.0	25.5	65.0	230.0	
@ 175F	CS	8.5	26.4	72.5	173.0	14.5	32.5	92.0	
@ 210F	CS	5.1	11.6	20.0	53.0	7.8	15.0	34.0	
METALS									
VANADIUM	WT. PPM							0.91	
NICKEL	WT. PPM							0.19	
IRON	WT. PPM							0.43	
A.P.		18.01	18.09	18.08	18.04	18.23		18.06	
W.P.		55.35	56.20	57.08	59.15	55.91		58.07	

TABLE A

Crude: COGOLLAR IX + CERRO NEGRO

LV.SC-PC.79

RESIDUA

15 % CUT POINT	°F VT	650+	698+	752+	851+	950+	995+		
15 % CUT POINT	°C VT	343+	370+	400+	455+	510+	535+		
YIELD ON CRUDE	VOL %	34.9	81.4	77.3	69.4	61.0	57.2		
GRAVITY	°API	5.4	4.9	4.4	3.4	2.3	1.8		
SPECIFIC GRAVITY	@ 60	1.034	1.037	1.041	1.049	1.058	1.062		
TOTAL SULFUR	WT. %	4.04	4.07	4.10	4.17	4.26	4.31		
CON CARBON	WT. %	17.6	18.1	18.6	20.5	23.6	25.7		
NITROGEN	WT. %	0.59	0.61	0.64	0.72	0.78	0.82		
HEAT NO. (D-848)	mg KOH/gm	3.24							
POUR POINT	°F	> +120	> +120	> +120	> +120	> +120	> +120		
VISCOSITIES									
KINEMATIC @ 210°F	cSt	2945	4150	7100					
275°F	cSt	308	410	596	1345	4546	7951		
300°F	cSt	164	214	293	617	1817	2091		
ABSOLUTE VISC. @ 140 F	POISES	2100	4495						
METALS									
VANADIUM	WT PPM	484	472	494	546	616	654		
NICKEL	WT PPM	120	117	122	135	153	162		
IRON	WT. PPM	12	13	14	15	17	18		
MM	WT. %	19.55					25.93		
MM	WT. %	18.76					24.17		

TABLE 9

CRUDE		
[illegible] IX - CERRO NEGRO		LV.SC-PC.79

LUBE DISTILLATES

		WAXY LUBE	DEWAXED LUBE
10/90 CUT POINT	°F VT	779-995	
10/90 CUT POINT	°C VT	415-535	
YIELD CUT RANGE	VOL. %	25.9 - 42.8	
YIELD ON CRUDE	VOL. %	17.3	
MID-POINT	VOL. %	33.9	
GRAVITY	°API	13.4	
SPECIFIC GRAVITY	60/60	0.977	
TOTAL SULFUR	WT. %	3.35	
CON CARBON	WT. %	0.50	
ANILINE POINT	°F	125	
REFRACTIVE INDEX @ 67°C		1.5245	
NEUT. NO. D-974	mg KOH/gm	5.57	
NITROGEN	WT. %	0.25	
POUR POINT	°F	40	
WAX CONTENT	WT. %		
WAX MELTING POINT	°F		
VISCOSITY INDEX		-115	
VISCOSITIES			
KINEMATIC @ 100°F	cSt	1224	
@ 150°F	cSt	130.0	
@ 175°F	cSt	53.0	
@ 210°F	cSt	23.5	
SAYBOLT UNIVERSAL @ 100°F	SEC	5669.5	
@ 210°F	SEC	113.6	

Yields on this table are those as cut from still and the inspections are raw data, not corrected

PHENOL TREATING SUSCEPTIBILITY*	
PHENOL TREATING CHARACTERISTICS OF DEWAXED LUBE CUT	
PHENOL/OIL RATIO	
Type	VI
RAW STOCK	-115
1/1	-53
2/1	-2
3/1	27
VISCOSITY GRAVITY CONSTANT	

* From [illegible] Correlations

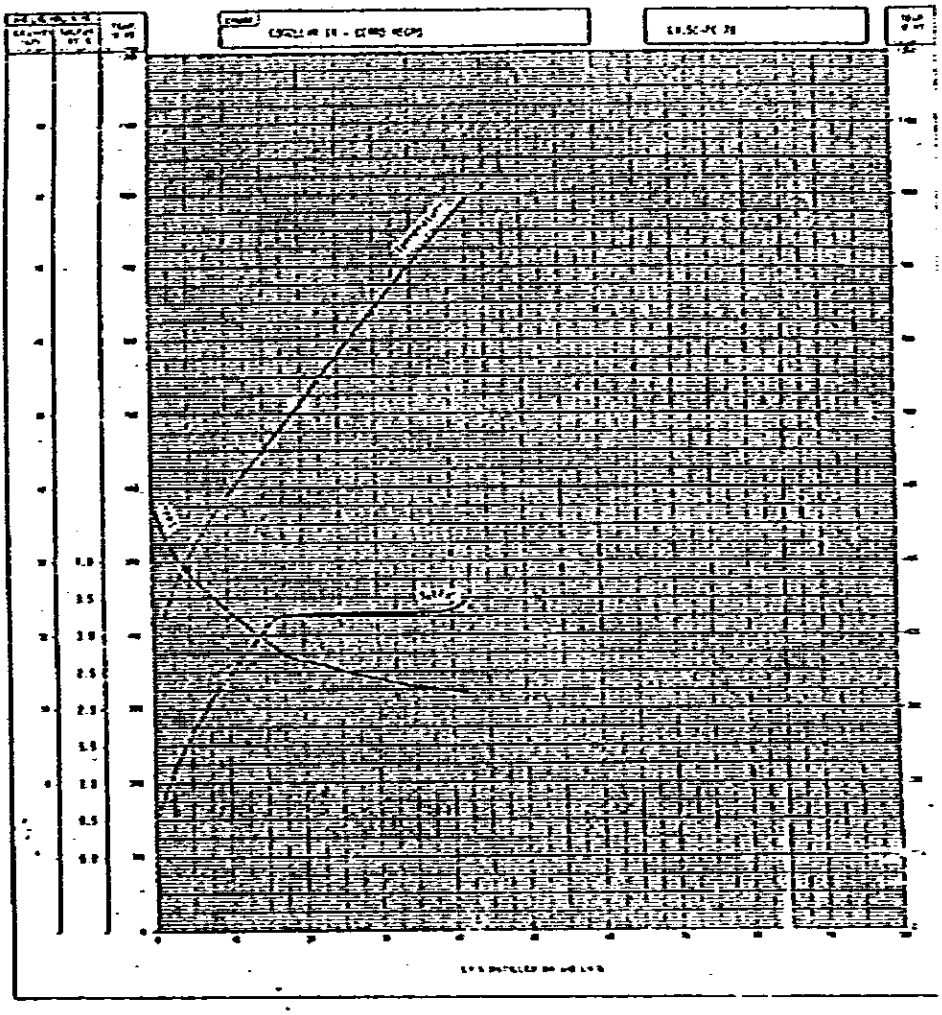
TABLE 10

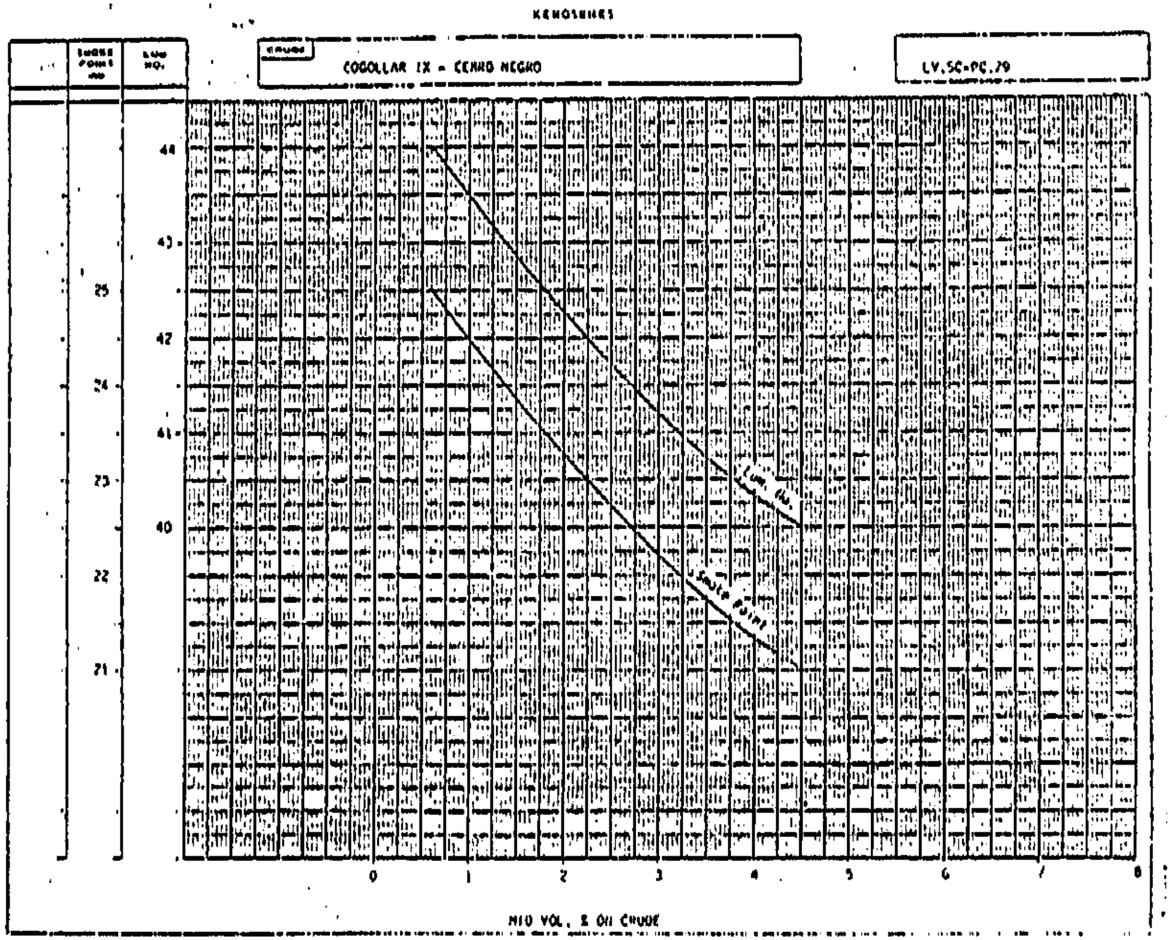
CRUDE: COGOLLAR IX - CERRO NEGRO

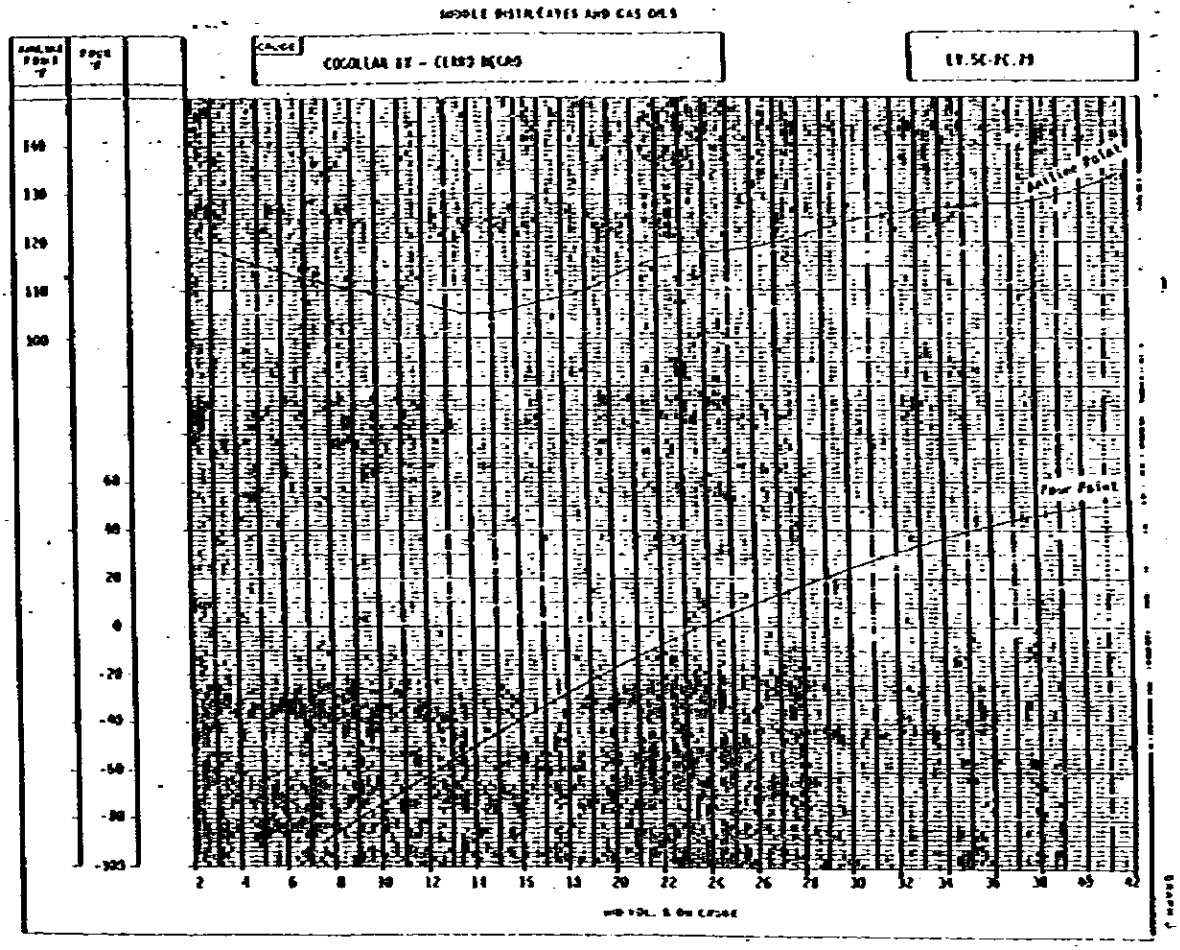
LV.SC-PC.79

STRAIGHT REDUCED ASPHALTS

INSPECTION	YIELD VOL. % ON CRUDE	15 5 CUT POINT F VT	FLASH - CLEVELAND OPEN CUP	SOFT POINT F	PENETRATION 77 F	VISCOSITY POISES 140 F	VISCOSITY KINEMATIC 275 F	SPECIFIC GRAVITY 60 60	TFOT. Ducta 60°F	TFOT. Pérdida	Spot Test
SAMPLES INSPECTED											
NO. 1	81.4	698+		123	59	4495	448	1.038			
NO. 2	89.8	590+	560	99	214	684	188	1.027			
NO. 3	84.9	650+		111	99	2114	311	1.033	55	1.49	
NO. 4	87.6	617+		104	154	1102	233	1.030	65	2.56	NEG.
NO. 5											
STANDARD GRADES (From Correlated Data)											
180 200	89.0	600+		101	190	850	210	1.028			
85 100	84.5	656+		112	93	2250	340	1.034			
60 70	82.0	687+		121	65	4200	415	1.037			
AC-10	87.9	615+		103	162	1000	225	1.029			
AC-20	85.1	643+		110	102	2000	300	1.033			

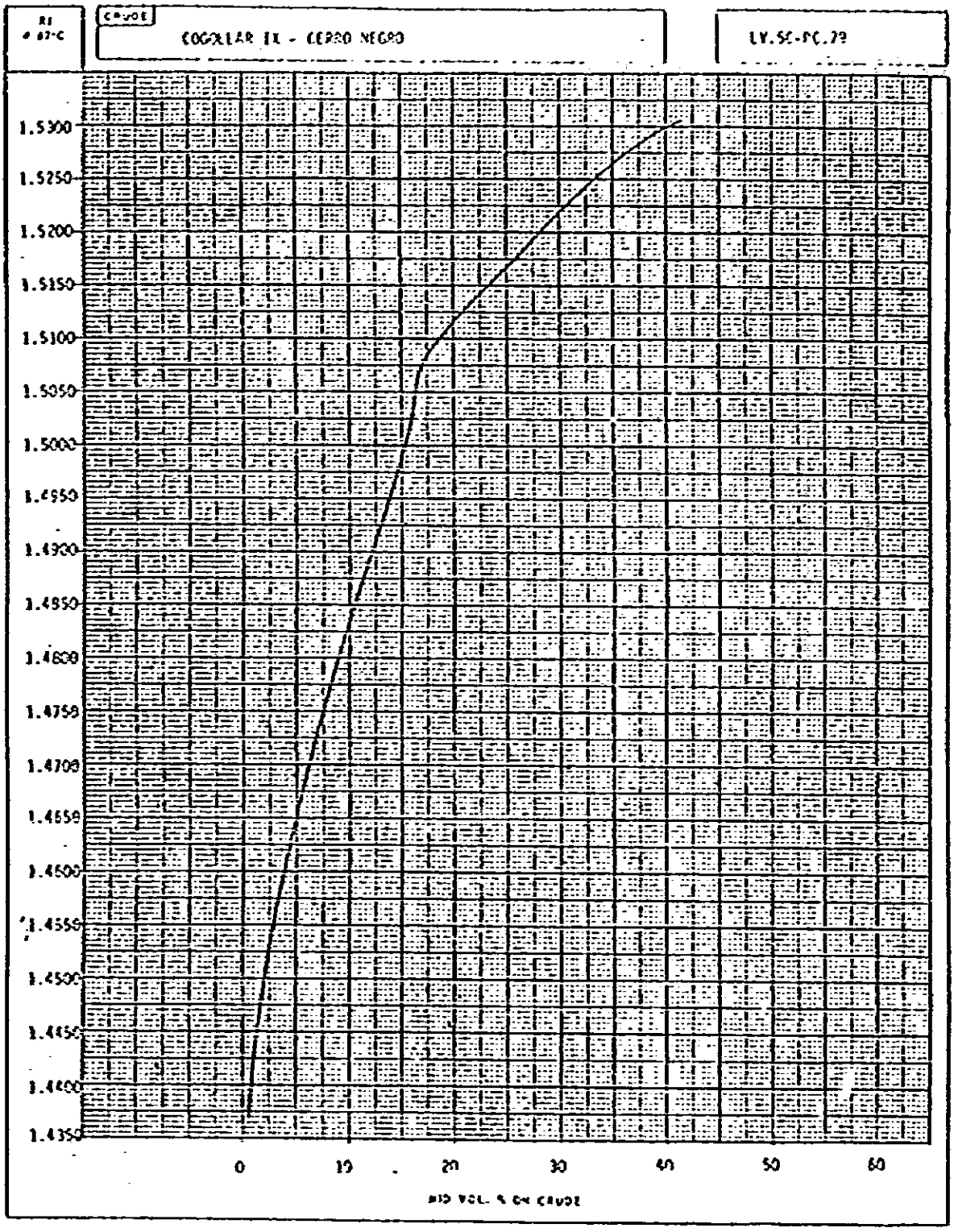



KEROSINES
CRUDE
COGOLLAR IX - CERRO NEGRO
LV.SC-PC.79
SMOKE POINT
LUM NO.
44
43
42
41
40
25
24
23
22
21
Lum. No.
Smoke Point
0
1
2
3
4
5
6
7
8
MID VOL. % ON CRUDE


COCKPIT
Airline Pilot
Four Pilot

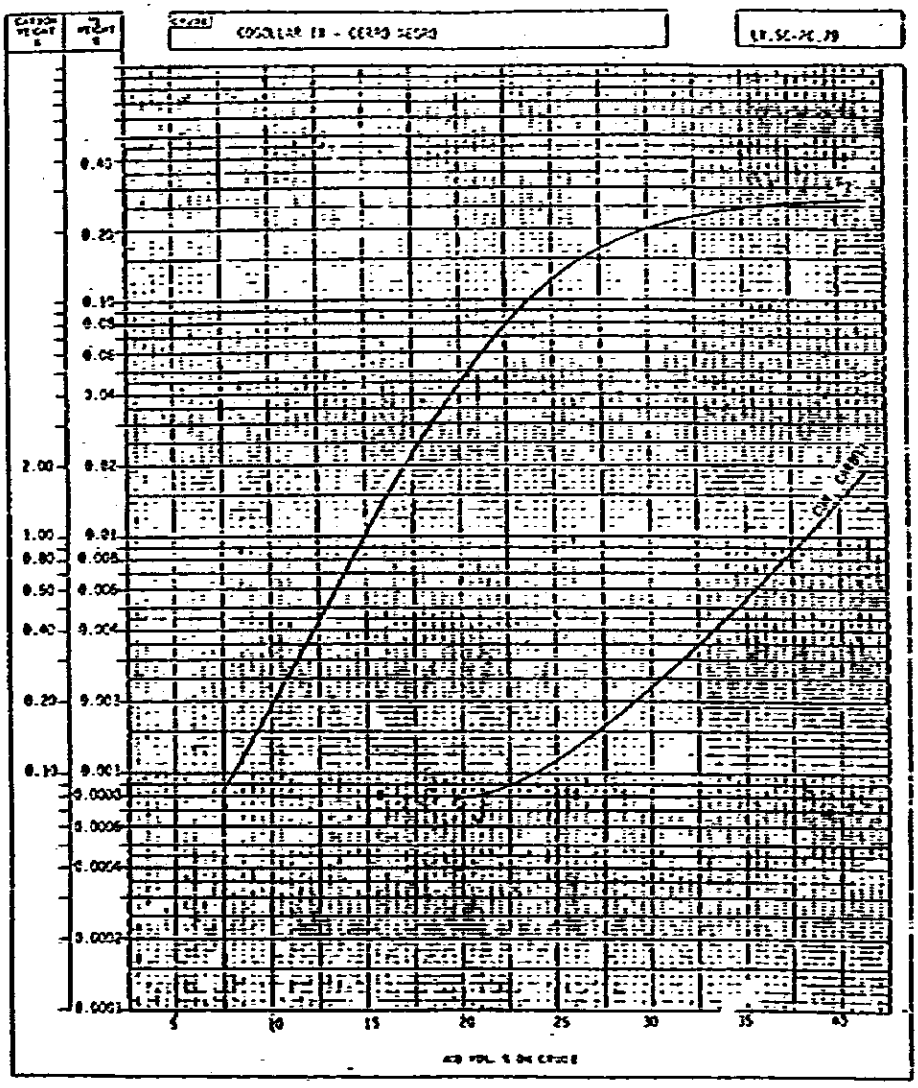
GRAPH NO. 4

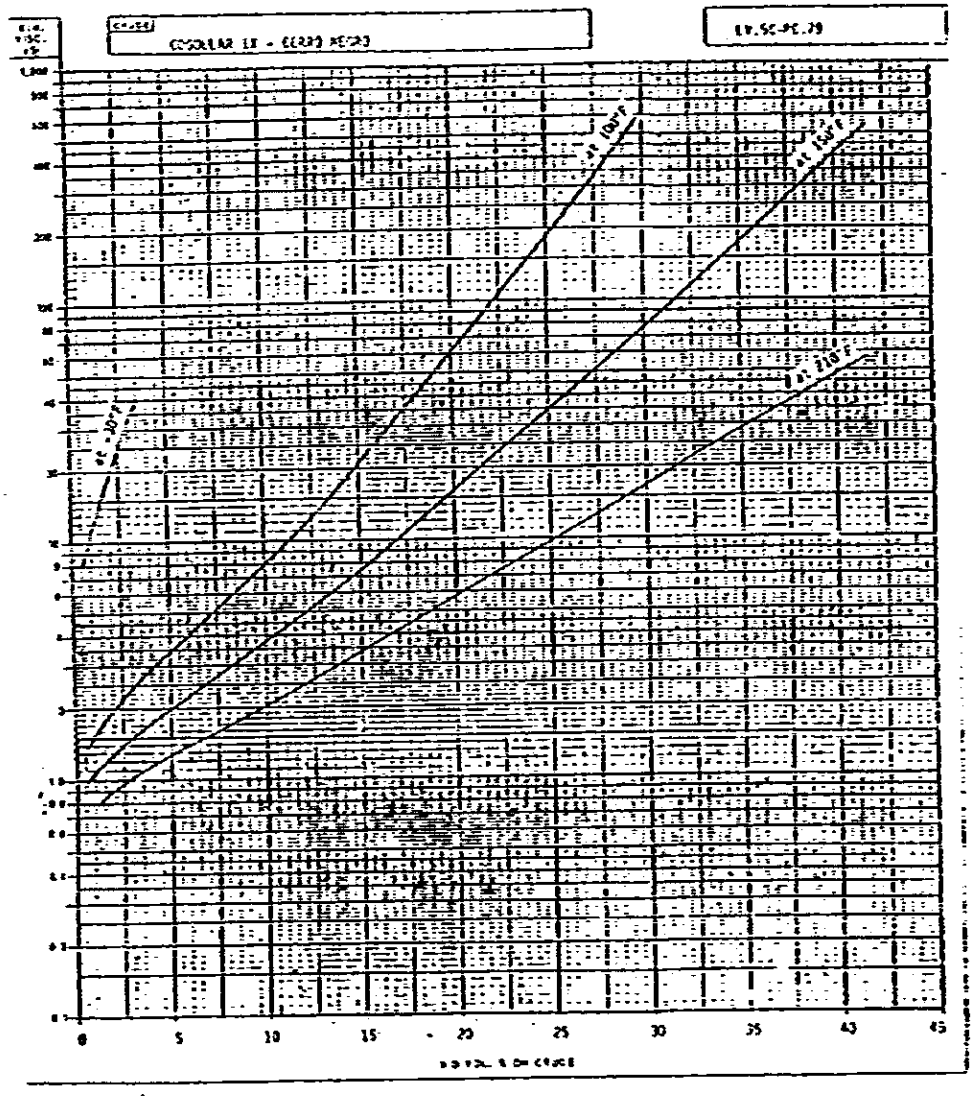
MIDDLE DISTILLATES AND GAS OILS

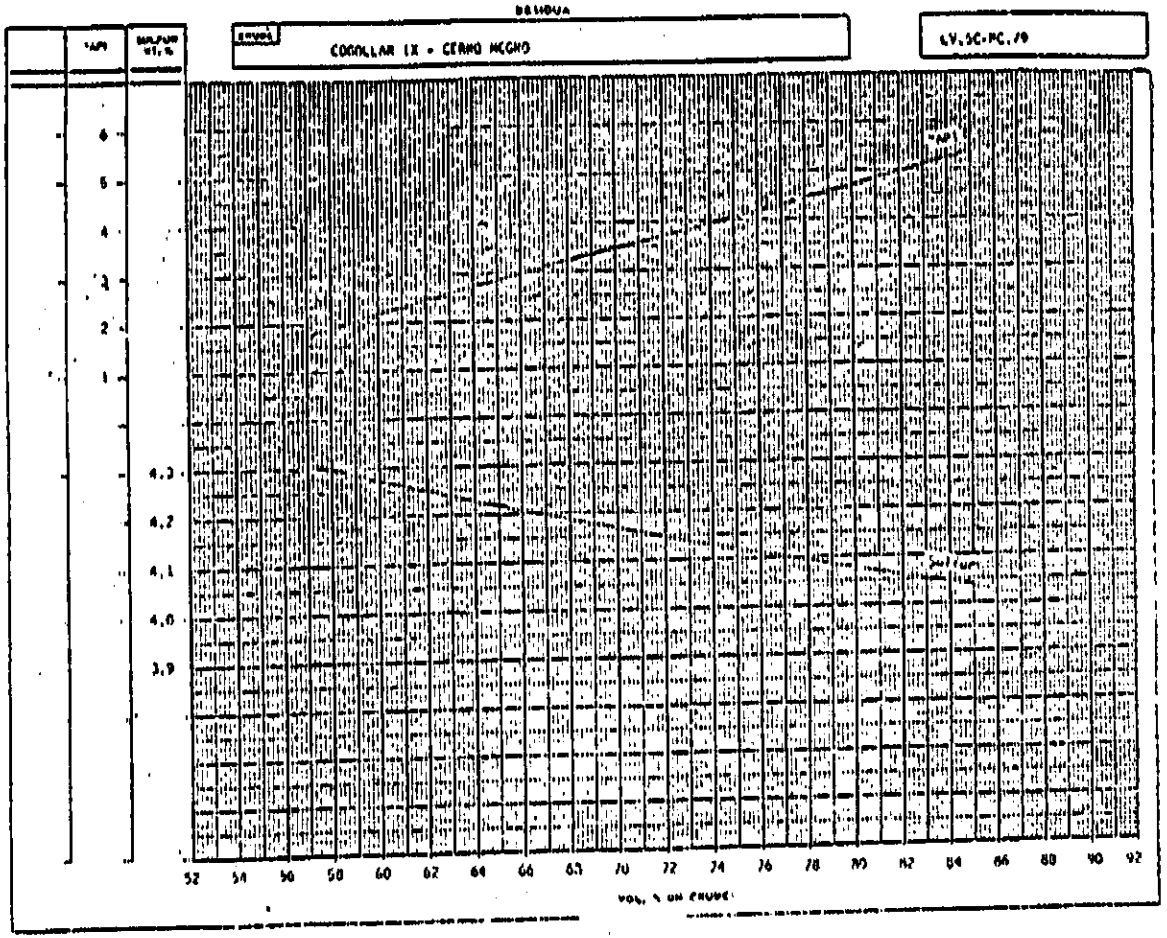


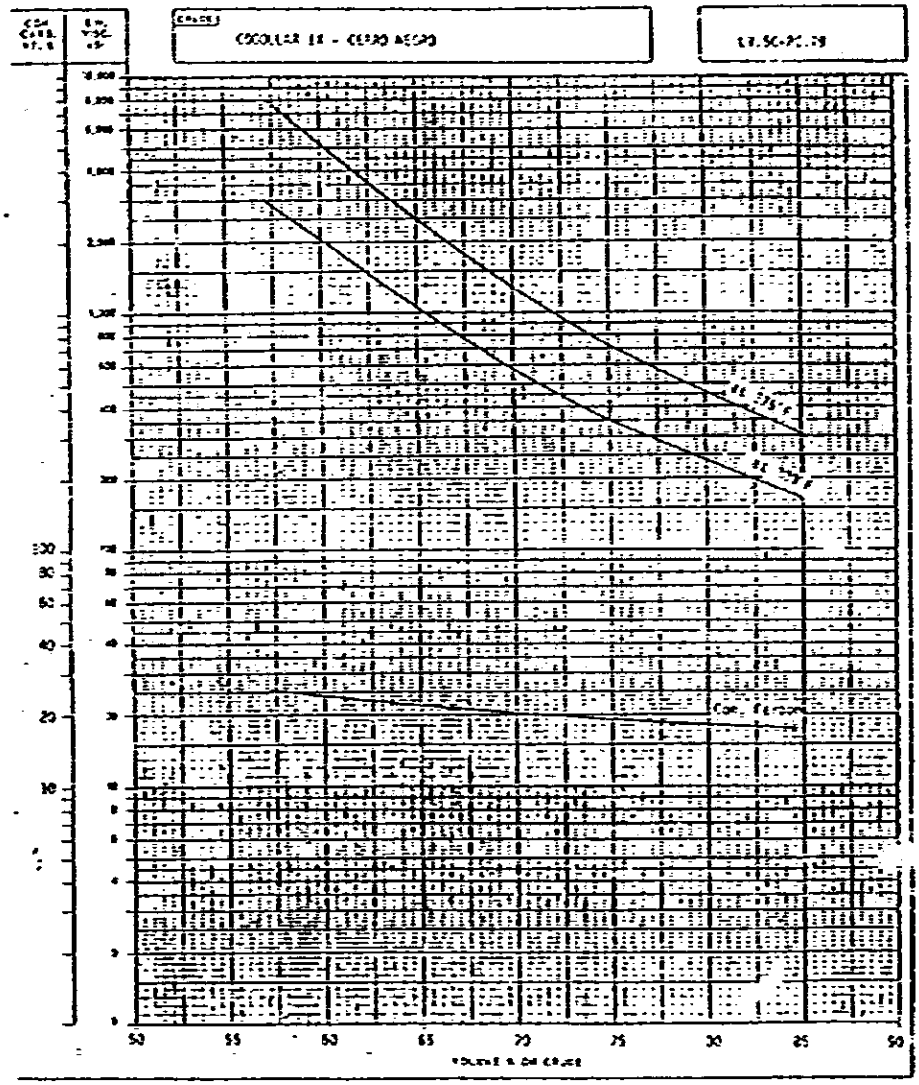
GRAPH NO. 5

MIDDLE DISTILLATES AND GAS OILS



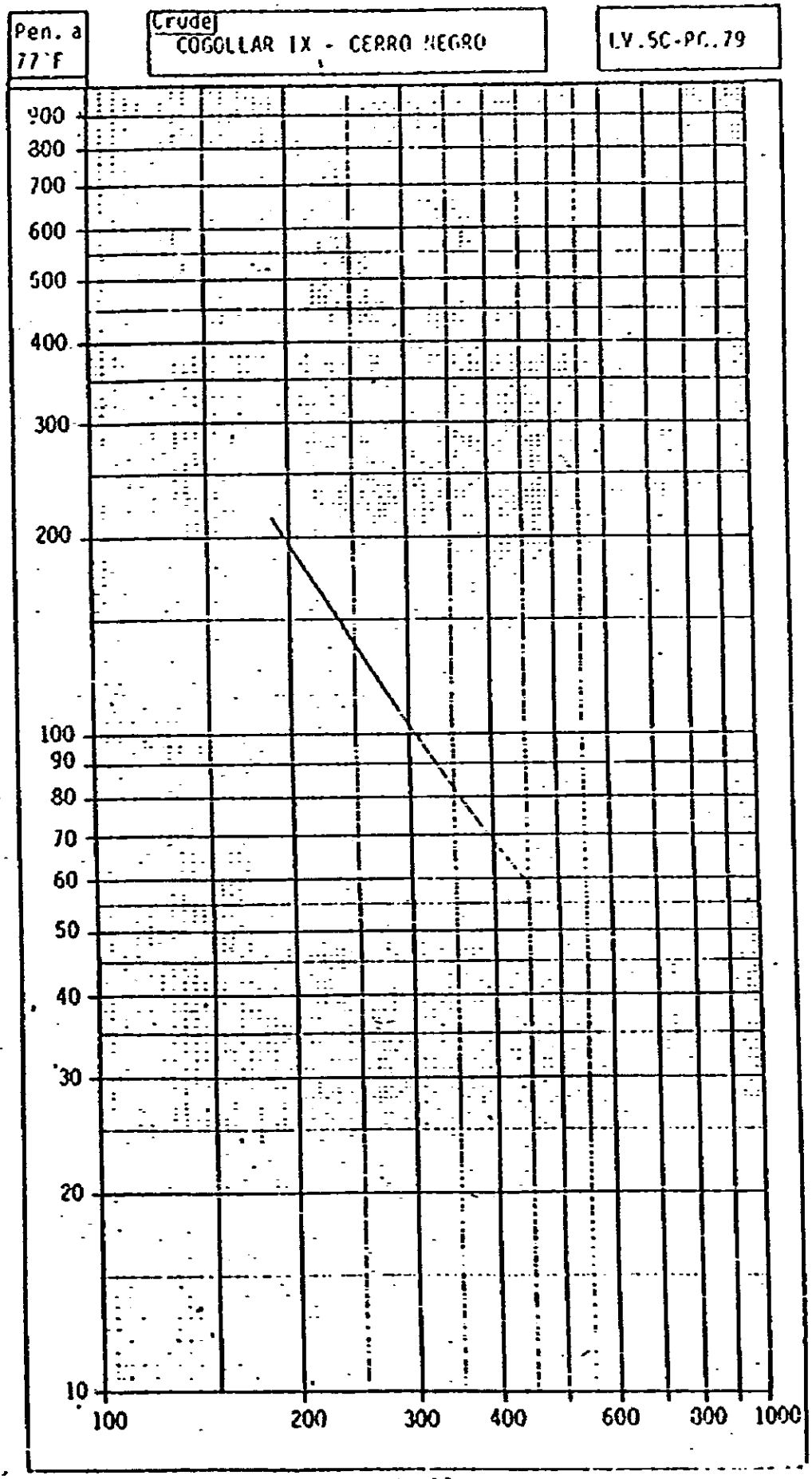


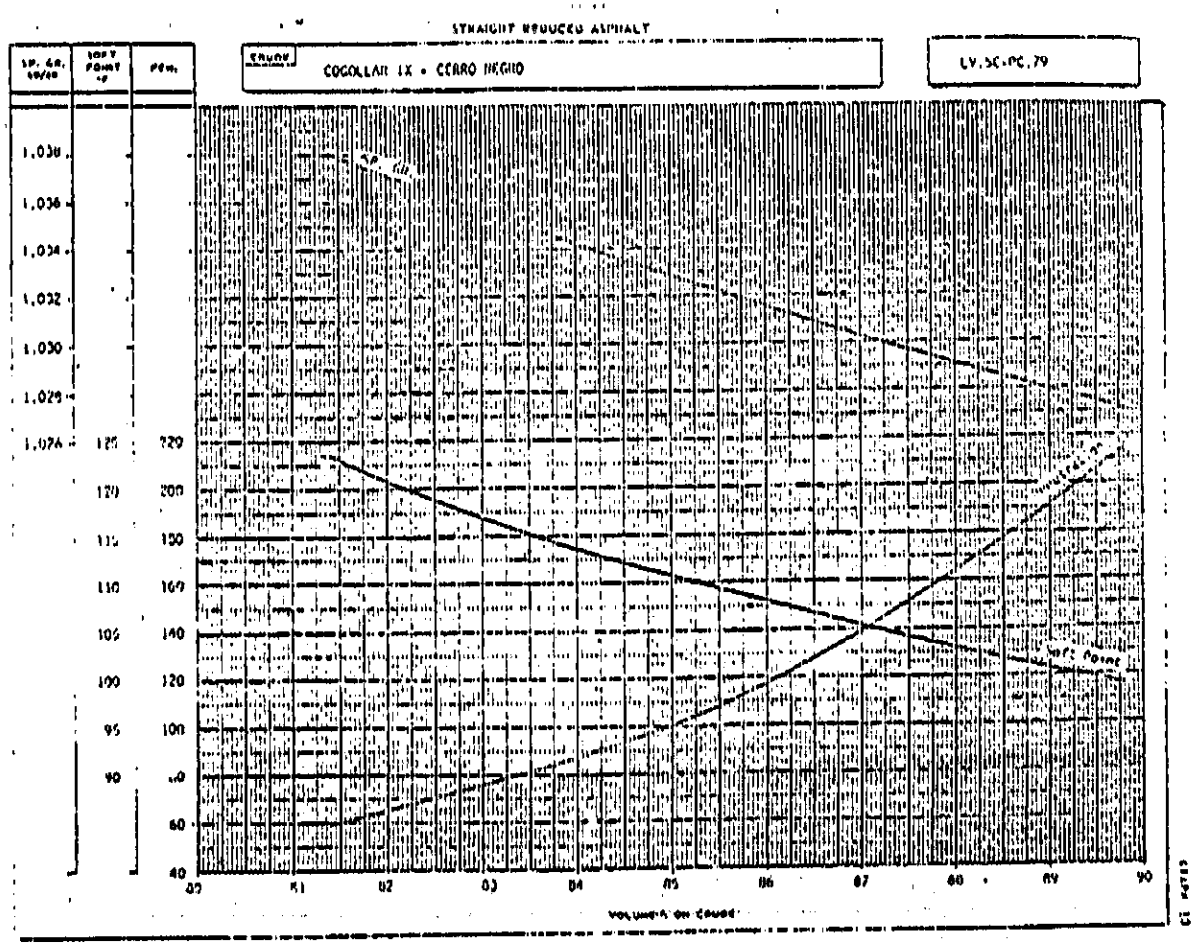

COGOLLAR IX - CERRO NEGRO
LV.SC-PC.19
API
SULFUR WT. %
4.3
4.2
4.1
4.0
3.9
52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92



GRAPH NO. 9

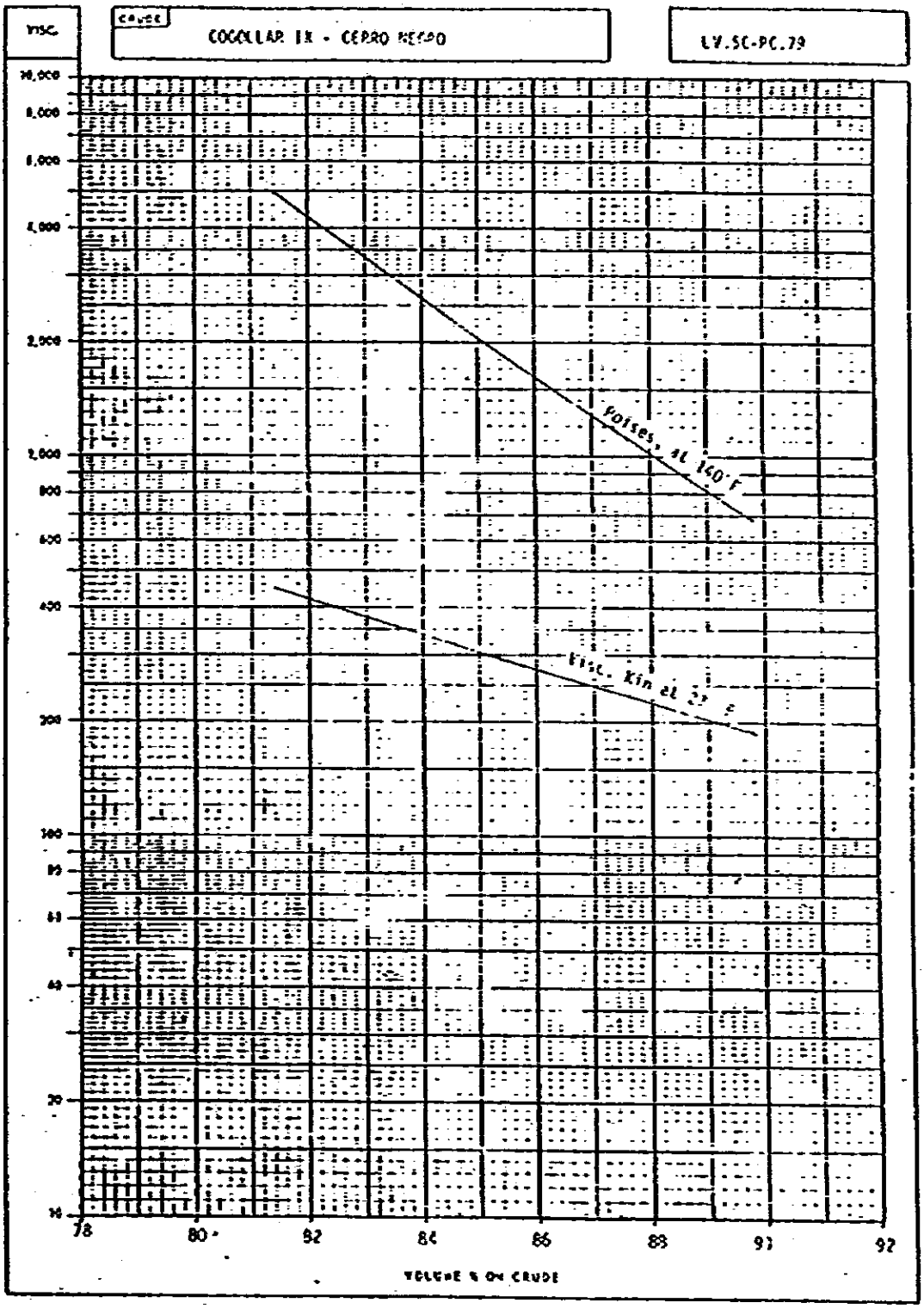
STRAIGHT REDUCED ASPHALTS




STRAIGHT REDUCED ASPHALT
COGOLLAR 1X • CERRO NEGRO
LV,SC-PC,79
1.038
1.036
1.034
1.032
1.030
1.028
1.026
120
110
100
95
90
720
200
160
140
120
100
80
60
40
.80
.81
.82
.83
.84
.85
.86
.87
.88
.89
.90

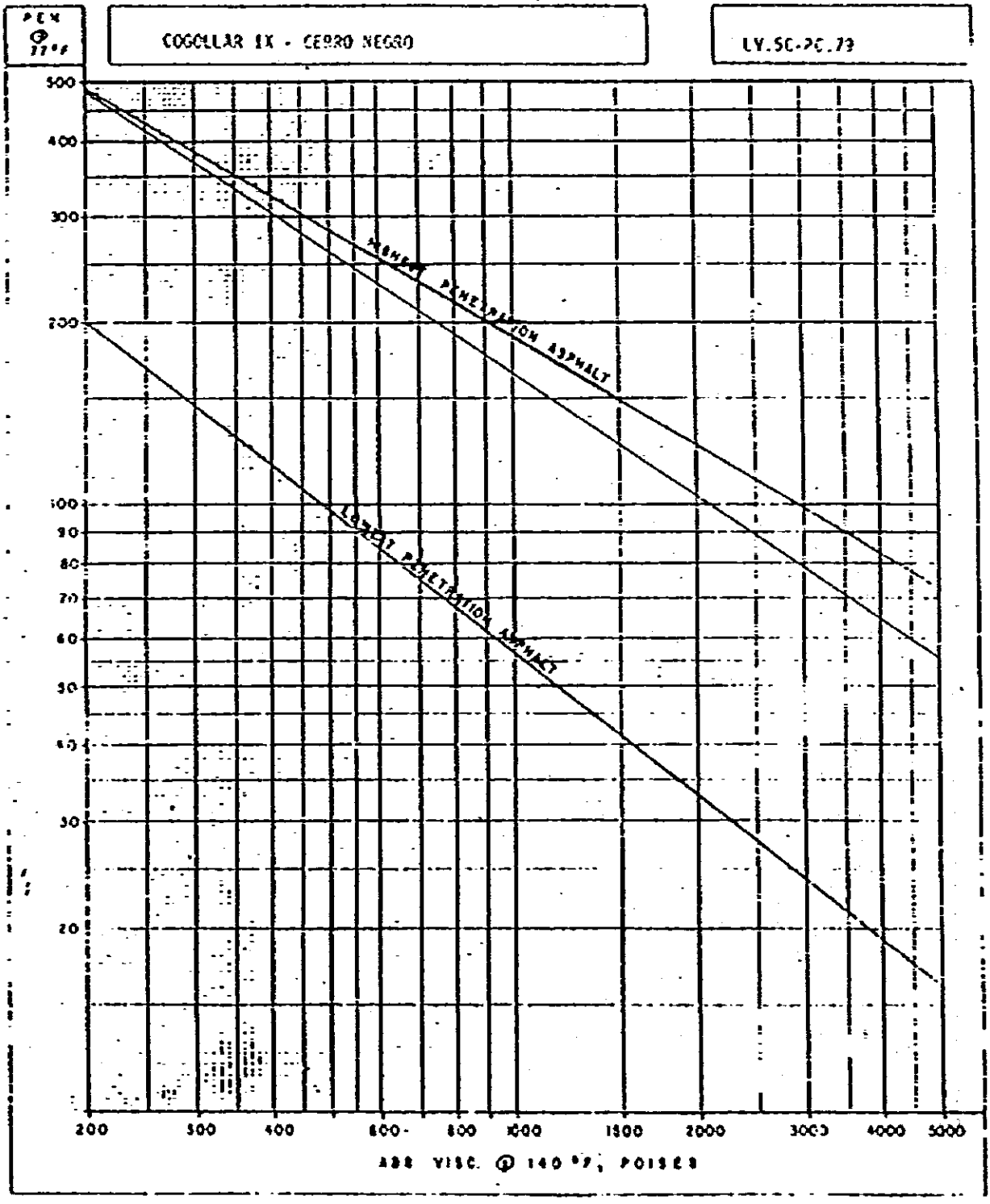
GRAPH NO. 11

STRAIGHT REDUCED ASPHALT VISCOSITY



GRAPH No. 12

STRAIGHT REDUCED ASPHALT
VISCOSITY-PENETRATION RELATIONSHIP
AND VISCOSITY GRADE IDENTIFICATION *



CRUDE INSPECTION PRIMARY DATA

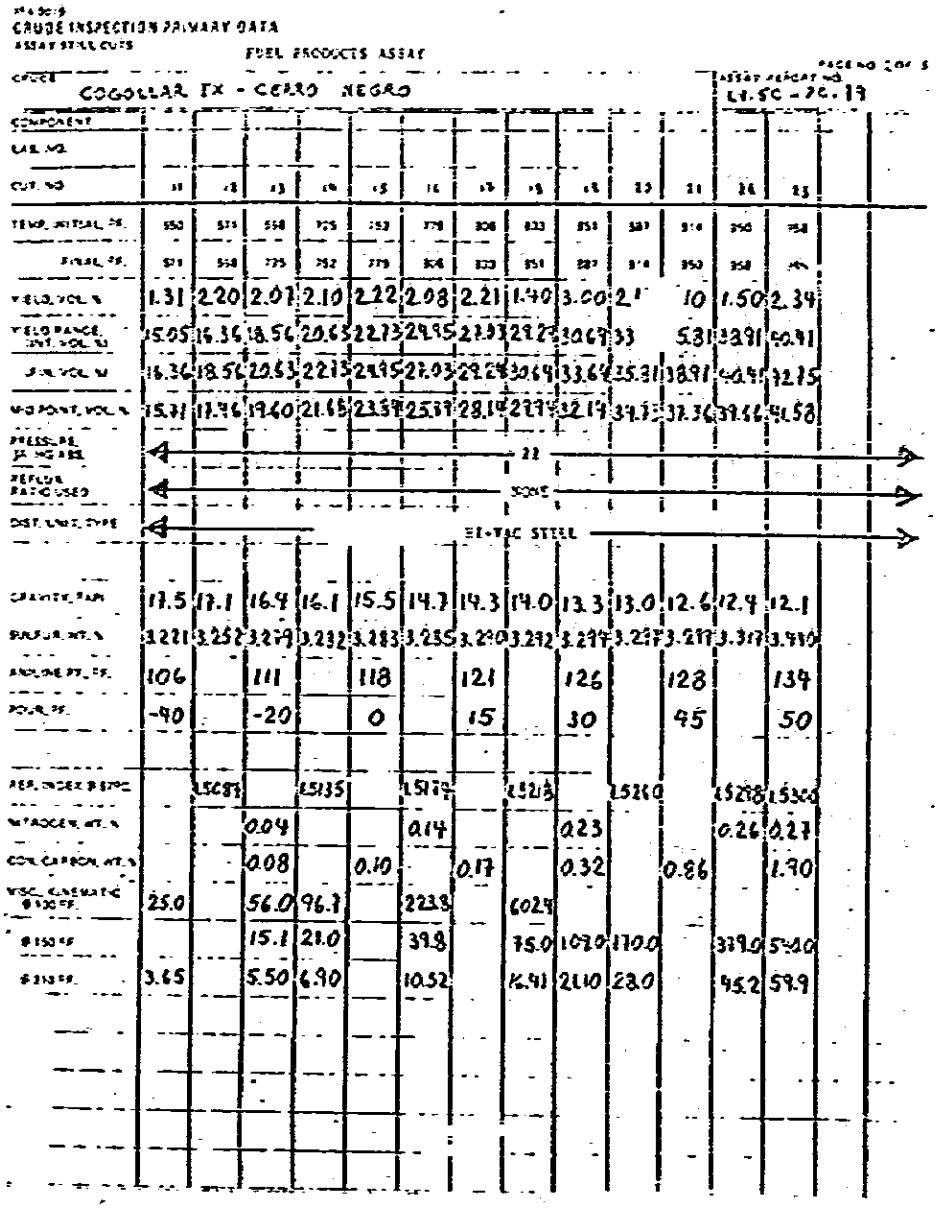
ASSAY STILL CUTS — FUEL PRODUCTS ASSAY

PAGE NO. 1 OF 1

CRUDE: COGOLLAR IX - CERRO NEGRO

ASSAY REPORT NO: CV.5C-PC.19

COMPONENT										
LAB. NO.										
CUT. NO.	1	2	3	4	5	6	7	8	9	10
TEMP. INITIAL, °F.	53	401	428	455	482	509	536	563	590	617
FINAL, °F	401	428	455	482	509	536	563	590	617	550
YIELD, VOL %	0.72	0.74	1.03	1.18	1.20	1.57	1.64	1.78	2.22	2.12
YIELD RANGE, (INT. VOL. %)	0.25	0.97	1.71	2.74	3.92	5.12	6.69	8.33	10.11	12.33
(FIN. VOL. %)	0.97	1.71	2.74	3.92	5.12	6.69	8.33	10.11	12.33	15.05
MID POINT, VOL. %	0.61	1.34	2.23	3.33	4.52	5.91	7.51	9.22	11.22	13.69
PRESSURE, MM. HG. ABS.	10	10	10	10	10	10	10	10	10	10
REFLUX RATIO USED	2:1	2:1	2:1	2:1	2:1	2:1	2:1	2:1	2:1	2:1
DIST. UNIT TYPE	15/5	15/5	15/5	15/5	15/5	15/5	15/5	15/5	15/5	15/5
RI @ 67°C	1.4310		1.4510		1.4625	1.4686	1.4745	1.4805	1.4830	1.4942
GRAVITY, °API	36.9	34.1	32.3	30.5	28.9	26.9	25.5	23.8	22.1	20.3
SULFUR, WT %	0.651	0.860	1.063	1.328	1.591	1.885	2.130	2.391	2.627	2.928
ANILINE PT., °F	118	119		118		114		110		105
FREEZE PT. °F	<-100	<-100	<-100	<-100						
CLOUD PT. °F	S/C		S/C		S/C		S/C		S/C	
POUR PT. °F	<-100		<-100		<-100		-90		-70	
NITROGEN, WT. %							0.0009			0.006
PARAFFINS VOL%										
NAPTH. VOL%										
AROM. FIA VOL%	37.3	62.7	69.2	76.9	87.1	88.3				
VISC. KINEMATIC @-30 °F	8.01	13.90	20.33	37.22						
@100°F	1.39	1.75		2.56		3.98		7.06		15.93
@150°F	0.98	1.18	1.35		1.85	2.22		3.40		6.10
@210°F		0.82		1.07		1.38		1.88		2.91
SMOKE PT. mm	25		23		21					
LUM NO.	44		42		40					



CRUDE INSPECTION PRIMARY DATA

ASSAY STEEL CUTS

FUEL PRODUCTS ASSAY

CRUDE: COGOLLAR TX - CERRO NEGRO

ASSAY REPORT NO.: LA.SC - FC. 17

COMPONENT													
LAB. NO.													
CUT. NO.	11	12	13	14	15	16	17	18	19	20	21	22	23
TEMP. INITIAL °F.	350	525	550	725	752	778	806	833	851	887	914	950	958
FINAL °F.	525	550	725	752	778	806	833	851	887	914	950	958	1000
YIELD, VOL. %	1.31	2.20	2.01	2.10	2.22	2.08	2.21	1.90	3.00	2.1	10	1.50	2.34
YIELD RANGE, UNIT. VOL. %	15.05	16.36	18.56	20.63	22.73	24.95	27.03	29.24	30.69	33	53.1	38.91	40.91
SUM, VOL. %	16.36	18.56	20.63	22.85	24.95	27.03	29.24	30.69	33.69	35.31	38.91	40.91	43.25
MID POINT, VOL. %	15.31	17.96	19.60	21.65	23.89	25.99	28.14	29.99	32.19	34.3	37.3	39.66	41.58
PRESSURE, IN. HG ABS.	← 22 →												
REFLUX RATIO USED	← SOHIO →												
DIST. UNIT. TYPE	←					← EE-VAC STEEL →							
GRAVITY, API	13.5	17.1	16.9	16.1	15.5	14.7	14.3	14.0	13.3	13.0	12.6	12.4	12.1
SULFUR, WT. %	3.221	3.252	3.279	3.232	3.283	3.235	3.290	3.292	3.299	3.227	3.287	3.317	3.310
ANILINE PT., °F.	106		111		118		121		126		128		134
POUR, °F.	-90		-20		0		15		30		45		50
REF. INDEX @ 20°C.		1.5081		1.5135		1.5179		1.5205		1.5260		1.5288	1.5300
NITROGEN, WT. %			0.04			0.14			0.23			0.26	0.27
CONRADSON CARBON, WT. %			0.08		0.10		0.17		0.32		0.86		1.90
VISC., KINEMATIC @ 100°F.	25.0		56.0	96.1		223.8		602.9					
@ 150°F.			15.1	21.0		39.8		75.0	109.0	110.0		339.0	540.0
@ 210°F.	3.65		5.50	6.90		10.52		16.91	21.40	23.0		45.2	59.9

CRUDE INSPECTION PRIMARY DATA
BLENDS

FUEL PRODUCTS ASSAY

PAGE NO. 3 OF 3

CRUDE: COGOLLAR IX - CERRO NEGRO

ASSAY REPORT NO. LT. SC-PC.79

COMPONENT														
LAB NO.														
CUT NO.														
TEMP INITIAL, °F.	401	545	401											
FINAL, °F.	545	650	650											
YIELD, VOL %	4.15	9.93	14.08											
YIELD RANGE, CRUDE VOL %	0.97	5.12	0.97											
... VOL %	5.12	15.05	15.05											
MID POINT, VOL %	3.05	10.10	8.01											
GRAVITY, °API	30.9	23.1	25.0											
SULFUR, WT %	1.257	2.316	2.142											
COLOR, SAYBOLT														
NEUT NO.	0.86	4.01												
KIN VISC cSt														
@ 100 °F.	2.37		5.67											
@ 150 °F.	1.52		2.91											
@ 210 °F.	1.02		1.69											
REF. INDEX @ 67 °C	1.4555		1.4765											
SMOKE POINT, MM	21													
CLOUD POINT, °F.	S/C		S/C											
FREEZING PT., °F.	<-100													
POUR POINT, °F.	<-100		-85											
AROMATICS, VOL %														
PARAFFINS, VOL %														
NAPTHENES, VOL %														

154 36124
CRUDE INSPECTION PRIMARY DATA
BLENDS

FUEL PRODUCTS ASSAY

PAGE NO 1 OF 3

CRUDE: COGOLLAR IX - CERRO NEGRO

ASSAY REPORT NO.: LV. SC - 76.19

COMPONENT			
LAB. NO.			
CUT. NO.			
TEMP. INITIAL °F	553	551	773
FINAL °F	551	79[illegible]	995
YIELD VOL %	15.59	12.11	17.8
YIELD RANGE CUT. VOL %	15.05	30.69	2[illegible]35
END VOL %	30.69	92.35	92.35
MID POINT, VOL %	22.85	36.30	33.35
GRAVITY, °API	15.6	13.1	13.4
SULFUR, WT. %	3.255	3.273	3.355
ANILINE PT. °F			126
POUR °F			40
KIN VISC cSt @100 °F	116.6		1224
@150 °F	25.5	231.9	120.0
@175 °F			53.0
@210 °F	7.81	39.38	23.53
REF. INDEX @ 67 °C	1.550	1.5275	1.5275
TOTAL NITROGEN WT %			0.26
BASIC NITROGEN WT %			
OXYGEN WT %			
CON CARB WT %	0.09	0.70	0.50
NEUT NO.	5.93		5.6[illegible]
IRON ppm		0.43	
NICKEL ppm		0.19	
VANADIUM ppm		0.91	
WAX SEA WT %			

CRUDE INSPECTION PRIMARY DATA

FUEL PRODUCTS ASSAY

CRUDE: COGOLLA R. IX - CERRO NEGRO

ASSAY REPORT NO. LV-SC-72.19

COMPONENT	82	83	84	85	86
LAB NO.	SR			SR	
BLEND PT. °F	450	752	951	950	955
YIELD VOL. %	8995	77.27	69.36	61.09	51.25
YIELD RANGE (EXT. VOL %)	5.05	22.73	30.64	38.91	92.15
(FEV. VOL %)	100	100	100	100	100
GRAVITY °API	5.5	4.4	3.4	2.3	1.8
OXYGEN WT%					
NEUT NO.	3.21				
SULFUR WT%	4.09	4.10	4.17	4.26	4.31
NOT WT%	19.55				25.13
NOT WT%	18.70				25.13
POUR POINT °F	125	>125	>125	>125	>125
NITROGEN WT%	0.63				0.82
CONRADSON WT%	17.59	18.62	20.99	23.56	25.65
SOFT PT. °F					
PEN @ 77 °F					
ABS VISC POISES @ 140°F					
NICKEL PPM WT.	97				162
VANADIUM PPM	12				18
VANADIUM ppm	484				654
VISC KINEMATIC @ 100 °F					
@ 122 °F					
@150 °F					
@175 °F					
@210 °F	2.945	3100			
@ 275 °F	308	534	345	594	7451
@ 300 °F	164	298	413	1817	2891

ATTACHMENT-4

JICA-1

THE UPGRADING PROJECT

OF ORINOCO HEAVY OIL IN THE REPUBLIC OF VENEZUELA

--- GENERAL DESCRIPTION ---

1. Venezuelan Government's Request

(1) In April 1978, the Venezuelan Government officially requested the technical cooperation of Japan in a letter of the Minister of Energy and Mines. The requested cooperation mainly consists in conducting studies and evaluations, from a neutral point of view, of various proposals to the Government made on an industry basis, on which the Government has difficulties in making judgements.

(2) In accordance with the request, the Japan International Cooperation Agency (hereinafter referred to as "JICA") sent a preliminary survey team to Venezuela in late August 1978 to discuss how to develop the cooperation with the Venezuelan Government. At the discussion, Venezuela requested the Japanese team to conduct a feasibility study on processes for upgrading the Orinoco heavy oil.

(3) The content of the request is as follows:

(a) Purposes of Feasibility Study

It is planned to produce the Orinoco heavy crude around 1985, for which a plant of the 100,000 - 120,000 BPSD class is expected to be built to upgrade and refine the crude. A feasibility study is to be made to judge what process could be best used for the plan, making examinations on mainly the processes proposed by three groups of Japan.

(b) Prerequisites of Feasibility Study

Properties of the Orinoco heavy crude and estimated grade of the product synthetic crude shall be presented. By-products from the upgrading shall be used to generate steam for use in crude production and energy needed for upgrading.

(c) Scope of Feasibility Study

The feasibility study excludes the survey on financing, the marketing of the synthetic crude, the infrastructure and site selection of the plant.

(d) Supply of Data

All data necessary for the feasibility study shall be provided by Venezuela.

2. Procedures for the Feasibility Study

JICA studied the approach based on the report of the preliminary survey team, and determined to conduct the feasibility study following the procedures below. In March 1979, Japan notified the Venezuelan Government of this decision via the Japanese Embassy in Venezuela, confirming the basic prerequisites and requesting the supply of crude samples. Procedures for the feasibility study are as follows:

(1) Objectives of Feasibility Study

This study is intended to make clear the respective features of the three processes proposed by three groups of Japan for the upgrading of the heavy crude to be produced in the Orinoco Heavy Crude Development Project located on the north side of the River Orinoco, and to provide data necessary for the selection of a process adequate for a commercial plant.

(2) Scope of Feasibility Study

Technical and economic studies will be conducted with limitations to the plant facilities for the upgrading of the crude:

(3) Procedures for Execution

(a) Conduct a preliminary study based on basic prerequisites and crude samples.

(b) After determining the terms of reference for the feasibility study, send a F/S survey team to Venezuela to hold discussions and to do a field survey.

(c) Perform work in Japan and prepare a report.

(4) Dispatch of First Survey Team

With regard to the confirmation of the basic prerequistites and the requested supply of the crude samples, it had been determined that the execution schedule was to be somewhat modified to accelerate the progress of the study. That is, the First Survey Team was dispatched to Venezuela on October, 1979 to do the following work:

(1) To confirm the basic prerequisites

(2) To obtain the crude samples

(3) To discuss the preliminary T/R which is prepared as a result of the preliminary survey

(5) Record of Discussions

As a result of the First Survey, the Record of Discussions as per attached was signed by both parties on October 10, 1979.

3. Project Execution Shedule and Execution Manner

Based on the above Record of Discussions, the preliminary study was conducted in Japan.
The project execution schedule and execution manner, however, have been revised as per Fig. 1.

And the Second Survey Team was dispatched to Venezuela to accomplish the following objectives.

(1) To report the results of the preliminary study.

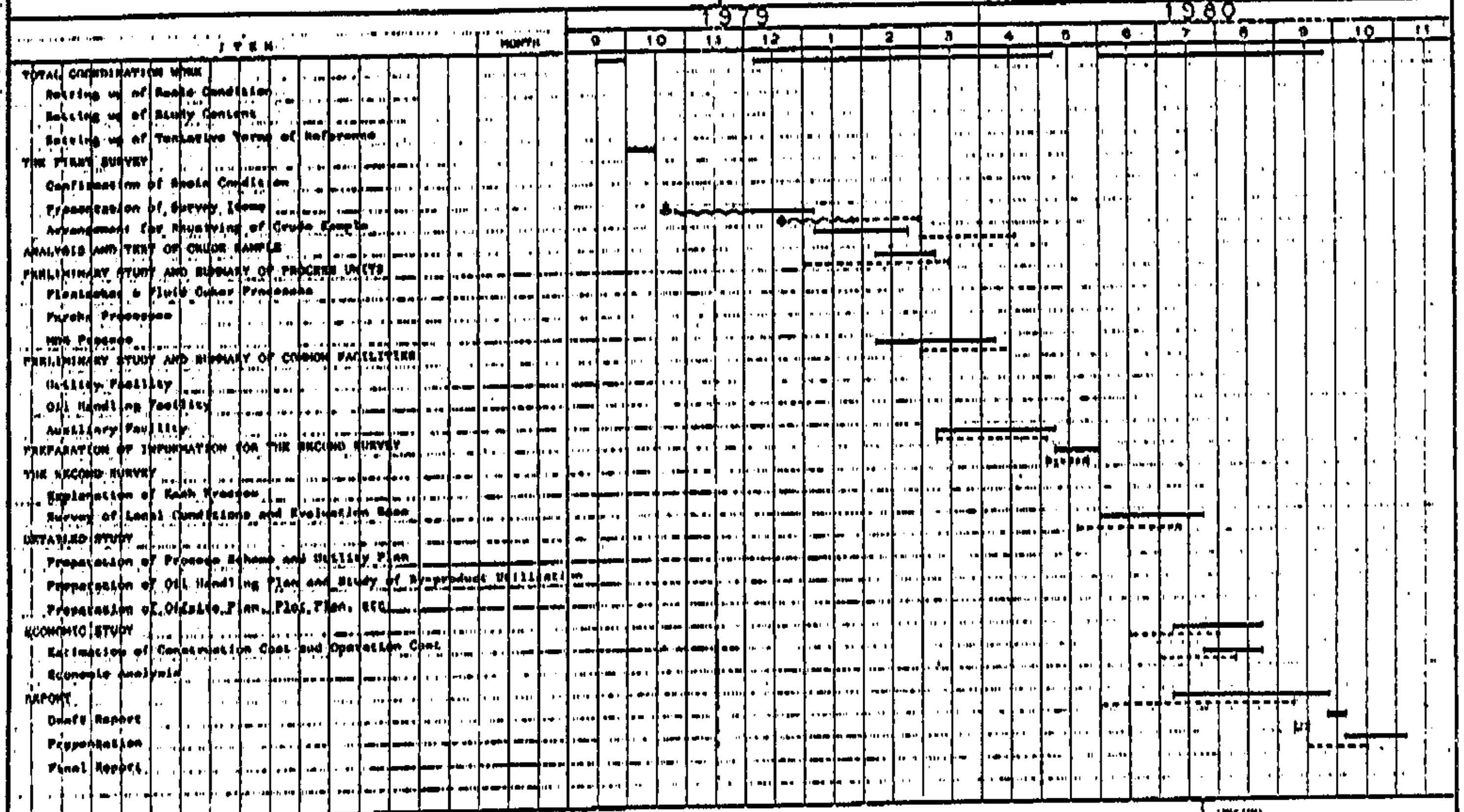
(2) To confirm the additional basic conditions for the feasibility study.

(3) To confirm the basic conditions for the economic study on the feasibility study.

(4) To collect information and data on construction planning for the feasibility study.

PROJECT SCHEDULE

PROJECT: ORINOCO HEAVY OIL UP-GRADING PROJECT



* Original Schedule was confirmed in the Record of Discussions signed by both parties on October 10, 1979.

ORIGINAL SCHEDULE
REVISED SCHEDULE

Rev. [illegible]
Rev. [illegible]

PREP'D
CHK'D
APP'D

JICA-2

THE SECOND SURVEY TEAM

THE UPGRADING PROJECT

OF ORINOCO HEAVY OIL IN THE REPUBLIC OF VENEZUELA

1. Objectives

The Japanese Second Survey Team sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") is expected to accomplish the following scope of work by exchanging views with the authorities concerned in the Republic of Venezuela, so as to meet the real needs of Venezuela:

(1) To report the results of the preliminary study

(2) To confirm the additional basic conditions for the feasibility study

(3) To confirm the basic conditions for the economic study on the feasibility study.

(4) To collect information and data on construction planning for the feasibility study.

2. Method of Approach by the Second Survey Team

The survey team will visit the government organization and other authorities concerned.
The survey team will be organized by two groups as Group-A and Group-B.
Group-A will accomplish (1), (2) and (3) on the scope of work in the above Section 1.
Upon completion of the survey, the survey team will prepare minutes of meetings, which are to be signed and exchanged with the Venezuelan side.
Group-B will accomplish (4) on the scope of work in the above Section 1.

3. Members of the Second Survey Team

The members of the Second Survey Team are organized as the attached "MEMBERS LIST".

Group A

Leader: Mr. Sen'ichi HIROSE
Mr. Kei'ichi GOTOH
Dr. Koji UKEGAWA
Mr. Hideo YASUKI
Mr. Yasuhisa HOSOYA
Mr. Terutada TSUKAGOSHI

Group B

Leader: Mr. Senichi HIROSE
Mr. Yasuhisa HOSOYA
Mr. Isao USUI
Mr. Akimasa IIMURA

Messrs. HIROSE and HOSOYA will join Group B after completion of Group A's work.

4. Schedule of the Second Survey

Schedule for the second survey is planned tentatively as indicated in the attached Fig. 2.

This tentative schedule is to be further developed and adjusted through discussions with you so as to accomplish the objectives of the survey most efficiently.
Your cooperation in this regard will be much appreciated.

5. Survey Items

(1) Result of Preliminary Study

Please refer to the attached "The Report of Preliminary Study". (1)

(2) Additional Basic Conditions for Feasibility Study

Please refer to the attached "Confirmation Items of Basis of Feasibility Study". (2)

(3) Basic Conditions for Economic Study on Feasibility Study

Please refer to the attached "Confirmation Items of Basis of Economic Study". (3)

(4) Information and Data on Construction Planning

Please refer to the attached "Information and Data on Construction Planning". (4)

FIG. 2 SECOND SURVEY SCHEDULE (TENTATIVE)

Date	Group A	Group B
Apr. 3 (Sat.)	Tokyo ——PA 800——→ New York	
4 (Sun.)	New York ——PA 217——→ Caracas	
5 (Mon.)	Meeting at Embassy of Japan	
6 (Tue.)	Meeting with MEM	
7 (Wed.)		Interview and Hearing at Instituto Nacional de Puertos (INP) Foraiconi, SADE REVACO etc.
8 (Thu.)	Meeting with PETROVEN/ INTEVEP/LAGOVEN	Caracas ——→ Pto. Ordaz
9 (Fri.)		General Survey of Orinoco Area
10 (Sat.)	Preparation of R/D	Visit to Pt. Ordaz Port Authority
11 (Sun.)	"	General Survey by Helicopter
12 (Mon.)	"	Visit to Vandam-Guayana Factory
13 (Tue.)	Submission of R/D	Pto. Ordaz ——→ Pto. Guanta
14 (Wed.)	Caracas ——PA 218——→ New York	Visit to Pto. Guanta Port Authority
15 (Thu.)	New York ↓ PA 801	Pto. Guanta →Caracas →Maracaibo
16 (Fri.)	Tokyo	Visit to AFCA Factory
17 (Sat.)		Maracaibo ——→ Caracas
18 (Sun.)		Preparation of Sruvey Report
19 (Mon.)		Collection of Data and Information at Caracas
20 (Tue.)		Preparation of Survey Report
21 (Wed.)		Caracas ——PA 218——→ New York
22 (Thu.)		New York ↓ PA 801
23 (Fri.)		Tokyo

ATTACH MENT TO JICA-2

①

THE REPORT OF PRELIMINARY STUDY

FOR

THE UPGRADING PROJECT

OF

ORINOCO HEAVY OIL

IN

THE REPUBLIC OF VENEZUELA

APRIL 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

1. INTRODUCTION

2. STUDY BASES

3. PROCESS FLOW SCHEME

4. BY-PRODUCT UTILIZATION SCHEME

5. UTILITY AND OFFSITE FLOW SCHEME

6. SUMMARY

ATTACHMENT

ANALYSIS OF SAMPLE CRUDE OIL

1. INTRODUCTION

Based on the basic conditions for preparing the scheme of the Orinoco Heavy Crude Oil Upgrading Refinery as determined in October 1979 between MEM and the JICA survey team, JICA promptly consulted three licensors and started studying flow schemes on the identical bases.

This is an interim report on the present development of the study on the Japanese side.

This report consists of the following items:

1) Study Bases

2) Process Flow Scheme

3) By-product Utilization Scheme

4) Utility and Offsite Flow Scheme

5) Summary

JICA sincerely hopes that the results of our study will prove useful to Venezuela, and for this purpose we wish to obtain various advice and further information from the Venezuelan side.

We will prepare a final report by adding further studies on construction cost, operating expenses, and general economic evaluations.

2. STUDY BASES

The basic conditions of the preliminary study has been established as a survey result of the first survey team which was sent to Venezuela in October 1979.
The main items are summarized on the "Record of Discussions" attached to the JICA-1.

3. PROCESS FLOW SCHEME

(1) Cases of process scheme

The following three (3) cases of process scheme are described in the preliminary study.

CASE	MAIN UPGRADING PROCESS	PROPOSER
Eureka Case	Eureka Process	Kureha Chemical Industry Co., Ltd. and the group
Fluid Coker Case	Fluid Coker Process	Toa Oil Co., Ltd. and the group
SDA Case	M-DS Process	Maruzen Oil Co., Ltd. and the group

Flexicoking is a residuum conversion process which integrates coke gasification with conventional fluid coking.
Energy loss is borne in course of the coke gasification and coke firing boiler is available, therefore, the fluid coker process is applied in the study.

(2) Refinery Scheme

The block flow diagrams of refinery scheme for each case are shown in Fig. 1, Fig. 2 and Fig. 3.
(Slide 1, 2 and 3)

(1/2)

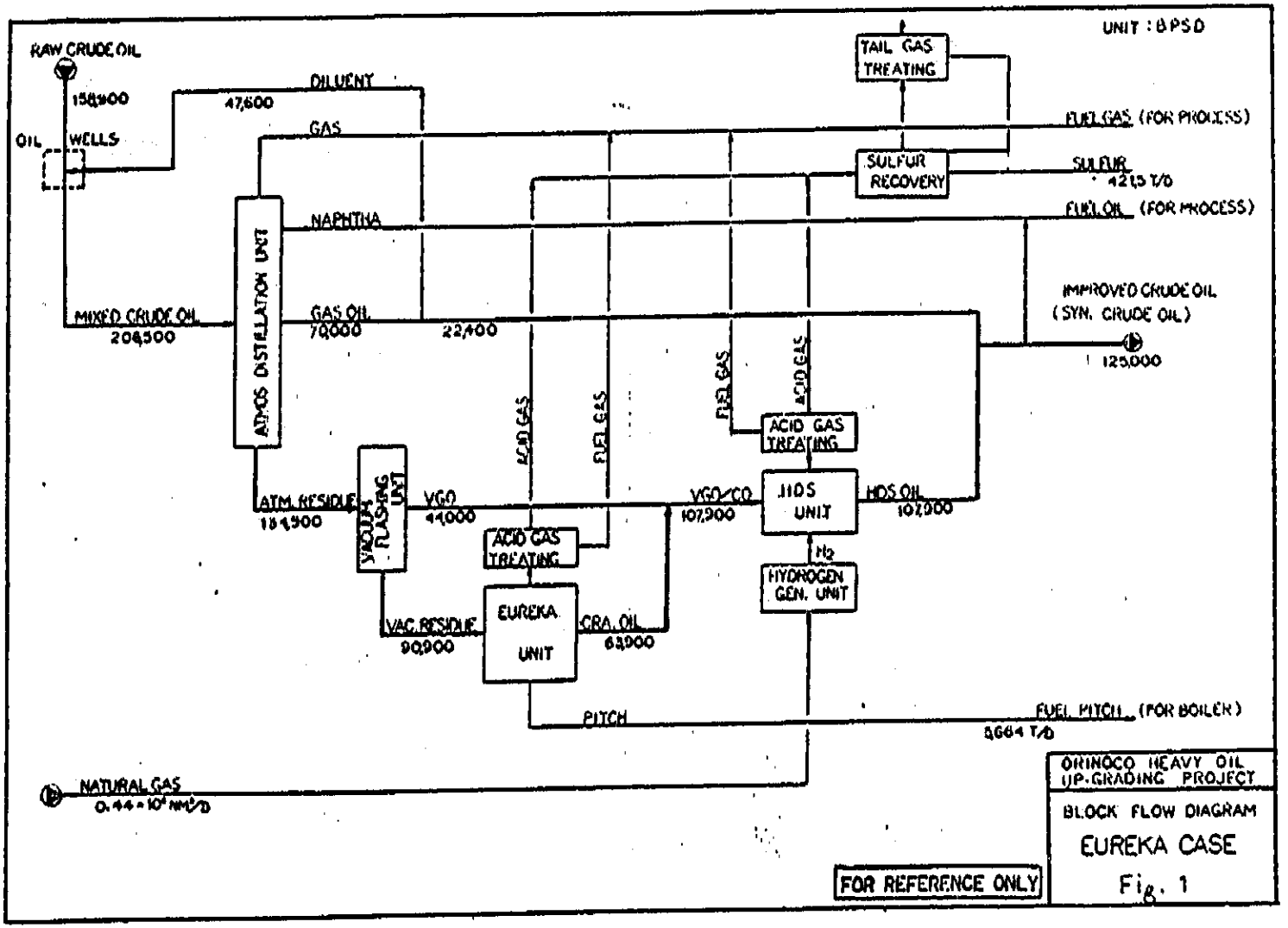
ATTACHMENT TO JICA-2

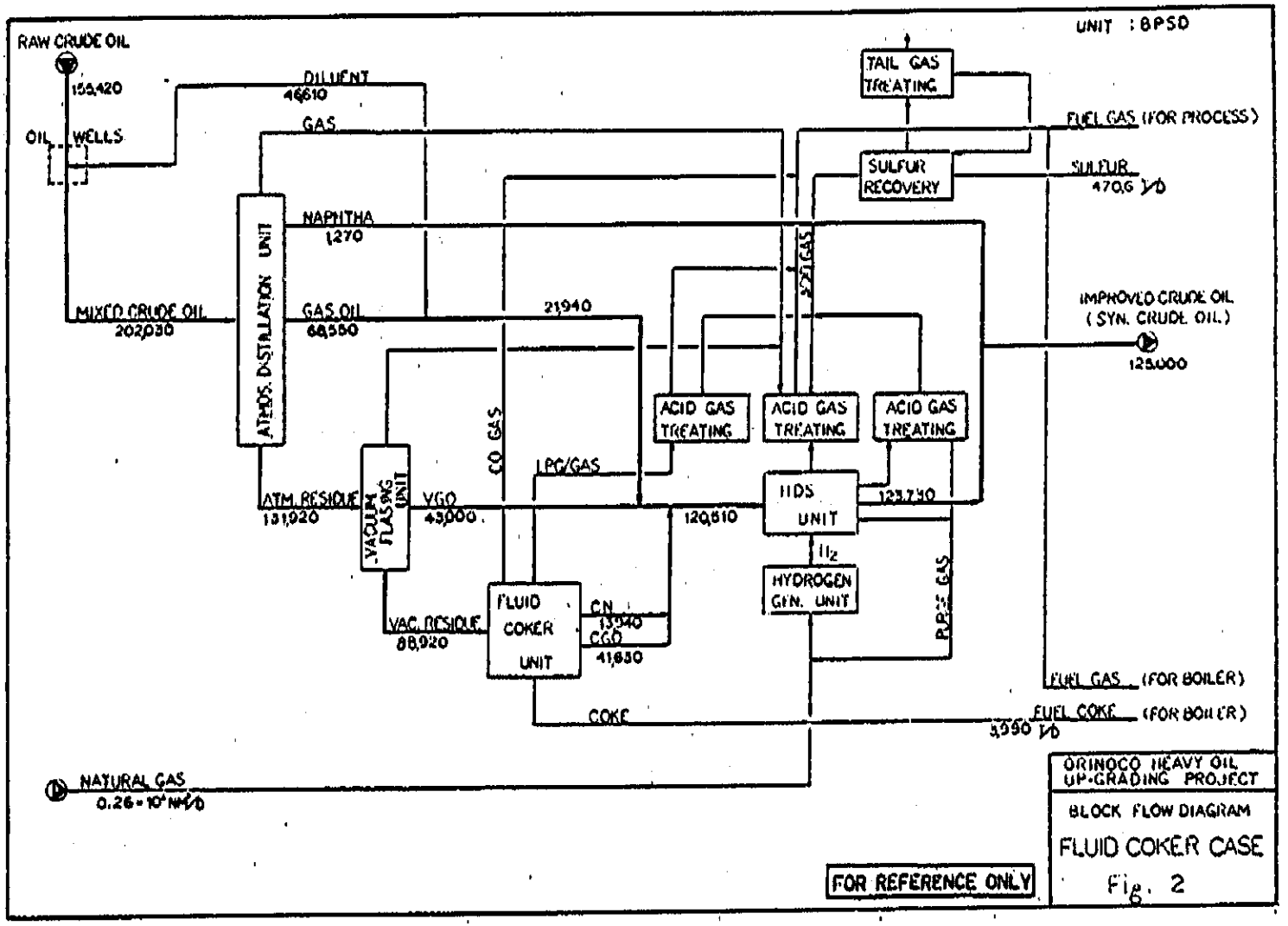
COMPARISON OF FLUIDCOKER VS FLEXICOKER

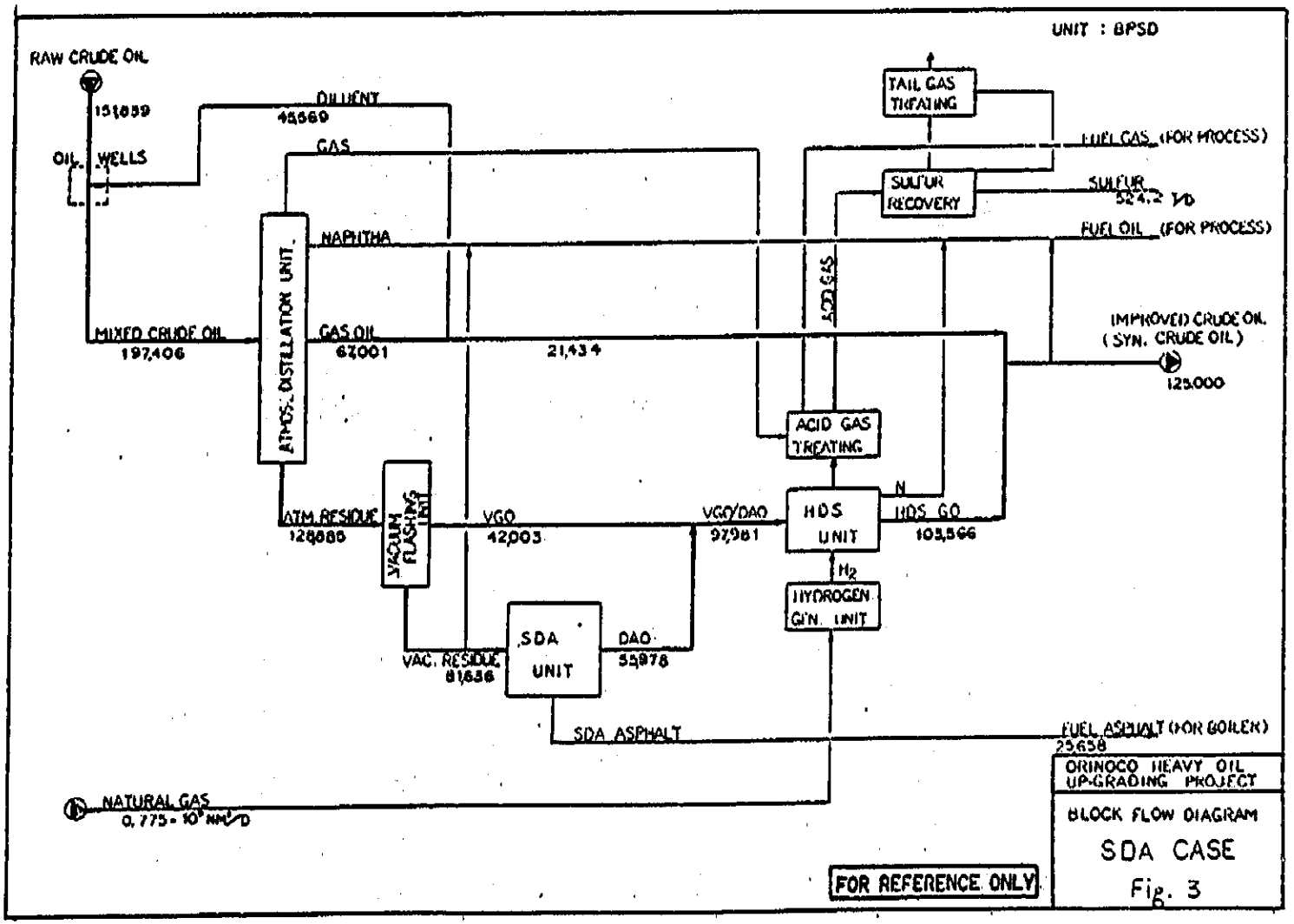
ITEM	FLUIDCOKER	FLEXICOKER
1. By-product	Coke	Low calorie gas
	a) Handling is complicated compared with gas.	a) Handling is easy.
	b) Storage is possible. (easy and practical)	b) Storage is impossible. (not practical)
2. Investment cost	a) Reactor has 2 trains due to limitation of mechanical design. (as 90,000 BPSD capacity)	a) Gasifier has 3 trains due to limitation of mechanical design. (as 90,000 BPSD capacity)
	b) Main equipment Reactor Burner Air blower	b) Main equipment Reactor Heater Gasifier Heater overhead system Air blower
	c) Required amount of equipment is small.	c) Required amount of equipment is large.
	d) Investment cost is low.	d) Investment cost far higher.
3. Coke Handling	a) Main equipment Coke silo for start-up and shutdown Coke silo for fuel Coke grinder for fuel	a) Main equipment Coke silo for star-up and shutdown Treating facility for entrained coke from heater overhead system
	b) Required items of equipment are many.	
	c) Investment cost is higher.	

(2/2)

4. Desulfurization facility for by-product combustion	a) Flue gas desulfurization at boiler b) Electric precipitator	a) Wet system desulfurization of low calorie gas b) No flue gas desulfurization at boiler c) No electric precipitator
5. Operation	a) Time for start-up and shutdown is short. b) Operation is easy c) Boiler is not directly affected by fluctuation of coker operation	a) Time for start-up and shutdown is twice that required for fluid coker. (operators are twice too) b) Operation is complicated. c) Boiler is directly affected by fluctuation of coker operation as the coker gas is burned in the boiler.
6. Maintenance	-	a) Much cost and time for maintenance are required compared with fluidcoker
7. Plot	a) Coke handling area is required.	a) Gasifier area is required.
	(Totally same area)	
8. Fuel efficiency of by-product	a) Total fuel efficiency of the Fluidcoke is higher than that of the Flexicoker gas.	a) Fuel loss for gasification of coke is much.


UNIT : BPSD
RAW CRUDE OIL
158,900
OIL WELLS
DILUENT
47,600
GAS
TAIL GAS TREATING
FUEL GAS (FOR PROCESS)
SULFUR RECOVERY
SULFUR
421.5 T/D
FUEL OIL (FOR PROCESS)
NAPHTHA
ATMOS DISTILLATION UNIT
MIXED CRUDE OIL
206,500
GAS OIL
70,000
22,400
IMPROVED CRUDE OIL
(SYN. CRUDE OIL)
125,000
ACID GAS
FUEL GAS
ACID GAS TREATING
ATM. RESIDUE
134,500
VACUUM FLASHING UNIT
VGO
44,000
VGO/CO
107,900
HDS UNIT
HDS OIL
107,000
ACID GAS TREATING
H2
HYDROGEN GEN. UNIT
VAC. RESIDUE
90,900
EUREKA UNIT
CRA. OIL
63,000
PITCH
FUEL PITCH (FOR BOILER)
9664 T/D
NATURAL GAS
0.44×10⁶ NM³/D
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
EUREKA CASE
Fig. 1
FOR REFERENCE ONLY


UNIT : BPSD
RAW CRUDE OIL
159,420
OIL WELLS
DILUENT
46610
GAS
TAIL GAS TREATING
FUEL GAS (FOR PROCESS)
SULFUR RECOVERY
SULFUR
470.6 L/D
NAPHTHA
1,270
ATMOS. DISTILLATION UNIT
MIXED CRUDE OIL
202,030
GAS OIL
68,550
21,940
S.R. GAS
IMPROVED CRUDE OIL
(SYN. CRUDE OIL)
125,000
ACID GAS TREATING
ACID GAS TREATING
ACID GAS TREATING
CO GAS
LPG/GAS
ATM. RESIDUE
131,920
VACUUM FLASHING UNIT
VGO
43,000
120,510
HDS UNIT
123,730
H2
HYDROGEN GEN. UNIT
RAW GAS
VAC. RESIDUE
88,920
FLUID COKER UNIT
CN
13,940
CGO
41,630
FUEL GAS (FOR BOILER)
COKE
FUEL COKE (FOR BOILER)
5,590 L/D
NATURAL GAS
0.26 - 10⁶ Nm³/D
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
FLUID COKER CASE
Fig. 2
FOR REFERENCE ONLY


UNIT : BPSD
RAW CRUDE OIL
151,659
DILUENT
45,569
OIL WELLS
GAS
TAIL GAS TREATING
FUEL GAS (FOR PROCESS)
SULFUR RECOVERY
SULFUR
524.2 LT/D
NAPHTHA
FUEL OIL (FOR PROCESS)
ATMOS. DISTILLATION UNIT
ACID GAS
MIXED CRUDE OIL
197,406
GAS OIL
67,001
21,434
IMPROVED CRUDE OIL
(SYN. CRUDE OIL)
125,000
ACID GAS TREATING
ATM. RESIDUE
128,680
VACUUM FLASHING UNIT
VGO
42,003
VGO/DAO
97,981
HDS UNIT
N
HDS GO
103,566
H_2
HYDROGEN GEN. UNIT
SDA UNIT
DAO
55,978
VAC. RESIDUE
81,636
SDA ASPHALT
FUEL ASPHALT (FOR BOILER)
25,658
NATURAL GAS
0.775 × 10⁶ NM³/D
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
SDA CASE
Fig. 3
FOR REFERENCE ONLY

The material balance of each refinery scheme is summarized in Table 1. (Slide 4)

Table 1 Material Balance of Process Scheme

CASE	Eureka	Fluid Coker	SDA
	BPSD	BPSD	BPSD
1. Feed			
Raw Crude Oil	158,900	155,420	151,839
Diluent Gas Oil	47,600	46,610	45,567
Mixed Crude Oil	206,500	202,030	197,406
Natural Gas	0.44×10^6 Nm^3/SD	0.26×10^6 Nm^3/SD	0.755×10^6 Nm^3/SD
3. Product			
Improved Crude Oil (Synthetic Crude Oil)	125,000	125,000	125,000
Sulfur	421.5 T/SD	470.6 T/SD	524.2 T/SD
Diluent Gas Oil	47,600	46,610	45,567
Excess By-product Fuel (for Boiler)	5,664 T/SD (pitch)	3,990 T/SD (coke) 11,220 FOE (Fuel Gas)	(4,772 T/SD) 25,658 (SDA Asphalt)
Fuel for process Furnace	as required	as required	as required

The properties of the improved crude oil are shown in Table 2. (Slide 5)

Table 2. Properties of Improved Crude Oil

CASE	Eureka	Fluid Coker	SDA
1. Feed (Raw Crude Oil)			
°API	8.5	8.5	8.5
Sulfur, wt%	3.67	3.67	3.67
2. Product (Improved Crude Oil)			
°API	25.8	25.4	25.0
Sulfur, wt%	1.0	0.91	0.4
Component, vol%			
S.R. Naphtha	-	1.0	-
S.R. LGO	17.2	-	17.1
HDS (VGO/CO)	82.8	-	-
HDS (LGO/VGO/CH/CGO)	-	99.0	-
HDS (VGO/DAO)	-	-	82.9

The installed capacity of the process units is summarized in Table 3 for each refinery scheme. (Slide 6)

Table 3. Installed Capacities of Process Unit

Unit \ CASE	Eureka	Fluid Coker	SDA
	BPSD	BPSD	BPSD
Atmospheric Distillation	206,500	202,000	197,400
Vacuum Flashing (2 trains)	134,900	132,900	128,900
Eureka	90,900	-	-
Fluid Coker (2 trains)	-	89,000	-
SDA	-	-	81,600
HDS	107,900	120,500	98,000
Hydrogen Generation (2 trains)	1.93×10^6 Nm^3/SD H_2	1.77×10^6 Nm^3/SD H_2	3.1×10^6 Nm^3/SD H_2
Acid Gas Treating (2 trains)	447.8 T/SD H_2S	500 T/SD H_2S	557 T/SD H_2S
Sulfur Recovery (2 trains)	421.5 T/D S	470.6 T/SD S	524.2 T/SD S
Tail Gas Treating (2 trains)	16.5 T/SD S	18.7 T/SD S	21.0 T/SD S

4. BY-PRODUCT UTILIZATION SCHEME

The by-product utilization scheme is the facilities which utilize the by-products as fuel oil for boiler. The following facilities are included in this scheme:

- storage of by-products
- transportation of by-products
- preparation of by-products fed to boilers
- boilers
- flue gas desulfurization
- hydrogen generation
- sulfur recovery

(1) Basic conditions

(a) 100 kg/cm^{2}G, 500°C steam of 1,000 T/H is produced for electric generation.

100 kg/cm^{2}G, saturate steam is also produced by the remaining fuel.

(b) The boilers are operated 330 days/year, the same as the upgrading refinery.

(c) The total boiler capacities are determined by the fuel quantities which are produced as by-product in the upgrading refinery.

The produced steam from the boilers and the required steam for production of raw crude oil to be charged in the upgrading refinery are not balanced.

(d) 50 MW electric power is supplied from the upgrading refinery for the production of raw crude oil.

(e) It is assumed that natural gases are used for feed and fuel of hydrogen generation unit in the flue gas desulfurization facility.

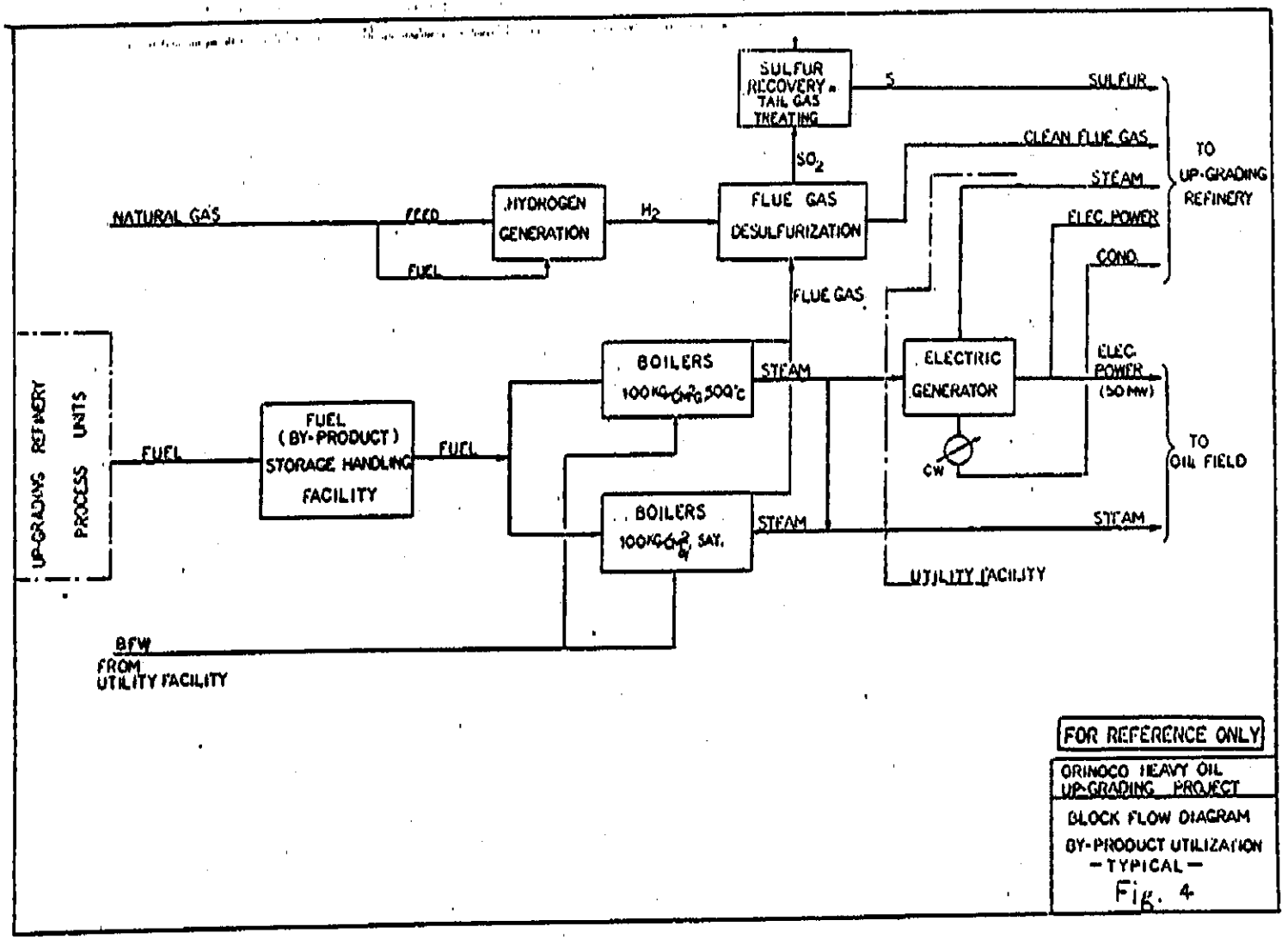
(f) Boiler feed waters for the above boilers are supplied from the utility facility of the upgrading refinery.
However, condensates are not recovered from the injection steam in the oil field.

(2) Boiler scheme

The boiler scheme for by-product utilization is shown in Fig. 4. (Slide 7)
The material balance is shown in Tablel 4. (Slide 8)

Table 4. Boiler Balance

CASE	EUREKA	FLUID COKER	SDA
1. Feed			
(1) By-product Fuel	5,664 T/SD (pitch)	3,990 T/SD (coke) 11,220 FOE BPSD (Fuel Gas)	25,658 BPSD (SDA Asphalt)
(2) Boiler Feed Water	2,550 T/H	2,450 T/H	2,210 T/H
(3) Natural Gas	0.34 x 10^6 Nm^3/SD	0.22 x 10^6 Nm^3/SD	0.27 x 10^6 Nm^3/SD
2. Product			
(1) 100 kg/cm^2G, 500°C Steam	1,000 T/H	1,000 T/H	1,000 T/H
100 kg/cm^2G, Sat, Steam	1,800 T/H	1,880 T/H	1,750 T/H
(2) Sulfur	351 T/SD	230 T/SD	277 T/SD


SULFUR RECOVERY + TAIL GAS TREATING
S
SULFUR
CLEAN FLUE GAS
STEAM
ELEC. POWER
COND.
TO UP-GRADING REFINERY
SO_2
NATURAL GAS
FEED
FUEL
HYDROGEN GENERATION
H_2
FLUE GAS DESULFURIZATION
FLUE GAS
BOILERS
100 KG/CM²G 500°C
STEAM
ELECTRIC GENERATOR
ELEC. POWER (50 MW)
CW
TO OIL FIELD
UP-GRADING REFINERY PROCESS UNITS
FUEL
FUEL (BY-PRODUCT) STORAGE HANDLING FACILITY
FUEL
BOILERS
100 KG/CM²G SAT.
STEAM
STEAM
UTILITY FACILITY
BFW FROM UTILITY FACILITY
FOR REFERENCE ONLY
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
BY-PRODUCT UTILIZATION
— TYPICAL —
Fig. 4

The installed capacity of the boiler facilities is summarized in Table 5. (Slide 9)

Table 5. Installed Capacities of Boiler Facilities

CASE	EUREKA	FLUID COKER	SDA
By-product Fuel Storage & Handling Facility	5,664 T/SD (pitch)	3,990 T/SD (coke)	25,658 BPSD (SDA Asphalt)
Boiler			
100 kg/cm^{2}G, 500°C	500 T/H x 2	500 T/H x 2	500 T/H x 2
100 kg/cm^{2}G, SAT	530 T/H x 4	540 T/H x 4	440 T/H x 4
Hydrogen Generation	0.80 x 10^6 (H_2) Nm^3/D	0.52 x 10^6 (H_2) Nm^3/D	0.63 x 10^6 (H_2) Nm^3/D
Flue Gas Desulfurization	351 T/SD (S)	230 T/SD (S)	277 T/SD (S)
Sulfur Recovery	351 T/SD (S)	230 T/SD (S)	277 T/SD (S)

5. UTILITY AND OFFSITE FLOW SCHEME

The study of utility and offsite flow scheme is now proceeding.

The facilities of the scheme are organized by utility facilities, storage facilities and general auxiliary facilities which are required for smooth operation of the process units and boiler facilities.

The utility and offsite scheme of each process scheme is different each other. However, a typical scheme for common to each case is described in this part.

(1) Utility Facilities

The following facilities are studied, besides the steam generation facility (boilers) included in the by-product utilization scheme:

Steam distribution facility in the refinery

Electric power generation and distribution facilities

Industrial water intake and desalination facilities

Water treatment facilities

Condensate recovery facility

Sanitary water facility

Cooling water facility

Fuel facility

Air facility

Inert gas facility

The system flow of steam, power and water is shown in Fig. 5. (Slide 10)

The capacity of each facility is not fixed now, but the following intake and output of utilities are assumed in the upgrading refinery:

Industrial Water	5,000 T/H
Brine	1,000 T/H
Steam for well injection	2,000 T/H
Power for Oil production	50 MW

(2) Offsite facility

The tank flow diagram of the upgrading refinery is shown in Fig. 6. (Slide 11)

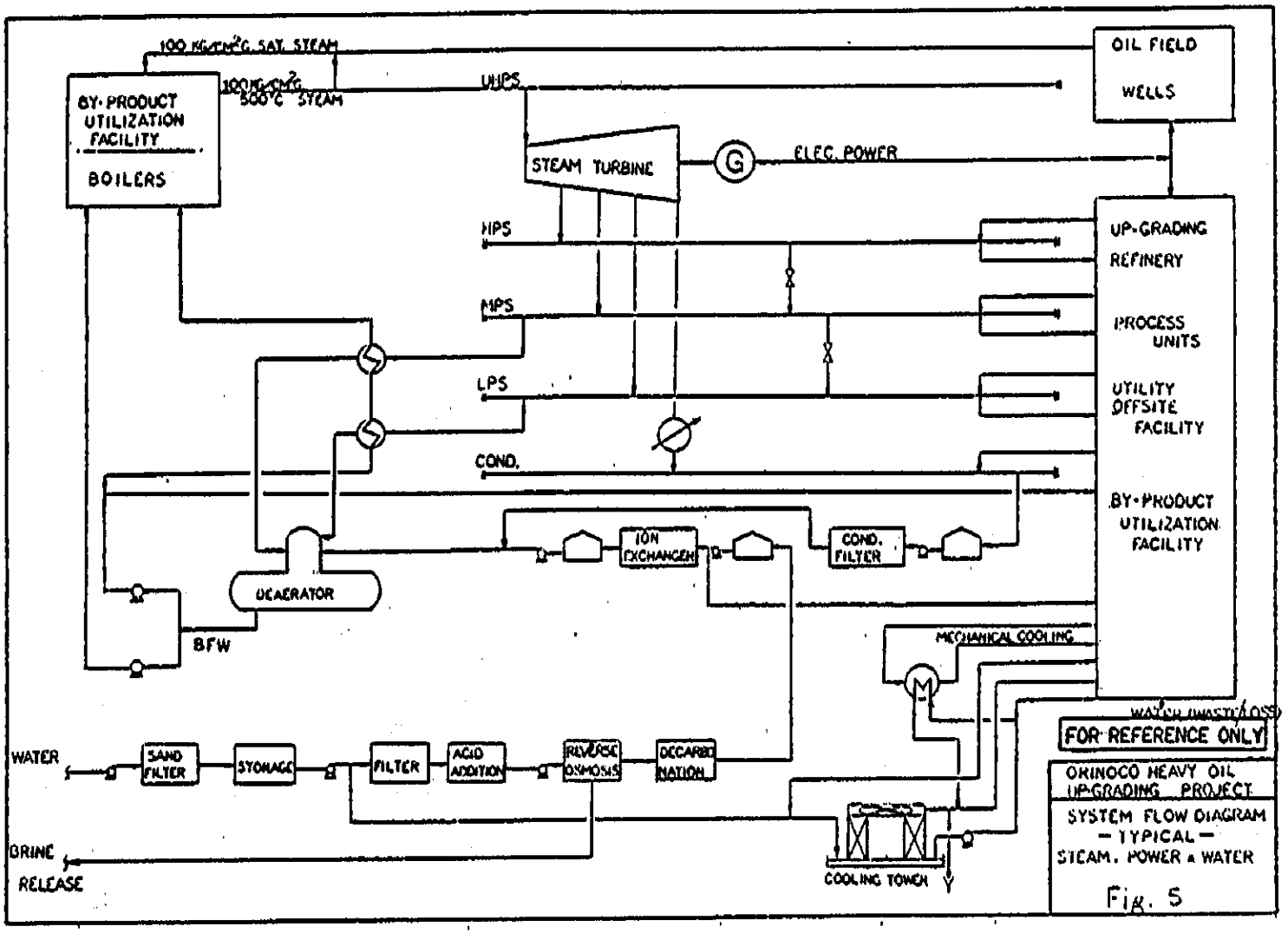

100 KG/CM²G SAT. STEAM
100 KG/CM²G 500°C STEAM
BY-PRODUCT UTILIZATION FACILITY
BOILERS
UHPS
OIL FIELD WELLS
STEAM TURBINE
G
ELEC. POWER
HPS
MPS
LPS
COND.
UP-GRADING REFINERY
PROCESS UNITS
UTILITY OFFSITE FACILITY
BY-PRODUCT UTILIZATION FACILITY
ION EXCHANGER
COND. FILTER
DEAERATOR
BFW
MECHANICAL COOLING
WATER
SAND FILTER
STORAGE
FILTER
ACID ADDITION
REVERSE OSMOSIS
DECARBONATION
BRINE RELEASE
COOLING TOWER
FOR REFERENCE ONLY
ORINOCO HEAVY OIL UPGRADING PROJECT
SYSTEM FLOW DIAGRAM
— TYPICAL —
STEAM, POWER & WATER

Fig. 5

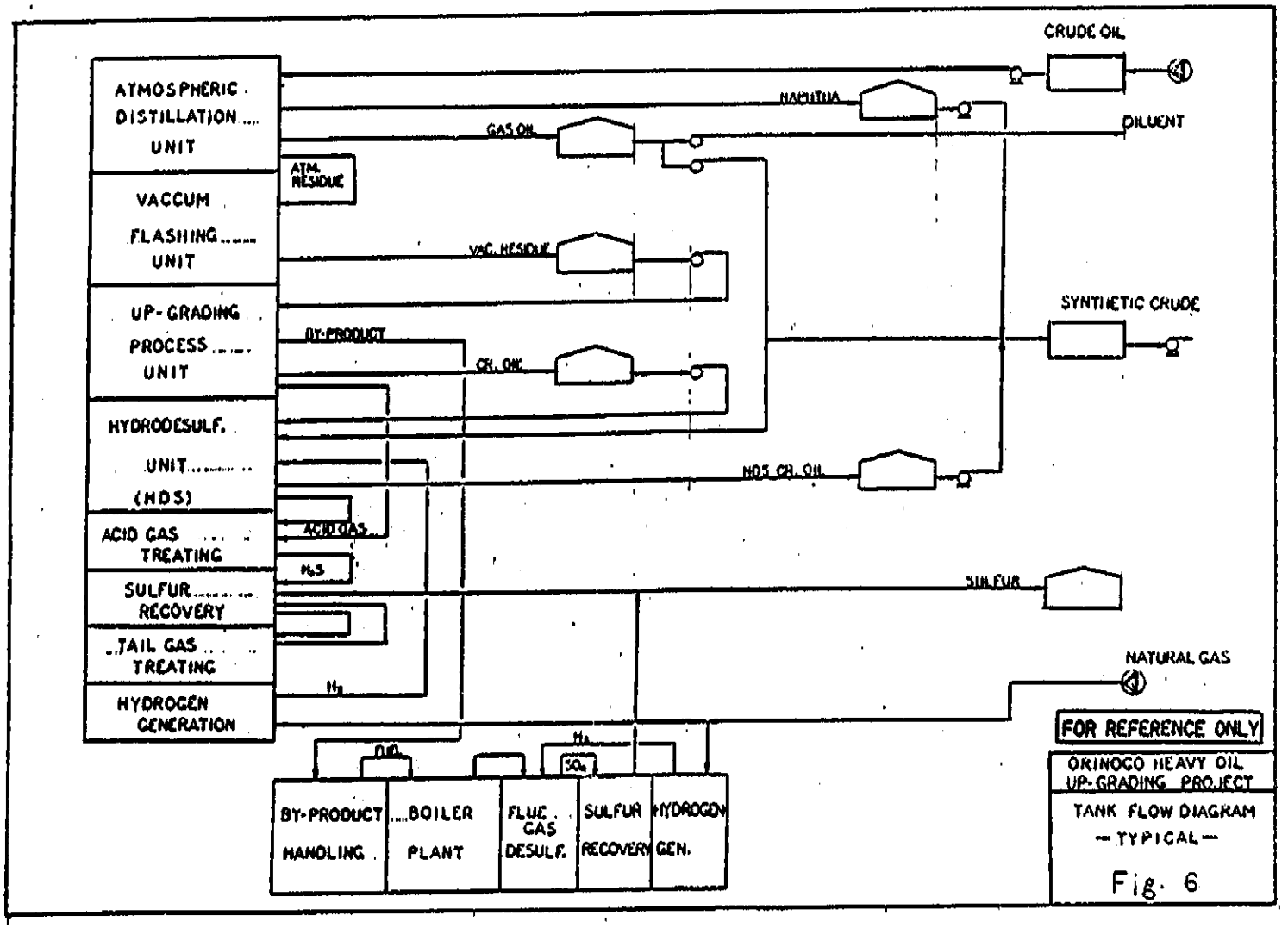

CRUDE OIL
ATMOSPHERIC DISTILLATION UNIT
VACCUM FLASHING UNIT
UP-GRADING PROCESS UNIT
HYDRODESULF. UNIT (HDS)
ACID GAS TREATING
SULFUR RECOVERY
TAIL GAS TREATING
HYDROGEN GENERATION
ATM. RESIDUE
NAPHTHA
GAS OIL
DILUENT
VAC. RESIDUE
BY-PRODUCT
CR. OIL
SYNTHETIC CRUDE
HDS CR. OIL
ACID GAS
H2S
SULFUR
NATURAL GAS
H2
O2
SO2
BY-PRODUCT HANDLING
BOILER PLANT
FLUE GAS DESULF.
SULFUR RECOVERY
HYDROGEN GEN.
FOR REFERENCE ONLY
ORINOCO HEAVY OIL UP-GRADING PROJECT
TANK FLOW DIAGRAM
— TYPICAL —

Fig. 6

The storage capacity of the upgrading refinery is smaller than a conventional refinery for the following reasons:

(a) The mixed crude oil before upgrading will be supplied anytime from the outside of the upgrading refinery.

(b) The improved crude oil will be transported by pipeline to storage tanks which will be installed at the port for export tanker.

The following facilities are studied besides the tank facility:

Waste water treating facility

Waste material treating facility

Control room

Communication facility

Lighting facility

Roads and fences

Flare stack and blow down facility

Stack for flue gases

Natural gas intake facility

Products loading facility

Buildings

- Administration office
- Maintenance shop
- Warehouse
- Laboratory
- Main station and sub-stations
- Fire station

Dressing room and resting room

Guardhouse

Clinic

Dining room

Other facilities

6. SUMMARY

The main flow of the upgrading refinery organized by the above process units, by-product utilization facilities and utility and offsite facilities is summarized in Fig. 7 (Slide 12)

Main input flow

(a) Mixed crude oil
(b) Natural gas
(c) Industrial Water

Main output flow

(d) Improved crude oil
(e) Sulfur
(f) Steam
(g) Electric power
(h) Waste Water and brine
(i) Diluent oil

The flows are different on each case. The approximate average flow rates are as follows:

(a)	Mixed crude oil	200,000 BPSD
(b)	Natural gas	0.5 - 1 x 10^6 Nm^3/D
(c)	Industrial Water	4,000 - 5,000 T/H
(d)	Improved crude oil	125,000 BPSD
(e)	Sulfur	700 - 800 T/D
(f)	Steam	2,000 T/H

Dressing room and resting room

Guardhouse

Clinic

Dining room

Other facilities

6. SUMMARY

The main flow of the upgrading refinery organized by the above process units, by-product utilization facilities and utility and offsite facilities is summarized in Fig. 7 (Slide 12)

Main input flow

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(b) Natural gas
(c) Industrial Water

Main output flow

(d) Improved crude oil
(e) Sulfur
(f) Steam
(g) Electric power
(h) Waste Water and brine
(i) Diluent oil

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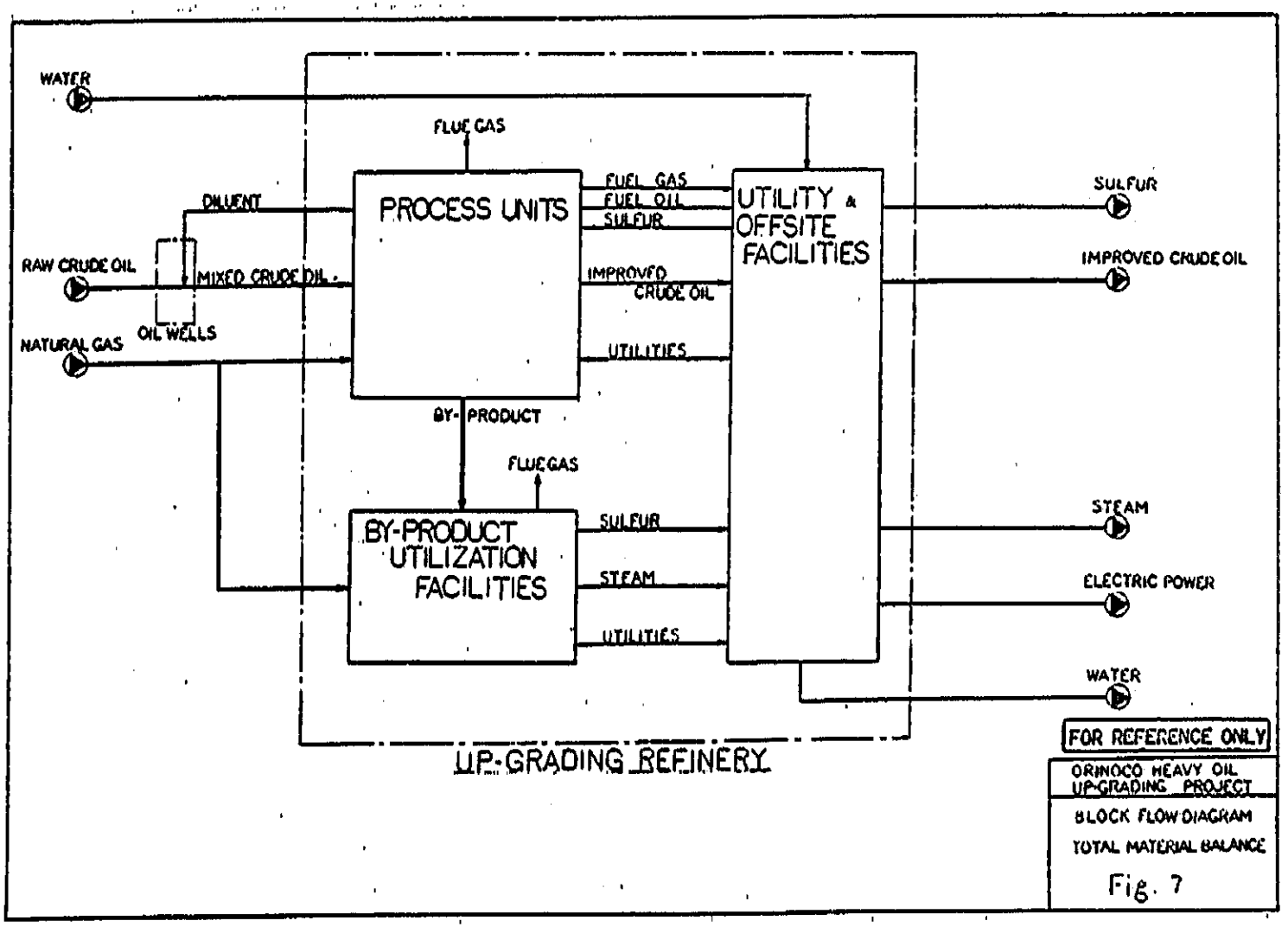

WATER
FLUE GAS
PROCESS UNITS
FUEL GAS
FUEL OIL
SULFUR
UTILITY & OFFSITE FACILITIES
SULFUR
DILUENT
RAW CRUDE OIL
MIXED CRUDE OIL
IMPROVED CRUDE OIL
IMPROVED CRUDE OIL
OIL WELLS
NATURAL GAS
UTILITIES
BY-PRODUCT
FLUE GAS
BY-PRODUCT UTILIZATION FACILITIES
SULFUR
STEAM
STEAM
ELECTRIC POWER
UTILITIES
WATER
UP-GRADING REFINERY
FOR REFERENCE ONLY
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
TOTAL MATERIAL BALANCE
Fig. 7

(g)	Electric power	50 MW
(h)*	Waste water and brine	2,000 - 3,000 T/H
(i)	Diluent Oil	45,000 BPSD

* Loss of water is included.

These figures are big values, so that basis of study should be discussed and reconfirmed before the detailed study.

The following few points shall be specially discussed to develop a realistic scheme:

Well water supply
Brine release
Sulfur loading

ATTACHMENT

ANALYSIS OF SAMPLE CRUDE OIL

Fig. 8 TBP Distillation Curve (Slide 13)

Table-6 Comparison of Main Analysis Data (Slide 14)

Fig. 8

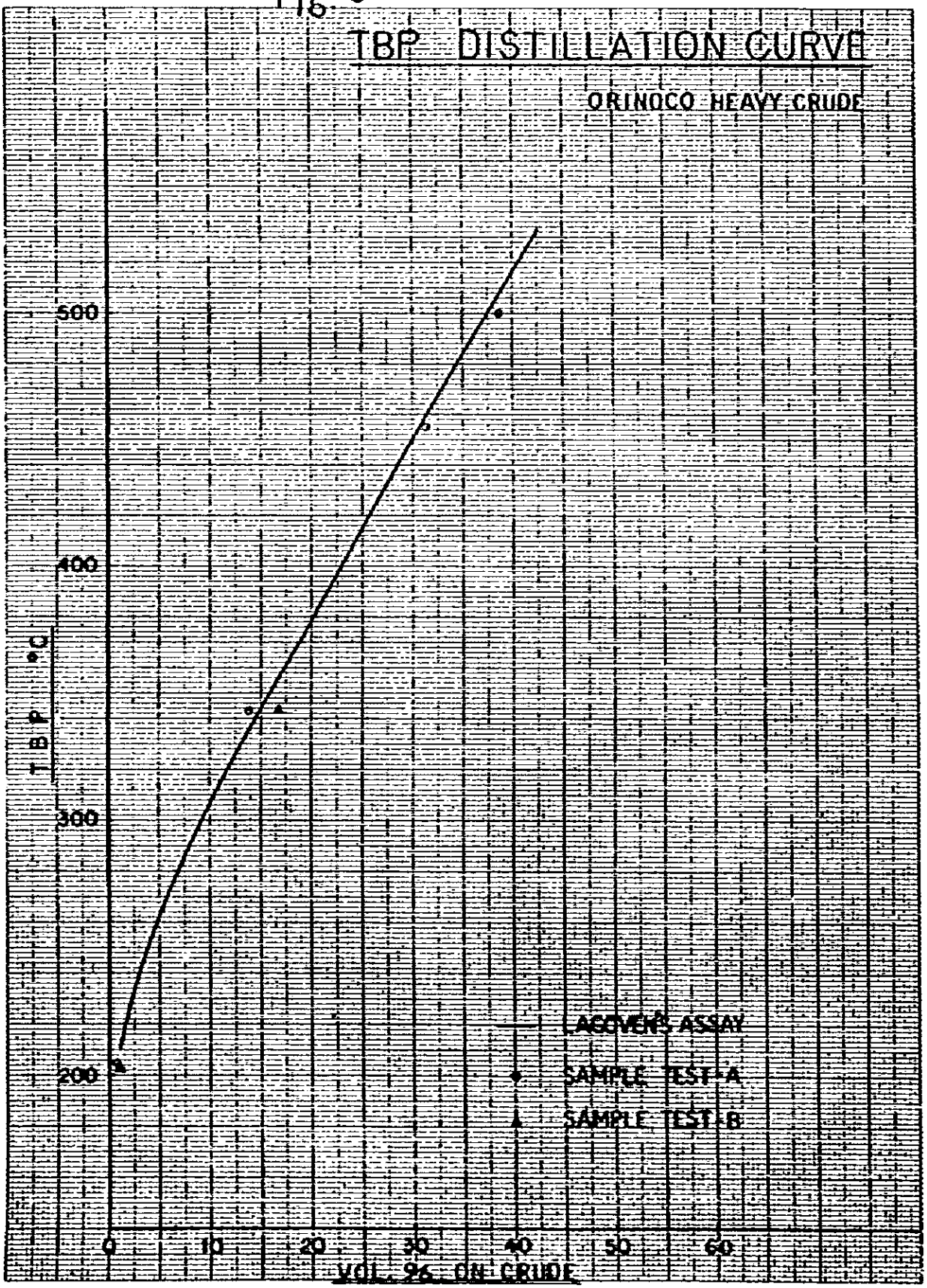

TBP DISTILLATION CURVE
ORINOCO HEAVY CRUDE
500
400
300
200
T.B.P. °C
0
10
20
30
40
50
60
VOL. % ON CRUDE
LAGOVEN'S ASSAY
SAMPLE TEST-A
SAMPLE TEST-B

TABLE-6 COMPARISON OF MAIN ANALYSIS DATA

SAMPLE	CUT. PT.	TEST	ANALYSIS Sp. Gr (15/4°C)	Sulfur wt.%	CCR wt.%	V w.ppm	Ni w.ppm	Ash wt.%	Na w.ppm	Asphalten wt.%
Crude Oil	-	A	1.019	3.75	18.1	420	110	0.451	840	-
	-	B	1.0199	3.87	17.0	310	120	0.246	1,100	-
	-	ASSAY	1.011	3.67	13.3	392	84	-	-	-
Long Residue	650°F+	A	1.038	3.96	20.60	480	110	0.46	850	-
	650°F+	B	1.0353	4.12	20.40	410	130	0.264	1,002	13.3
	650°F+	ASSAY	1.034	4.04	17.6	484	120	-	-	-
Short Residue	930°F+	A	1.062	4.21	29.50	660	160	0.609	1,190	-
	950°F+	B	1.0514	4.26	-	-	170	0.357	1,500	-
	830°F+	C	1.045	4.14	22.79	559	148	0.3	1,190	-
	995°F+	ASSAY	1.062	4.32	25.7	654	162	-	-	-
	950°F+	ASSAY	1.058	4.26	23.6	616	153	-	-	-
	851°F+	ASSAY	1.049	4.17	20.5	546	135	-	-	-

ATTACH MENT TO JICA-2

(2)

CONFIRMATION ITEMS OF BASIS

OF

FEASIBILITY STUDY

FOR

THE UPGRADING PROJECT

OF

ORINOCO HEAVY OIL

IN

THE REPUBLIC OF VENEZUELA

APRIL 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Battery limits of the upgrading refinery on the feasibility study (Please refer to the attached Fig. A)

As the feasibility study bases, the upgrading refinery fence is assumed as the battery limits of the following input and output flows:

(1) Feed oil: mixture of raw crude oil and diluent

The feed oil is dehydrated and desalted in a main station after handling at oil production, gathering and block stations which are excluded from the scope of study. Storage of one week is considered.

(2) Natural gas for feedstock of hydrogen generation.

(3) Diluent (gas oil)

(4) Industrial water

(5) Product sulfur (molten type)

Storage of one week production is considered in the fence.

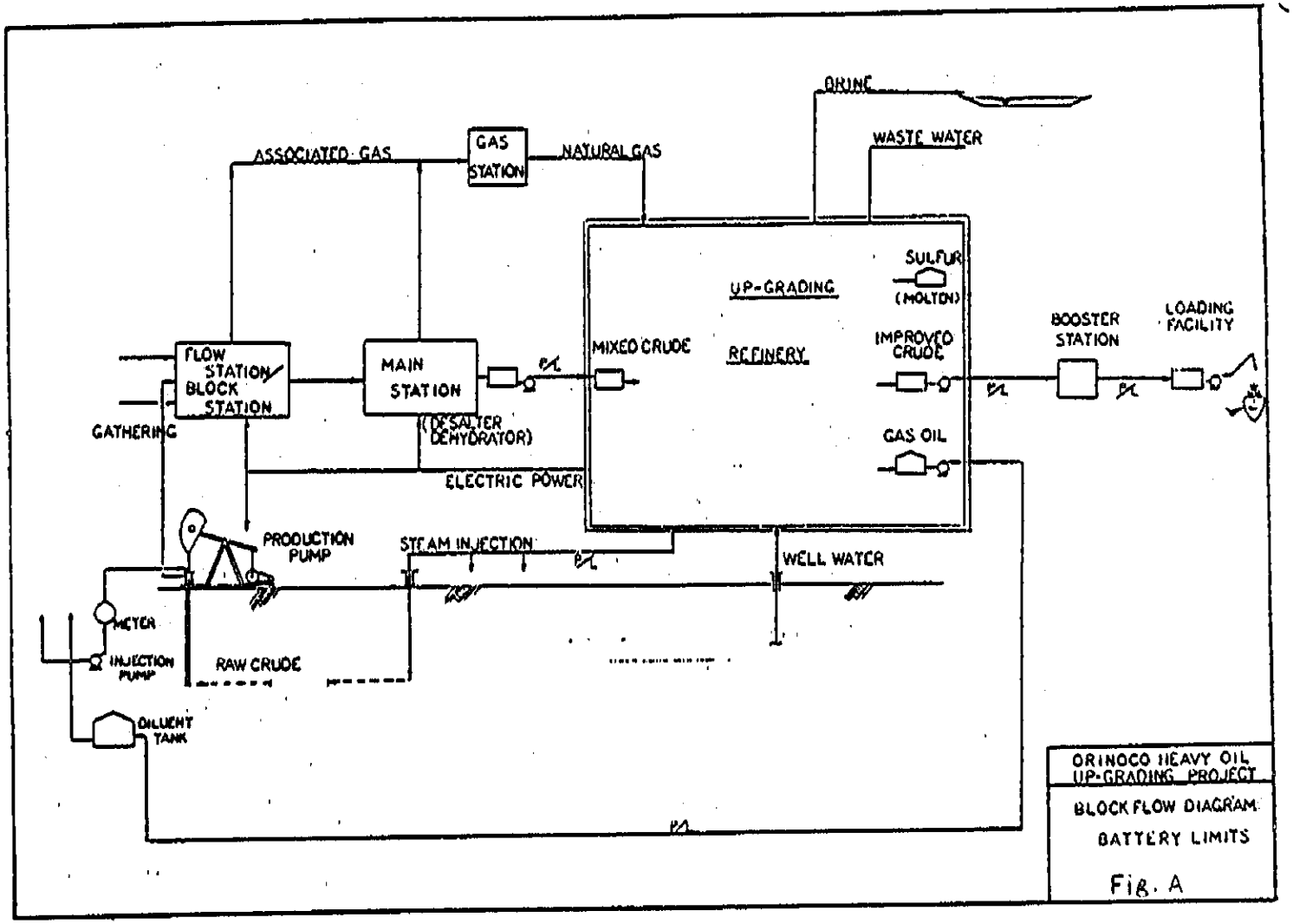
(6) Synthetic crude oil (Improved crude oil)

Storage of one week production and loading pumps of 40 kg/cm^2G discharge pressure are considered in the fence.

Transmission pipeline, booster stations, storage tanks at the port and loading facilities are outside the scope of the study.

(7) Steam

Surplus by-products are used as boiler fuel to produce ultra-high pressure steam.


ORINC
WASTE WATER
ASSOCIATED GAS
GAS STATION
NATURAL GAS
SULFUR
(MOLTON)
UP-GRADING
REFINERY
MIXED CRUDE
IMPROVED CRUDE
BOOSTER STATION
LOADING FACILITY
FLOW STATION BLOCK STATION
MAIN STATION
(DESALTER DEHYDRATOR)
GATHERING
GAS OIL
ELECTRIC POWER
PRODUCTION PUMP
STEAM INJECTION
WELL WATER
METER
INJECTION PUMP
RAW CRUDE
DILUENT TANK
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
BATTERY LIMITS
Fig. A

Surplus ultra-high pressure steam is exported for well injection.

(8) Electric power

50 MW electric power is exported for well users.

(9) Waste water

Waste water and brine are discharged.

2. Data required

(1) Properties, availability and supply conditions of natural gas.

(2) Properties, availability and supply conditions of industrial water.

3. Information required (Discussion items)

(1) Difference of the data on the crude assay and sample oil
(Please refer to Table 6 and Fig. 8 in the report of preliminary study)

(a) The preliminary study was conducted based on the crude assay.

(2) Specification of improved oil

(a) Specifications of improved oil suggested by MEM are °API gravity and total sulfur content only. However, in a certain case, it is difficut to keep sulfur content at 1.0 wt. percent when gravity is kept at 25 - 28 °API due to the features of the hydrodesulfurization process.

(b) May we understand the high sulfur light gas oil is mixed with the improved oil?

(3) Sulfur

(a) More than 700 Ton/SD sulfur is produced in the refinery.
How to transport the molten sulfur from the refinery to a port, and from a port to market?
Maximum capacity of tanker for molten sulfur will be 2000 ton.

(b) Please kindly give us information on the prevailing restrictions on air pollution.
Is it necessary to recover sulfur from the flue gas?

(4) Desulfurization of boiler flue gas

(a) Molten sulfur production is applied on the preliminary study.
Therefore, hydrogen generation and sulfur recovery units are included in the flue gas desulfurization facilities.

(b) Please kindly give us the following information:

(b-1) demand for sulfur compounds
sulfur, sulfuric acid, sulfite, gypsum, ...

(b-2) availability and price of limestone, magnesium hydrooxide, silica, sand

(b-3) price of gypsum

(5) Boiler feed water

(a) Since the oil well injection steam is not recovered as condensate, a large quantity of fresh water must be produced from underground water, which is assumed to be high in salt content.

(b) For the production of fresh water, a reverse osmosis process is applied, because it is simple and is less expensive compared with other processes such as evaporation process.

(c) Is there a possibility to recover water from the oil well?

(d) Please kindly give us information on the fresh water production system presently used at the oil production field.

(6) Waste water and brine

(a) Discharge point of waste water and brine

(b) Restrictions on water pollution

(7) Operation of boiler and refinery

(a) Operation days of the refinery and boiler facilities are 330 days/year.

(b) Concerning the storage of boiler fuel, the following should be taken into consideration:

(b-1) storage facility of gas fuel for one month consumption is very large and is not practical

(b-2) solid fuel can be stored. However, storage for one month consumption is large. And coke has to be stored indoor.

(b-3) Liquid fuel can be stored. However, since high temperature heating is required, storage of large quantity is undesirable.

(c) Please kindly give us an idea on heating system of the tank presently used for the crude storage.

ATTACH MENT TO JICA-2

③

CONFIRMATION ITEMS OF BASIS

OF

ECONOMIC STUDY

FOR

THE UPGRADING PROJECT

OF

ORINOCO HEAVY OIL

IN

THE REPUBLIC OF VENEZUELA

APRIL 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Schedule

(1) What is the time schedule for the Orinoco heavy crude development and production?

Expected starting time of 150,000 - 160,000 BPSD crude production

(a) 1989
(b) Other ( )

(2) What is the time schedule for the plans for the upgrading plant installation?

Expected operating start-up of the upgrading plant

(a) Early of 1989
(b) Other ( )

(3) How many years should be taken for the project life after start-up operation?

(a) 20 years
(b) Other years

(4) What should be the stream factor for plant operation?

(a) 1st year [ ] %
(b) 2nd year [ ] %
(c) after 3 year [ ] %

2. Raw material cost and product price

(1) What do you suppose is the cost of Orinoco heavy crude (mixture of raw crude oil and diluent) at the upgrading plant fence?

US$ [ ] /BBL
on [ ] /(Year)

(2) Waht do you suppose is the cost of the diluent at the upgrading plant fence?

US$ [ ] /BBL
on [ ] (year)

(3) What do you suppose is the price of Natural gas at the upgrading plant fence?

US$ [ ] /MMCF

on [ ] (MM Nm^3) (year)

(4) What do you suppose is the price of synthetic crude at the upgrading plant fence?

US$ [ ] /BBL
on the condition of
[ ] °API
[ ] wt.% S
[ ] year base

Syn. crude		Est. price US$/BBL
API	Sulfur (wt%)	at [ ] year
22	1.0	[ ]
24	1.0	[ ]
25	1.0	[ ]
26	1.0	[ ]
28	1.0	[ ]
30	1.0	[ ]
Sulfur premium		[ ] US$/0.1 wt.% S

(5) What is the price of sulfur product at plant fence?

US$ [ ] /ton

(6) What is the price of steam at the plant fence?

US$ [ ] /ton
on [ ] year
at condition of 100 kg/cm^2G saturate

US$ [ ] /ton
on [ ] year
at condition of 100 kg/cm^2G 500 °C

(7) What do you suppose is the supply cost of water of the plant fence?

US$ [ ] /ton
on [ ] year

(8) What is the supply price of electric power at the plant fence?

US$ [ ] /kw
on [ ] (year)

3. Conditions of Cost

(1) What are the inflation factors in Venezuela?

- Construction material [ ] %/year
- Construction labor [ ] %/year
- Raw material, products, [ ] %/year
- Operating labor [ ] %/year

(2) What is the local factor of construction cost compared to US Gulf cost?

- Equipment & materials cost [ ]
- Installation cost [ ]

(3) What are the import duties for import materials & equipment and the income tax of foreign engineers & labor?

[ ] %
[ ] %

(4) What should be considered for working capital?

(a) Land cost

Feed storage
Product storage
Production cost
Product sales

(b) Land

What is the land cost of plant site? [ ]

(c) Oil inventory

What percent full of tank is considered at the end of start-up period? [ ]

(d) Chemical inventory

How many months of supply or how much quantity is required? [ ]

(e) Spare parts

What percent of construction cost is estimated for spare parts? [ ]

(5) What are the salaries including all allowances of operators in the plant?

- Administrative staff
- Technical staff
- Foreman & operator
- Worker

US$ [ ] /year

at [ ] year

(6) Can you give us a typical organization chart of the existing refinery?

(a) Yes
(b) No

(7) What are the average wages of skilled labor and other?

	US$/Day
Supervisor	
Welder	
Driver (car)	
Driver (crane)	
Driver (truck)	
Mechanic	
Pipe fitter	
Piping worker	
Painter	
Duct worker	
Electrician	
Insulation worker	
Common Labor	
Offie clerk	
Typist	
Accountant	
Engineer	
Draftsman	

(8) What are the costs of construction materials?

	US$/Ton
Cement	
Steel bar	
Gravel	
Concrete	

(9) How many years should be taken for the depreciation period of plant after start-up operation?

(a) 10 year
(b) Other [ ] years

What kind of depresciation method shall be taken?

(a) straight run
(b) Other

(10) How much is taken for salvage value?

[ ]

4. Debt & Equity

(1) What is the ratio of Debt/Equity for investment?

[ ] / [ ]

(2) What is the interest ratio of loan?

for long-term loan
for short-term loan

(a) 8%
(b) 10%
(c) Other [ ] %

(3) How should the interest be handled during construction?

(a) Capitalized
(b) Other

(4) What kind of method for refund of loan should be assumed?

(a) Constant refund
(b) Other

(5) How many years should be assumed for payment of loan?

(a) 10 years
(b) Other [ ] years

(6) How many years are taken as grace period?

[ ] year

And when is a counting point of the period?

[ ]

(7) What is accounting method?

(a) Base account
(b) Mid-year account

5. Taxes

(1) What percent is the corporate tax and what kind of method is selected?

[ ] %
(a) Uniform
(b) Progressive
(c) Other

(2) What percent is the fixed property tax to fixed assets of plants and what kind of method is selected?

[ ] %
(a) Uniform
(b) Progressive
(c) Other

(3) What percent is the insurance for fixed assets of plants?

[ ] %

(4) How much is the royalty for oil production?

[ ]

(5) How many years are considered as tax holiday?

[ ] year

6. Economic Analysis

(1) What kind of analysis method is recommendable?

(a) DCF method
(b) Paid out time method
(c) Other

(2) What is the definition of cash flow?

(a) IRR
(b) NPV

(3) What is the base year?

(a) Start of construction
(b) Completion of construction
(c) Start of operation

(4) Which is a recommendable method of IRR?

(a) ROI
(b) ROE

(5) What sensitivity analysis item shall be calculated?

(a) IRR 15%
20%
25%

(b) Investment Cost
Base
+20%
-20%

(c) Other

(5) What Sensitivity analysis item shall be calculated?

(a) IRR 15%
20%
25%

(b) Investment Cost
Base
+20%
-20%

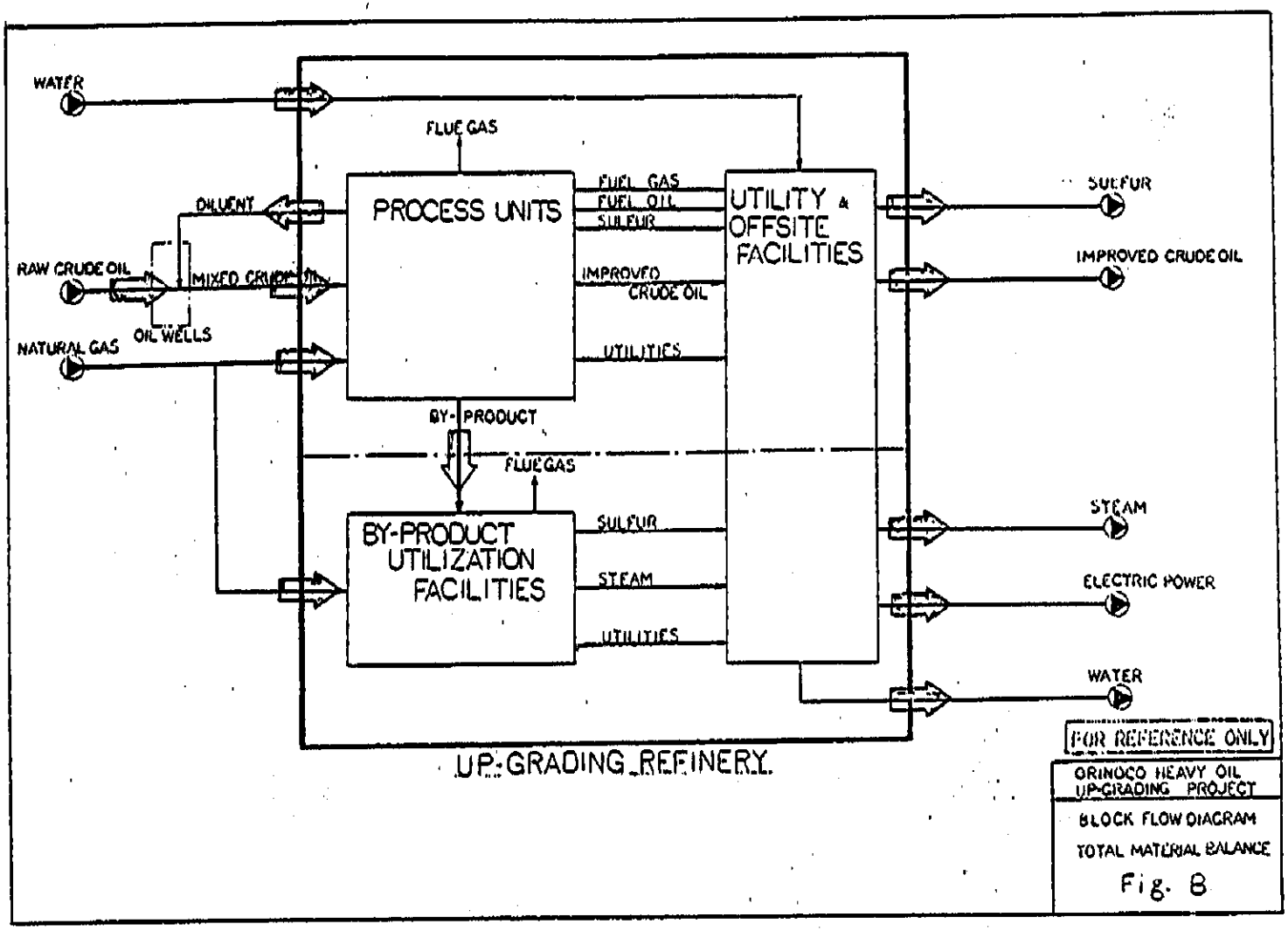
(c) Other

7. Calculation method of Economic analysis

Please refer to the attached Fig. B.

Price/Cost	IN/OUT	Initial Fixed Value	Objective Value (Fixed)	Calculated Value
(a) Mixed crude oil	IN	o		
(b) Raw crude oil	IN	(o)*		
(c) Natural gas	IN	o		
(d) Water	IN			
(e) Diluent	OUT	o		
(f) Improved crude oil	OUT	-		o
(g) Sulfur	OUT	o		
(h) Steam (UHP)	OUT	o		
(i) Electric power	OUT	o		
(j) Water	OUT	o		
(k) By-product fuel	OUT/IN	-		
(l) Utilities	OUT/IN	-		
(m) IRR	-	-	o	

* (b) instead of (a) + (e);
in this case outlet diluent is the same value as inlet diluent.


WATER
FLUE GAS
PROCESS UNITS
FUEL GAS
FUEL OIL
SULFUR
UTILITY & OFFSITE FACILITIES
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SULFUR
STEAM
ELECTRIC POWER
UTILITIES
WATER
UP-GRADING REFINERY
FOR REFERENCE ONLY
ORINOCO HEAVY OIL UP-GRADING PROJECT
BLOCK FLOW DIAGRAM
TOTAL MATERIAL BALANCE
Fig. 8

ATTACHMENT TO JICA-2

④

INFORMATION AND DATA

ON

CONSTRUCTION PLANNING

FOR

THE UPGRADING PROJECT

OF

ORINOCO HEAVY OIL

IN

THE REPUBLIC OF VENEAUELA

APRIL 1980

JAPAN INTERNATIONAL COOPERTION AGENCY

PORT CONDITION

1. Brief description of dock facilities
   (Port drawings and harbor charts)

2. Size of ship that can be berthed

3. Maximum size and weight of cargo unloaded at port to date

4. Can vessels be offloaded into sea at port and towed to shore for loading

5. Type and capacities of unloading facilities

Type	Capacity	Quantity
Floating crane		
Crane		
Forklift		

6. Information on unloading extraordinarily large and heavy cargo

   (1) Limitation due to wind, if any

   (2) Effect of tide and height of waves

7. Capacities, available numbers of lighters and any other carriers for cargo

8. Storage capacities

   Shed

   Warehouse

   Bonded warehouse

   Outdoor storage space

9. Port congestion and required period for unloading

10. Harbor permits and regulations

11. Charges, duties and other levies

DATA AND INFORMATION ON SITE

1. Map

   (1) Map of country or state showing roads and railroads

   (2) Large scale map of site

   (3) Contour map of site

2. Geology

   (1) Nature of surface soil

      Gradation
      Color
      Acidity
      Salt content
      Sulfur content
      Permeability
      Stability under watery condition

   (2) Subsoil condition

   (3) Soil data

      Boring logs
      Soil analysis
      Laboratory test reports

   (4) Elevation above sea level

   (5) Flood and tidal data

   (6) Elevation of ground water level

   (7) Drainage of site

3. Climate

   (1) Meteorological records
      Clear, cloudy and rainy days
      Temperature and humidity
      Rainfall
      Wind velocity
      Earthquake
      Record of floods, droughts

4. Obstructions on site

   Buildings
   Transmission lines
   Underground obstructions
   Others

5. Utilities required during construction work

   Water
   Electric power

LOCAL TRANSPORTATION

1. Organization concerned. The country, state, city?

2. Roads
   (1) Distance between site and port
   (2) Buried items
   (3) Width
   (4) Curve radius
   (5) Slope
   (6) Condition and size of side ditches

3. Width and type of bridge

4. Width, height and type of tunnel

5. Limitations relating to above 2, 3 and 4
   (1) Weight
   (2) Length

LABOR CONDITION

1. General

   (1) Governmental authority in charge

   (2) Labor laws and regulations

   (3) Estimated level of local skilled labor compared with that of Japanese

   (4) Working hours and holidays

   (5) Conditions on labor unions

2. Expatriate labors

   Possibility of hiring foreign labors
   (Engineer, technician, skilled and unskilled worker)

3. Contracators for the following works

   (1) Building work

   (2) Civil work

   (3) Steel structure work

   (4) Airconditioning work

   (5) Drainage work

SUBCONTRACTOR

1. Name

   Address

   Telephone No.

   Representative

2. Speciality

3. Experience

   Project, owner

   Site

   Time

4. Equipment owned

5. Number of regular personnel and workers

6. Observation of rubcontractor's jobsites, workshops, construction equipment, office, material yards, etc.

ATTACHMENT-5

Caracas, May 12, 1980

RECORD OF DISCUSSIONS

The Venezuelan authorities concerning with Orinoco Oil development, which are Ministerio de Energía y Minas (hereinafter referred to as "MEM"), Petróleos de Venezuela S.A. (hereinafter referred to as "PDVSA"), LAGOVEN, S.A. (hereinafter referred to as "LAGOVEN") and Instituto Technologico del Petróleo (hereinafter referred to as "INTEVEP"), and the Japanese Second Survey Team for the Upgrading project of Orinoco Heavy Oil in the Republic of Venezuela (hereinafter referred to as "The Team"), sent by Japan International Corporation Agency (hereinafter referred to as "JICA") had meetings.

The schedule of meetings and persons who participated in the discussions are listed in Annex - A and Annex - B, respectively.

Both parties exchanged views and discussed.

The following is a summary of the meetings.

1.- Reporting of the Result of the Preliminary Study
The Team reported the result of the preliminary study based on "Attachment to JICA - 2 ①" included in Annex - D.

2.- Revision of Basic Conditions for the Study in "Record of Discussions" signed by both parties on October 10, 1979.
Both parties agreed to the following items:

(1) Feed Oil of the Upgrading Refinery

(a) Name of the raw Orinoco Heavy Oil
50/50% Cogollar IX and Cerro Negro Crude Oil

(b) Diluent for the oil production
Distillate of 380 - 510°F, mainly light gas Oil of the upgrading refinery is recycled.

../..

(c) Analysis Data of Raw Orinoco Heavy Oil for futher study use.
"Crude assay of 50/50% COCOLLAR IX and Cerro Negro (Report No. LV.5C - PC.79)" prepared by LAGOVEN and "Characterization de los residuos (700°F,+) y de sus crudos de origen" in the Annex - C are used.

(d) Capacity of the upgrading refinery
To produce 125,000 BPSD minimum of product oil.

(2) Product of the Upgrading Refinery

(a) Properties of product
"Target Yields of synthetic crude" and. "Target key qualities of components" in the Annex - C is to be referred.

(3) By products of the Upgrading Refinery

(a) Use of by - product
Fuel for the generation of electric power for the oil production and the upgrading refinery and the generation of steam for the upgrading refinery.
Excess fuel is piled in the upgrading refinery.

(b) Boiler plant site
One centralized boiler plant for use of by-product is installed in the upgrading refinery.
Field portable boilers for steam injection are installed separately in the field which are excluded from the feasibility study.

(c) Fuel supply for the field portable boiler
Excess fuel gas from the upgrading refinery is supplied.
Main fuel for the boiler is natural gas.

(4) Sulfur Recovery

(a) Recovery Sources
Sulfur in the sour gas of hydrodesulfurization units is recovered as elemental sulfur.
Sulfur of 90 % in the flue gas of boilers is recovered as gypsum or others.

(b) Type of Sulfur

Elemental sulfur is solid.

(5) Steam and Electrical Power Requirements for oil production.

(a) Steam

Steam is not supplied from the upgrading refinery.

(b) Electric Power

150 MW on the basis of the raw crude production of 170,000 BPCD is required for the raw crude oil production.

3.- Items Confirmed

Both parties confirmed the following items:

3.1 Items relating to the "Attachment to JICA - 2 ①"

(1) The further study on the Flexicober case is excluded from the feasibility study.

(2) Fuel for furnace of the upgrading refinery

Shortage of fuel is balanced by vacuum residue.

(3) Feed for hydrogen generation unit

Natural gas is supplied.

(4) Industry water

River water is supplied.

3.2 Items relating to the "Attachment to JICA - 2 ②"

(1) Properties, availability and supply conditions of natural gas

C1	93.1	mol%
C2	1.9	mol%
CO2	3.7	mol%
C3+	1.3	mol%
Total	100.0	mol%
H2S	60	ppm
Mercaptan & COS	10	ppm
Supply pressure	500 psig	

Required quantity is available.

(2) Properties, availability and supply conditions of industrial water

"REPORTE DE ANALISIS DE AGUA" in the attachment - C is to be referred.

Required quantity is available.

(3) Waste Water

(a) Discharge point of waste water is the fence of the upgrading refinery.

(b) Restriction of water pollution are not specially considered.

(4) Operation of Boiler and Refinery

(a) Stream days of the refinery units are 330 days/year. And minimum half train of process units during shutdown maintenance is to be opereted continuously.

(b) Boiler and power generating facilities are to be operated continuously for 365 days operation of oil production.

3.3 Items relating to the "Attachment to JICA - 2 ③"

(1) Schedule

(a) Mechanical completion of the refinery = end of 1987
Start-up of the refinery = early of 1988
Full production of crude oil = early of 1989

(b) Project life = 20 years

(c) Operating rate of the refinery =

1988 ...330 stream days/year X 50%

1989 ...330 stream days/year X 100%

(2) Raw Material Cost and Product Price

(a) Raw crude oil = US $ 10/BBL on 1980

(b) Diluent gas oil = No value

(c) Natural gas & fuel gas = US $ 3/MMBTU on 1980

(d) Synthetic crude
"Upgraded Crude Values" in the Annex - C is to be referred.

(e) Sulfur = No value

(f) Industrial water = No value

(g) Electric power = US $ 0.023/KW on 1980

(h) Limestone & gypsum = No value

(i) Escalation of price is not considered for the study.

(3) Condition of Cost

(a) Investment and operating cost are estimated on Venezuela site, 1980 base.
And escalation is not considered for the study.

(b) Oil inventry
Feed crude oil = 50% of 30 days storage capacity
Product = 50% of 7 days storage capacity

(c) Chemical inventry = 2 Months

(d) Spare parts = Standard

(e) Salaries including all allowances of operation persons
= Total average US $ 22/MH
on 1980

(f) Typical organization chart of refinery
The refinery is organized by three (3) Department of operation, maintenance and technical.
Other departments are outside of the refinery.

(g) Depreciation period after start-up operation
= 16.6 years (Total average)

(h) Depreciation method = straight line

(i) Salvage value = No

(j) Land cost = No value

(4) Debt & Equity
All equity

(5) Taxes

(a) Corporation tax = 50% & 67%

(b) Method of corporation tax = Uniform

(c) Fixed property tax to fixed assets = No

(d) Insurance for fixed assets = No

(6) Economic Analysis

(a) Analysis method = DCF Method

(b) Definition of cash flow = IRR

(c) Base year = Start of operation (1988)

(d) Method of IRR = ROE

(f) Sensitivity analysis = Investment cost
- 20% & + 20%
Raw Crude Oil
- 50% & + 50%

(7) Calculation Method

(a) Fixed value

Raw crude oil, diluent, natural gas, water, sulfur, limestone, gypsum, steam, electric power, waste water, by-product fuel, fuel gas,

(b) Objective fixed value

Improved crude oil

(c) Calculated value

IRR (ROE)

4.- Submission of the Report

The explanation of the report will be made in the middle of September, 1980 as per attached schedule in "JICA - 1" of the Annex - D.

Dr. Arévalo Guzmán Reyes
Director General Sectorial
Ministerio de Energía y Minas

S. Hirose

Senichi Hirose
Chief of the Japanese Second Survey Team for the Upgrading Project of Orinoco Heavy oil in the Republic of Venezuela

c.c.: Petróleos de Venezuela S.A.

c.c.: Lagoven S.A.

c.c.: Instituto Tecnológico Venezolano de Petróleo.

SCHEDULE OF VISIT

DATE	TIME	PLACE
May 6, 1980	14:30 - 17:00	Ministerio de Energía y Minas
May 7, 1980	09:00 - 15:00	Petróleos de Venezuela, S.A.
May 8, 1980	11:45 - 16:00	Lagoven, S.A.
May 9, 1980	15:00 - 16:00	Petróleos de Venezuela, S.A.
May 12, 1980	10:00	Ministerio de Energía y Minas

Annex - B

(B - 1)

MEMBERS OF MEETING

DATE: May 6, 1980

PLACE: MEM

Venezuelan side

MEM

Dr. Arévalo Guzmán Reyes	General Director for Hydrocarbons
Dr. Alfredo Essis	Production Planning Advisor
Dr. Ricardo Nuñez	Refining Division Head
Dr. José Méndez Zadato	Exploration Advisor
Ing°Luis Rivas Rodríguez	Chemical Engineer
Dr. Manuel Alayeto	Director Adjusto

Japanese side

The second survey team - Group A

Mr. Senichi Hirose	Chief of the Team (Consultant to JICA)
Mr. Keiichi Goto	Deputy Director, Petroleum Development Division, MITI
Dr. Koji Ukegawa	Senior Scientific Officer, Natural Research Institute, MITI
Mr. Hideo Yasuki	Deputy Director, Industrial Survey DIvision, JICA
Mr. Yasuhisa Hosoya	Mechanical Engineer (Consultant to JICA)
Mr. Terutada Tsukagoshi	Chemical Engineer (Consultant to JICA)

Embassy of Japan

Mr. Katsuhiko Tsunoda	Minister
Mr. Hiroshi Yoshida	First Secretary

MEMBERS OF MEETING

DATE: May 7, 1980
PLACE: Petróleos de Venezuela, S.A.

Venezuelan side

MEM

Dr. Alfred Essis
Dr. Ricardo Nuñez
Ing°Luis Rivas Rodríguez

PDVSA

Dr. Carlos Borregales	Orinoco Oil Belt Coordinator
Dr. Angel Behrends	Coordinator Refinacion
Dr. José Prats	Planning Manager, Refinery Coordination
Dr. Edison Perozo	Pet. Engineer, Manager Orinoco Belt

LAGOVEN

Dr. Humberto Vidal	Coordinator of Cooporate Planning
Dr. Orlando Castillo	DSVA Project Deputy Upgrading Coordination

INTEVEP

Dr. Jerry J. Toman	Economic Technical analysis
Dr. Franzo Marruffo	Evaluation of Project

Japanese side

The second survey team - Group A

Embassy of Japan

Mr. Katsuhiko Tsunoda
Mr. Hiroshi Yoshida

MEMBERS OF MEETING

DATE: May 8, 1980
PLACE: LAGOVEN

Venezuelan side

MEM

Dr. Alfred Essis

Dr. Ricardo Nuñez

Ingº Luis Rivas Rodríguez

PDVSA

Dr. Angel Behrends

LAGOVEN

Dr. Humberto Vidal

Dr. Orlando Castillo

INTEVEP

Dr. Franzo Marruffo

Dr. Jerry J. Joman

Japanese side

The second survey team - Group A

Embassy of Japan

Mr. Hiroshi Yoshida

MEMBERS OF MEETING

DATE: may 9, 1980
PLACE: PDVSA

Venezuelan side

PDVSA
Dr. Carlos Borregales

Japanese side

The second survey team
Mr. Senichi Hirose
Mr. Keiichi Goto
Mr. Hideo Yasuki
Mr. Yasuhisa Hosoya

Annex - B
(B - 5)

MEMBERS OF MEETING

DATE: May 12, 1980
PLACE: MEM

Venezuelan side

MEM, PDVSA, LAGOVEN and INTEVEP members

Japanese side

The second survey team - A Group
Embassy of Japan
Mr. Katsuhiko Tsunoda
Mr. Hiroshi Yoshida

TABLA 1

CARACTERIZACION DE LOS RESIDUOS (700°F+)

Y DE SUS CRUDOS DE ORIGEN.

CRUDO	CERRO NEGRO		COCOLLAR		JOSO 2	
TIPO DE MUESTRA	CRUDO	RESIDUO	CRUDO	RESIDUO	CRUDO	RESIDUO
Gravedad especifica 60/60	1.0129	1.0306	1.0078	1.0343	1.0113	1.0279
Gravedad, °API	8.2	5.8	8.9	5.3	8.4	6.2
Contenido Sal (PTB)	220.0	210	72.0	65	680	225
Azufre (% peso)	3.28	3.74	3.58	3.80	3.67	4.07
Vanadio (PPM)	418	476	442	475	390	490
Niquel (PPM)	92	115	81	109	106	101
Hierro (PPM)	---	13.7	---	---	---	---
Carbono Conradson (%P)	14.3	15.7	12.9	16.9	11.8	16.4
Asfaltenos (% PESO)	12.55	13.50	15.51	16.57	8.64	10.28
Pour Point (°F)	+ 65	+ 95	+ 55	+ 90	+ 65	+ 85
Viscosidad a 140°F (C.S.)	6252	49342	3726	43286	5537	27681
Viscosidad a 210°F (C.S.)	376.0	1256.0	177.9	1020.0	262.6	941.0
Rendimiento sobre crudo (%Peso)	100	90.74	100	89.37	100	92.27

ANNEX I-C (3)

TABLE I

TARGET YIELDS OF SYNTHETIC CRUDES

			HDAO	HDAO+C	HC/SHC
C_4	-	375 °F	3	10-25	10-25
375	-	650 °F	16	25 min.	25 min.
650	-	1000 °F	47	40 max.	50 max.
1000 + °F			34	25 max.	0

HDAO : Hydrotreated deasphalted oil.

HDAO+C : HDAO plus conversion. (Hydrocracking)

HC : Hydrotreated (for stability) coker synthetic crude.

SHC : Severely hydrotreated coker synthetic crude.

TABLE II

TARGET KEY QUALITIES OF COMPONENTS

		HDAO	HDAO+C	HIC	SHC
C_4 - 375 °F	S, % wt.		0.05 max.	0.05 max.	0.03 max.
	N_2, ppm		2 max.	2 max.	2 max.
375 - 650 °F	S, % wt.	0.2 max.	0.2 max	0.2 max.	0.2 max.
	Cetane #	40 min.	40 min.	35 min.	45 min.
650 - 1000 °F	S, % wt.	0.5 max.	0.5 max.	0.7 max.	0.5 max.
	N_2, % wt. **	0.10 max.	0.10 max.	0.10 max.	0.10 max.
	CCR, % wt.	0.7 max.	0.7 max.	1.0 max.	0.7 max.
	Aniline Point *	( )	( )	( )	( )
1000+ °F	S, % wt.	1.0 max.	1.25 max.	N/A	N/A

* Number to be estimated by contractor

N/A: Not Applicable

** Contractor will look at less severe hydrocracking conditions such that this value is 0.25 maximum.

ANNEX-C (4/5)

REPORTE DE ANALISIS DE AGUA

BALANCE ANALITICO	ppm	%
Calcio	6	12.34
Magnesio	2	4.11
Sodio más		
Potasio	16.3	33.53
Bicarbonatos	6	12.34
Sulfatos	10	20.57
Cloruros	5.3	10.90
Nitratos	3	6.17

DETERMINACIONES VARIAS	
Turbidez como JTU	14
Total sólidos Disueltos ppm	9.6
Sólidos Suspendidos mg/lt	225
Dureza Total	8
Alcalinidad Total	6
Hierro Total ppm Fe	2.4
Manganeso ppm Mn	NIL
Sílica Soluble ppm SiO_2	6.8
Sílica Total ppm SiO_2	14.4
Nitritos ppm NO_2	NIL
Indice de Permanganato ppm O_2	13.7
Dióxido de Carbono ppm CO_2	7
Oxígeno Disuelto ppm O_2	6.7
Aceite Mg/lt	1.5

pH	6.6		
Conductividad	18		
Temperatura °C	26		
pH Saturación	9.3		

Muestra: Agua del Orinoco

Tomada en: Casa Bombas

Fecha: 27-2-75

Compañía: Sidor.

COMENTARIOS: Valores expresados en ppm como $CaCO_3$ si no está indicada otra equivalencia.
Conductividad expresada en: MS^{m-1}
pH de Saturación calculado a 60°F
Sodio más Potasio calculado por diferencia.

9.11 Upgraded Crude Values

The values established for the possible synthetic crudes are listed in Table I below along with Tia Juana Medium, the "marker" crude oil. Tia Juana Medium was selected as the "marker" crude because its gravity is very similar to the delayed coker synthetic crude.

TABLE I

1990 Crude Values

	Tia Juana Medium	Fluidcoker HFC	Deasphalter HDAO	Delayed Coker DC	[illegible]
Gravity, API	26.3	28.2	19.4	24.0	20
Sulfur, wt.%	1.5	0.3	0.4	2.3	0.3
Metals, ppm.	-	3	2	20	2
1978 $/BBL	23.86	24.86	24.86	23.86	25.01
1979 $/BBL	25.53	26.60	26.60	25.53	26.76

These values for the synthetic crudes allow for differences in product qualities; i. e. sulfur level and gravity. Since the qualities in Table I were estimates the following procedure was used to allow for changes in the sulfur levels or gravities of the synthetic crudes as the process selection study progressed. A value of $0.05/API was used for gravity differences. Sulfur levels are more complex therefore the following schedule was used for sulfur differences:

for each 0.1% S in the 650° F+ fraction,

Range	Value
% S less than 0.5	$0.25/B
% S between 0.5 and 1.0	$0.15/B
% S between 1.0 and 1.5	$0.08/B
% S between 1.5 and 2.5	$0.04/B
% S greater than 2.5	$0.02/B

The above method allows calculations of relative values of synthetic crudes based on their API gravity and sulfur level. All calculated values are then escalated to a mid-1979 basis by a seven (7) percent factor.

ATTACHMENT-6

Minutes of Meetings

Caracas, October 16, 1980

The Japanese study team for the Up-grading Project of Orinoco Heavy Oil in the Republic of Venezuela (Hereinafter referred to as "The Team"), sent by the Japan International Cooperation Agency (Hereinafter referred to as "JICA"), presented to the Venezuelan authorities a report entitled "DRAFT FINAL REPORT, THE STUDY ON THE ORINOCO HEAVY OIL UP-GRADING PROJECT FOR THE REPUBLIC OF VENEZUELA".

The following is a summary of the meetings and discussions:

1. Schedule of Meetings and Participants

   The schedule of meetings and participants are listed in Annex-A and Annex-B, respectively.

2. Presentation of the Draft Final Report

   2.1 The Team presented the Draft Final Report which has been prepared based on the objectives, the scope of work, and information described in the following record of discussions:

   - Record of discussions dated October 10, 1979
   - Record of discussions dated May 12, 1980

   The presentation was made by highlighting the features of the study and results.

   2.2 The Venezuelan authorities and the Team exchanged views on the Draft Final Report.

   (1) The Venezuelan authorities expressed satisfaction regarding the dedication and efforts made to complete the study.

   (2) A preliminary review of the Draft Final Report indicates that the contents of the Report are objective.

   (3) The Venezuelan authorities requested the following additions to the Draft Final Report.

- to indicate the properties of fractions of the improved crude oil, as much as possible
- to make clear the bases of informations and data on main up-grading processes and hydrotreating/hydrodesulfurization processes.

(4) The Venezuelan authorities expressed the intention of making questions in order to clarify the contents of the Draft Final Report.

- The Team replied to the Venezuelan authorities that such questions should be made to the Embassy of Japan in Caracas by November 17, 1980. The answers will be made in written form outside the final report.

3. Final Report

The Draft Final Report will be considered as final after completion of the additions mentioned above 2.2 (3).
The Final Report will be submitted to the Venezuelan authorities by the end of November 1980.

Both parties accepted the above.

S Hirose

Dr. Arévalo Guzmán Reyes
Director General Sectorial de Hidrocarburos
Ministerio de Energía y Minas
República de Venezuela

Senichi Hirose
Chief of the Japanese
Team for the Up-Grading
Project of Orinoco Heavy
Oil in the Republic of
Venezuela

c.c: Petróleos de Venezuela, S. A.
Lagoven, S. A.
INTEVEP, S. A.

Annex-A

SCHEDULE OF MEETINGS

DATE	TIME	PLACE
October 13, 1980	15:30-16:30	Ministerio de Energía y Minas
October 14, 1980	8:30-12:00	Petróleos de Venezuela, S. A.
October 16, 1980	9:00-10:00	Petróleos de Venezuela, S. A.
October 16, 1980	15:00-16:00	Ministerio de Energía y Minas

MEMBERS OF MEETINGS

DATE: October 13, 1980
PLACE: MEM

MEM

Dr. Arévalo Guzmán Reyes	General Director Sectorial for Hydrocarbons
Dr. Enrique Daboin Vera	Director of Hydrocarbons
Dr. Manuel Alayeto	Deputy General Director Sectorial for Hydrocarbons
Dr. Ricardo Núñez	Refining Division Head
Ing° Luis Rivas Rodríguez	Head of Project Evaluation Department

PDVSA

Dr. Carlos J. Borregales	Orinoco Oil Belt Coordinator
Dr. Angel Behrends	Refinery Coordinator
Dr. José Prats	Manager, Refinery Coordination

Japanese side

The Team

Mr. Senichi Hirose	Chief of the Team (Consultant to JICA).
Mr. Toshio Ibi	Deputy Director, Development Division Petroleum Department Agency of Natural Resources and Energy,MITI.
Mr. Hideo Yasuki	Deputy Director, Industrial Survey Division JICA.
Mr. Yasuhisa Kosoya	Petroleum Refinery Engineer (Consultant to JICA).
Mr. Terutada Tsukagoshi	Petroleum Refinery Engineer (Consultant to JICA)

Embassy of Japan

Mr. Katsuhiko Tsunoda	Minister
Mr. Hiroshi Yoshida	First Secretary

MEMBERS OF MEETING

DATE : October 14, 1980
PLACE: PDVSA

Venezuelan Side

MEM

Dr. Ricardo Nuñez
Ing. Luis Rivas Rodríguez

PDVSA

Dr. Angel Behrends
Dr. José Prats
Ing. Armando Herrera — Orinoco Oil Belt Coordination

LAGOVEN

Dr. Humberto Vidal — Manager of Corporate Planning

INTEVEP

Dr. Jerry J. Thoman — Economic Technical Analysis
Dra. Carmen Elvira Alvarez — Process Engineer

Japanese Side

The Team

Embassy of Japan

Mr. Hiroshi Yoshida

Annex-B (B-3)

MEMBERS OF MEETING

DATE : October 16, 1980
PLACE: PDVSA

Venezuelan Side:

MEM

Dr. Ricardo Núñez
Ing. Luis Rivas Rodríguez

PDVSA

Dr. Angel Behrends
Dr. Carlos J. Borregales
Dr. José Prats

Japanese Side

The Team

Embassy of Japan

Mr. Hiroshi Yoshida

Annex-B (B-4)

MEMBERS OF MEETING

DATE : October 16, 1980
PLACE: MEM

Venezuelan Side

MEM and PDVSA members

Japanese Side

The Team

Embassy of Japan

Mr. Katsuhiko Tsunoda
Mr. Hiroshi Yoshida