Chapter 9.

Design Engineering

Chapter 9. Design Engineering

9.1 Basic engineering design data

This paragraph indicates the conditions relating to the basic design for the EXPORT REFINERY PROJECT.

9.1.1 General

(1) Measurement system

Metric system

(2) Laws, and regulations

Plant is to be designed in accordance with laws and regulations are indicated as the TENDER DOCUMENTS.

(3) Codes and standards

The codes and standards indicated as applicable to this project is the TENDER DOCUMENTS will be followed as a rule, but conformance to them will be adjusted from the following standpoints:

(a) Since this engineering base has been prepared based on the procurement of Japanese-made equiment, the equipment will be designed and fabricated in accordance with the codes and standards indicated in the TENDER DOCUMENTS to the extent this is economically practicable in Japan.

(b) Also, world-wide procurement has been considered. Conformance to the codes and standards followed in the countries where the equipment and materials will be manufactured, will be regarded as permissible.

(c) Rotary equipment, electrical equipment, instrumentation equipment, and package facilities will be designed and fabricated in accordance with the codes and standards used by the maker and the maker's standards.

(d) Regarding steels and other materials to be used for non-pressure parts, it is understood that the use of JIS (Japanese Industrial Standards) materials will be permitted unconditionally.

9.1.2 Utility

(1) Steam

		Press. (kg/cm2G)	Temp. (°C)
(a)	Generated steam at boiler plant	35	365
(b)	Supply rating (nor. conditions)		
	High press. steam	32	350
	Middle press. steam (super heated)	15	300
	Middle press. steam (saturated)	15	200
	Low press. steam (saturated)	3.5	147

(2) Electric power

(a) Receiving conditions for Zubair Refinery Site

Number of phase and wire: 3 phase - 3 wire

Rated voltage : 33 KV

Rated frequency : 50 Hz

Required capacity : Approx. 152 MVA/4 feeders

Number of feeders : 5 feeders

Grounding system : Neutral resistor grounded (100 A)

Short circuit capacity at receiving point : Max. 25 KA (1,600 MVA) at 33 KV with 4 feeders

(3) Water system

(a) All water is supplied from the Shatt-Al-Arab river.

Raw water is regulated as follows:

Cation		
Ca^{++}	365	ppm as $CaCO_3$
Mg^{++}	230	"
$Fe^{++} + Fe^{+++}$	4	"
$Na^{+} + K^{+}$	358	"
Total Cation:	957	ppm as $CaCO_3$

Anion		
Cl^{-}	365	ppm as $CaCO_3$
SO_4^{--}	414	"
HCO_3^{-}	178	"
Total Anion:	957	ppm as $CaCO_3$

pH	7.6	
Free CO_2	9	ppm as CO_2
SiO_2	10.3	ppm as SiO_2

(b) Cooling water

Cooling water conditions

		Supply	Return
Pressure	(kg/cm^2G)	4.5	2.5
Temperature	(°C)	32	Max. 46 Ave. 40

(c) Boiler feed water

Supply condition: 6.0 kg/cm^2G, 38°C

(4) Fuel system

(a) Fuel oil

(i) Specifications

Net heating value	:	9,810 kcal/kg
Sulfur content	:	6.07 wt%
Viscosity @50°C	:	529 FUROL
" @98.9°C	:	74.08 c.st
Sp. gravity @15.6°C	:	0.9923
Ash content	:	0.033 wt%
Vanadium	:	112 ppm
Nickel	:	17 ppm
Asphaltenes	:	2.32 wt%

(ii) Supply conditions

Pressure	:	12 kg/cm^{2}G
Temperature	:	120°C

(b) Fuel gas

(i) Specifications

	Home Fuel	LPG Summer	LPG Winter	Natural Gas
Net heating value (kcal/Nm^3)	16,645	10,096	10,090	12,413
Molecular weight	34.8	20.578	20.419	25.13

(ii) Gas analysis

	Home Fuel	LGP Summer	LGP Winter	Natural Gas
H_2 (mol%)	20.3			
C_1 "	4.6	72.413	72.780	60.157
C_2 "	14.6	22.561	22.057	18.700
C_3 "	42.9	1.566	1.761	10.475
C_4 "	16.9	0.250	0.244	4.990
C_5 "	0.6	0.031	0.027	1.722
C_6^+ "	0.1	0.005	0.004	1.392
CO_2 "	-	2.675	2.605	2.140
N_2 "	-	0.499	0.522	0.424

(iii) Supply conditions

Pressure : 3.5 kg/cm^{2}G

Temperature: 40°C

(5) Air and inert gas system

(a) Plant air conditions

Pressure : 7.0 kg/cm^{2}G

Temperature: 40°C

(b) Instrument air conditions

Pressure : 7.0 kg/cm^{2}G

Temperature: 40°C

Dew point : -15°C

(c) Inert gas

(i) High pressure inert gas conditions

Pressure : 28.0 kg/cm^{2}G

Temperature: 40°C

(ii) Low pressure inert gas conditions

Pressure : 7.0 kg/cm^{2}G

Temperature: 40°C

9.1.3 Site conditions

(1) Wind

(a) Direction of prevailing wind

SE or E

(b) Wind pressure

9 m and less	120 kg/m^2
9 m - 15 m	170 "
15 m - 30 m	220 "
30 m - 150 m	270 "
150 m - 365 m	290 "
365 m and over	340 "

(c) Max. wind velocity: 160 km/hr at 15 m above grade

(2) Temperatures

(a) Dry bulb temp. max. : 43.3°C
min. : 1.7°C

(b) Wet bult temp. for cooling tower design: 28.3°C

(3) Rainfall intensity : 25 mm/hr

(4) Snow load : None

(5) Earthquake : None

(6) Site elevation

EL + 100,000 mm = M.S.L. at FaO + 16,000 mm

Process unit area	:	EL + 100,000
Utility unit area	:	EL + 100,000
Storage tank area	:	EL + 98,500 and EL + 102,000
Administration area	:	EL + 100,000

(7) Soil exploration data

Bearing value : Max. 20 tons/m^2 at 1.2 m in depth below grade level

9.1.4 Anti-pollution measures

(1) Water disposal

The effluent from refinery shall be regulated as follows:

pH	6 - 8
Oil	25 ppm and less

Water pollution has been reviewed based on the Basis of Design given in Sect. 9.7.14 of TENDER DOCUMENTS Vol. II; specially severe conditions have not been considered.

(2) Waste gas

The waste gas from stacks of refinery shall be regulated as follows:

SO_2	40 PPHM at ground

Air pollution problems have been reviewed based on a SO_2 ground level concentration indicated in the TENDER DOCUMENTS (Vol. III Class B Specification B-2 Steel Stacks Article 2.1.3 (3)). Also, it has been checked whether individual stacks or few common stack should be provided, and their heights have been reviewed from the overall standpoint.

(3) Noise

The noise level indicated in the TENDER DOCUMENTS specification has been considered. It is understood that all other noise reduction requirements are optional, and no specially severe conditions have been considered.

(4) Standard of pollution control in Japan have not been applied for this project.

9.2 Equipment design

9.2.1 Fired heater

(1) In general, Fired Heater design are based on the following specifications which are given in TENDER DOCUMENT Vol. III.

Specification	Class B-1	Furnace
	Class B-2	Steel stacks
	KIC B40-1S69	Furnace tubes, headers and fittings

Of these specifications, the requirements considered inadequate or incompative with CONTRACTOR's engineering practice will be listed as "Deviation and Clarification" in Technical Proposal.

(2) In precaution against air pollution, it has been so designed that the flue gases from all the furnaces except those for the hydrogen units and gas oil desulphurization units will be introduced into the common stacks.

(3) High heating efficiency of furnaces except those for residue desulphurization units has been attained by providing extended surfaces in the convection sections.

(4) Materials of the furnaces will conform to ASTM or will be the equivalents of the ASTM materials.

(5) By providing wind boxes, the noise level at a distance of 1 m from each furnaces will be 90 dB(A) or less.

(6) Climate data for thermal calculation

Wind velocity : 2 m/sec

Ambient temperature: 20°C

(7) Sootblowers will be automatically operated when push the start button.

(8) A pilot burner will be provided on each burner except for steam reformer furnaces.

9.2.2 Heat exchanger

(1) Heat exchangers for general use are designed in consideration of operation and maintenance of the relative units and facilities involved in the refinery.

(2) Deviations and clarification of the TENDER DOCUMENTS will be listed and attached to technical proposal.

(3) Applicable codes and standards

(a) ASME boiler and pressure vessel code Sect. VIII, Div. 1 "Pressure Vessel" (Winter Addenda 1975)

(b) ASME boiler and pressure vessel code Sect. IX "Welding Qualifications" (Winter Addenda 1975)

(c) TEMA standard class "R" (1970 Addenda)

(d) ASTM standard (1975 Annual)

(e) ANSI

B 1.1 - 1974	"Unified Inch Screw Threads"
B 2.1 - 1968	"Pipe Threads"
B 16.5 - 1968	"Steel Pipe Flanges and Fittings" (Including supplements (a) and (b) 1971)
B 16.20 - 1973	"Ring-joint Gasket and Groove"
B 18.2.1 - 1972	"Square and Hex Bolts and Screws"
B 18.2.2 - 1972	"Square and Hex Nuts"
B 36.10 - 1970	"Wrought Steel and Wrought Iron Pipe"
B 16.21 - 1962	"Non-metallic Gaskets for Pipe Flanges"

(f) API 605 - 1967 (for 26 inches and over)
"Large Diameter Carbon Steel Flanges"

(g) API 601 - 1974 "Metallic Gasket for Piping"

(h) TENDER DOCUMENTS Vol. III, Class C

(4) Special notes for design

(a) Standard bolts and nuts for pressure parts

Threads	:	ANSI B 1.1
Thread series	:	One inch nominal diameter and under; UNC series, 1-1/8 inch nominal diameter and over; 8 UN series
Tolerance classes	:	2A, 2B
Shape of nut	:	ANSI 18.2.2 "Heavy Hex Nut"

(b) Sliding shoes will be provided on the bundles of shells which are equal to or larger than 400 mm in diameter. Wherever applicable, longitudinal sealing strips can be used in common with the sliding shoes.

(c) Reinforcing pads will be used for nozzles 2 inches and larger, unless otherwise specified, and for 1-1/2 inches and smaller nozzles coupling or intergrally forged type (long welding neck type) will be used.

(d) One set of test rings will be provided for each floating head and U-tube type heat exchanger installed.
When more than one idential exchanger is supplied, the following is required.

Two identical exchangers*:	One set of test ring
More than two identical exchangers :	Two sets of test rings

* For stacked units: Test shall be done in the stacked condition.

(e) Regarding the equipment for which strength weld is specified in the drawings, the following requirements will also be satisfied in addition to conformance to KIC Spec. C4-LIP-74.

- o No tube hole groove is provided in the case of strength welding.
- o Tubes will be expanded with a light expanding.

(f) Each equipment will be provided with earth lug. (Inclusive of upper equipment where two equipment items are stacked.)

(g) Installation of instrument nozzles for each nozzle will conform to TEMA "R" and KIC Spec. C40-1068.

(h) Hardness of the base metal, and the weld metal and the related heat affected zone (HAZ) of all welds will not exceed the limits given below.

These test will be made with a Brinell Testing Machine or a portable hardness tester such as Talebrineller using a 10 mm ball. The hardness test for the HAZ will be made with the ball centered in the HAZ (representing a composite of weld metal, HAZ and base metal.)

ASME "P" Number of Material	Brinnel Hardness
1 - 4	225 or less
5 - 6	235 or less

Note: Base metal hardness tests are not required on P-1 material.

(i) anchor bolts or setting bolts at sliding side for horizontal heat exchangers will have double nuts.

(j) Nozzles and manways, and their reinforcement will be attached to the heat exchanger with full penetration welds.

(k) Regarding the material of the nozzle necks, which is presently specified to be A106-Gr.B, it may be changed to A53-Gr.B for the nozzle necks subject to design temperature of 399°C or under. However, in the case of A53-Gr.B, seamless type must be used for the nozzle necks.

(l) The baffle spacer material may be changed from A106-Gr.A to A53-Gr.A.

(5) Materials

(a) Metal lined nozzle

Following type of lining for nozzle neck will be used.

6 inches NPS and under: Tubular liner

8 inches NPS and over : Deposit or clad plate

Strip lining can be used to mild conditions.

(b) In the following cases, after bending, annealing will be done: (Austenitic stainless steel tubes will not be annealed.)

(i) Chromium molybdenum, and ferrite stainless steel tubes which have been bent to a radius smaller than five times their diameters, will be annealed at their bends only.

(ii) Copper alloy and cupronickel tubes which have been bent, will be annealed full length. Annealing shall be done by the best method recommended in the applicable specification or by the fabricator according to the types of materials used.

(c) Gaskets

(i) Spiral wound gasket will be as per API 601 and filled material is asbestos, except for the following:

Materials of hoop and outer ring for "Spiral Wound" gaskets will be used as follows:

Design temperature below 426°C:	Hoop - TP 304 Ring - CS
Design temperature over 426°C :	Hoop - TP 347 Ring - TP 347

(ii) Ring-jont gaskets and grooves will be in accordance with ANSI B 16.20. Meanwhile, the ring-joint gasket will be of the "OCtagonal Ring Type".

(iii) Gasket for internal parts

Design Temperature	Gasket Material
232°C or lower	85% asbestos
233°C - 399°C	AAA grade
400°C - 483°C	AAAA grade
484°C or higher	Pure asbestos

9.2.3 Air cooled exchanger

API standard 661 (Aug. 1968) and KIC Purchasing Specification for air cooled exchangers Spec. C45-LIE issued an appendix to specification C-1 of TENDER DOCUMENTS Vol. III will be conformed to as a rule, but the basic requirements are indicated in the following:

(1) Ventilation system type : Forced draft type

(2) Dry bulb temperature for designing air cooled exchangers: 43.5°C

(3) Fouling factor: Air side ..... 0.0004 $(kcal/m^2hr \cdot °C)^{-1}$
Process side ... Conforms to TEMA

(4) Header type : Box type

However, the cover type will be applied to those of reflux coolers and regenerator O.H. condensers.

(5) Fin tube

Length ..... 30'-0"

As regards the fractionator O.H. condensers in the crude unit, the fin tube length shall be 40'-0".

Thickness (seemed or seamless)

C-steel	:	Welded	BWG #12
Stainless steel	:	Seamless	BWG #13

Tube O.D. : 25.4 mm

Fin material : Alminium

Type : Embedded and L-foot

(6) Type of drive : Gear driver with motor

(7) Vibration swith : Not provided

(8) Control devices : As necessity

9.2.4 Unfired pressure vessel

(1) In general, unfired pressure vessels are designed to facilitate operation and maintenance of relative units and facilities involved in this refinery.

(2) Deviations and clarification of the TENDER DOCUMENTS will be listed and attached to technical proposal, which are used as the design basis.

(3) Applicable codes and standards

(a) ASME boiler and pressure vessel code Sect. VIII, Div. 1 "Pressure Vessel" (including Winter Addenda 1975 with non-mandatory appendices)

(b) ASME boiler and pressure vessel code Sect. IX "Welding Qualifications" (including Winter Addenda 1975)

(c) ASTM standard (1975 annual)

(d) ANSI

B 1.1 - 1974	"Unified Inch Screw Threads"
B 2.1 - 1968	"Pipe Threads"
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B 18.2.2 - 1972	"Square and Hex Nuts"
B 36.10 - 1970	"Wrought-steel and Wrought Iron Pipe"
B 16.21 - 1962	"Non-metallic Gaskets for Pipe Flanges"

(e) API standard 601 - 1974 "Metallic Gaskets for Refinery Piping"

API standard 605 - 1967 "Large Diameter Carbon Steel Flanges" (For 26 inches and over)

(f) AISC "American Institute of Steel Construction"

(4) Special notes

(a) Gaskets

(i) Corrugated jacketed asbestos filled will be as per API 601.

(ii) "Spiral Wound" gasket

Spiral wound gasket will be as per API 601 and filled material is asbestos, except for the following:

Materials of hoop and outer ring for "Spiral Wound" gaskets shall be used as follows:

Design temperature below 426°C:	Hoop - TP 340 Ring - CS
Design temperature over 426°C :	Hoop - TP 347 Ring - TP 347

(iii) Ring-joint gasket

Ring-joint gaskets and grooves will be in accordance with ANSI B 16.20, mean while, the ring-joint gasket will be of the "Octagonal Ring" type.

(iv) Gasket for internal parts

Design Temperature	Gasket Material
232°C or lower	85% asbestos
233°C - 399°C	AAA grade
400°C - 483°C	AAAA grade
484°C or higher	Pure asbestos

(b) Hardness of the base metal, and the weld metal and the related heat affected zone (HAZ) of all welds will not exceed the limits given below.

These test will be made with a Brinell Testing Machine or a portable hardness tester such as a Telebrineller using a 10 mm ball. The hardness test for the HAZ will be made with the ball centered in the HAZ (representing a composite of weld metal, HAZ, and base metal).

ASME "P" Number of Material	Brinnel Hardness
1 - 4	225 or less
5 - 6	235 or less

Note: Base metal hardness tests are not required on P-1 material.

(c) Reinforcing pads will be used for nozzles 2 inches and larger, unless otherwise specified, and for 1-1/2 inches and smaller nozzles, coupling or integrally forged type (long welding neck type) will be used.

(d) Anchor bolts holes of baseplate for vertical vessels will straddle the vessel center line in construction north direction.

(e) Anchor bolts or setting bolts at sliding side for horizontal vessels will have double nuts.

(f) Nozzles and manways, and their reinforcement will be attached to the vessel with full penetration welds.

(g) Standard bolt and nuts for pressure parts

Thread	:	ANSI B 1.1
Thread series	:	One inch nominal diameter and under; UNC series, 1-1/8 inches nominal diameter and over; 8 UN series
Tolerance classes	:	2A, 2B
Shape of nut	:	ANSI B 18.2.2 "Heavy Hex Nut"

(h) For material of the nozzle necks, ASTM A53-Gr.B will be used seamless type.

9.2.5 Pumps and drivers

(1) Safety and economy based on the Specification, Class J per the TENDER DOCUMENTS will be considered in the designs, especially with regard to the high temperatures, humidity, sand storms, etc. at the job site.

(2) Proposed deviations from the Specifications per the TENDER DOCUMENTS will be listed and attached to the Technical Proposal. Further, it is desired that SCOP possible changes in these deviations at the time of actual pump selection.

(3) The driving motors will be designed based on the TENDER DOCUMENTS Class N.
The deviations therefrom will be listed and explained in the Technical Proposal.

(4) As for the selection of driving motors or steam turbines, turbine drive will be used only for the pumps required to shut down the process units safety at an emergency (power failure, etc.).
Motor drive is considered even for furnace feed pumps in cases where turbine drive is used for the compressors on the gas sides of combined feed design.

Though the base for the above-mentioned has been decided, consideration has been given to deciding the details at the time of carrying out the project.

9.2.6 Compressor and driver

(1) Regarding the selection of compressors, the final specification details have not yet been fixed at the present stage. Therefore, at the time of carrying out the project, it will be necessary to take the local climatic conditions and process requirements into consideration for re-study and to select suitable manufacturers accordingly.

Therefore, some items of deviation in Technical Proposal will be subject to change at the time of carrying out the project.

(2) It will be understood that the present specifications and deviations for rotary equipment are subject to change. Especially, as the compressors are the most important items of equipment in the plant, their selection must be made with adequate care.

9.3 Piping design

Piping will be designed in accordance with requirements of TENDER DOCUMENTS Vol. III Class M.
The deviations therefrom will be listed and explained in the Technical Proposal.

9.3.1 General note for piping specification

(1) Pipe and fitting

(a) Edge preparation

(i) Galvanized

1/2" to 6" NPT with a coupling, 8" and larger bevel end.

(ii) Carbon and alloy

2" and smaller plain end.

2-1/2" and larger bevel end.

(b) Make it a rule to all elbow are to be long radias.

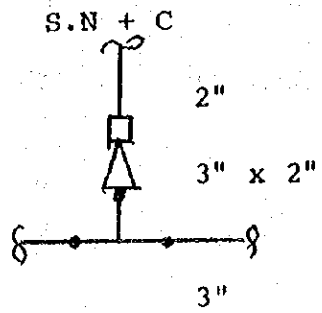
(2) Branch connections

In cases where pipes larger than 2-1/2" are jointed by butt welding, the following pipe fittings (except flanges and elbows) will be used. In the case of reducing tees and reducers, if there are differences in wall thickness between the larger size side pipe and the smaller size side pipe, the larger wall thickness will be used.
Branch pipes will conform to the table below.

		Main Pipe												
		1/2"	3/4"	1"	1-1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16" & Over
Branch Pipe	1/2"	T	T	T	B	B	B	B	B	B	B	B	B	B
	3/4"		T	T	B	B	B	B	B	B	B	B	B	B
	1"			T	T	B	B	B	B	B	B	B	B	B
	1-1/2"				T	T	B	B	B	B	B	B	B	B
	2"					T	S.N *1 +C	B	B	B	B	B	B	B
	3"						M	M	M	W.O N	W.O N	W.O N	W.O N	W.O N
	4"							M	M	M	W.O N	W.O N	W.O N	W.O N
	6"								M	M	M	W.O N	W.O N	W.O N
	8"									M	M	M	W.O N	W.O N
	10"										M	M	M	R.S N
	12"											M	M	R.S N
	14"												M	R.S N
	16"												M	R.S N

Remarks: 1. The above symbols mean as follows:

B : Socket or screw boss
T : Socket or screw tee
W.O: Weld-o-let
R.S: Reinforcing saddle
M : Butt welding tee
N : Nozzle welding
S.N: Swaged nipple
C : Coupling



(3) Reducing piping

Reducing piping will conform to the table below.

Small Size Pipe \ Large Side Size	3/4"	1"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"
1/2"	N or C	N	N	N									
3/4"		N or C	N	N									
1"			N or C	N									
1-1/2"				N or C	N	N							
2"					N	N	N						
2-1/2"						R	R	R					
3"							R	R	R				
4"								R	R	R			
5"									R	R	R		
6"										R	R	R	
8"											R	R	R
10"												R	R
12"													R

Remarks: 1. The above symbols mean as follows:

C: Reducing or straight coupling

R: Butt welding reducer

N: Swaged nipple

2. In the case of reducers larger than 2-1/2", as a standard, the reducing size will be smaller than three nominal sizes. If required reducing sizes are larger than three nominal sizes, the larger size will be reduced by three nominal sizes and then to the required smaller nominal size.

9.3.2 Piping specification classes

	Class No.	Rating	Max. Temp. °C	Service
(1)	A111	ANSI 125 lbs FF	66	Plant air
(2)	A112	" 125 lbs FF	66	Cooling water and industrial water
(3)	A121	" 125 lbs FF	66	Instrument air and drinking water
(4)	B111	" 150 lbs RF	232	Low pressure steam and steam condensate, fuel oil, fuel gas, inert gas, hydrocarbon/ hydrogen
(5)	B112	" 150 lbs RF	350	Hydrocarbon/hydrogen
(6)	B113	" 150 lbs RF	232	Foul water and acid gas and amine
(7)	B114	" 150 lbs RF	232	Catacarb solution
(8)	B115	" 150 lbs RF	232	Low pressure steam (steam heating)
(9)	B116	" 150 lbs RF		Hydrogen
(10)	B117	" 150 lbs RF	232	Outer pipe for sulfur line
(11)	B118	" 150 lbs RF	399	Sulfur line
(12)	B211	" 150 lbs RF	Minimum -46	Freon
(13)	B311	" 150 lbs RF	Minimum -47 - 100	Freon
(14)	B321	" 150 lbs RF	Minimum -47 - 100	CO_2 + H_2O vapor
(15)	C111	" 300 lbs RF	232	Hydrocarbon/hydrogen and fuel oil

	Class No.	Rating	Max. Temp. °C	Service
(16)	C112	ANSI 300 lbs RF	350	Hydrocarbon/hydrogen
(17)	C113	" 300 lbs RF	399	Amine and hydrocarbon
(18)	C114	" 300 lbs RF	232	Catacarb solution
(19)	C115	" 300 lbs RF	300	MED pressure steam and boiler feed water
(20)	C117	" 300 lbs RF	399	Hydrocarbon/hydrogen
(21)	C311	" 300 lbs RF	232	Deionized and oxygen
(22)	C321	" 300 lbs RF	232	Comverted gas + CO_2 + H_2O
(23)	C331	" 300 lbs RF	430	Hydrocarbon liquid and vapor
(24)	C411	" 300 lbs RF	450	Comverted gas
(25)	C421	" 300 lbs RF	399	Transfer line
(26)	D111	" 600 lbs RF	232	Hydrocarbon/hydrogen
(27)	D112	" 600 lbs RF	370	High pressure steam
(28)	D113	" 600 lbs RF	232	Hydrocarbon/hydrogen
(29)	D211	" 600 lbs RF	Minimum -46	Hydrogen gas
(30)	D311	" 600 lbs RF	Minimum -47 - 100	Hydrogen gas
(31)	D331	" 600 lbs RF	427	H_2S
(32)	D411	" 600 lbs RF	420	Reformer feed gas
(33)	E111	" 900 lbs RF	300	Hydrogen gas
(34)	F131	" 1,500 lbs RTJ	300	Hydrocarbon liquid and vapor
(35)	F132	" 1,500 lbs RTJ	300	HP amine solution

	Class No.	Rating	Max. Temp. °C	Service
(36)	F331	ANSI 1,500 lbs RTJ	350	Hydrocarbon liquid and vapor
(37)	G131	" 2,500 lbs RTJ	320	Hydrocarbon liquid
(38)	G331	" 2,500 lbs RTJ	450	Hydrocarbon liquid and vapor

9.4 Civil design

9.4.1 General

Civil design engineering involved in works such as site preparation, foundations, roads, tank dikes, fence, etc., are based on the following specifications which are given in TENDER DOCUMENTS Vol. III.

(1) Specification Class A

Site preparation, foundations, structures and concrete structures

(2) Specification Class H

Steel structures, platforms and industrial buildings

Of these specifications, the requirements considered inadequate or incompatible with CONTRACTOR's engineering practice will be listed as "Deviation and Clarification in Technical Proposal.

9.4.2 Codes and standards applicable to the design work

(1) ACI ..... American Concrete Institute

(2) AISC ..... American Institute of Steel Construction

(3) ASA ..... American Standard Association

(4) ASTM ..... American Society for Testing and Materials

(5) AASHO ..... American Association of State Highway Officials

(6) JIS ..... Japanese Industrial Standards

9.4.3 Concrete work

(1) This paragraph covers the design work in connection with concrete foundations, roads, paving, structures, concrete pit, water pond, etc.

(2) References and codes

TENDER DOCUMENT Vol. III Specification Class A A-CE-4 Para. 3 "Concrete Work", AIC and AISC.

(3) Materials

The following standards will be applied with regard to materials to be used for Concrete Work.

(a)	Cement	:	ASTM C 150 or equivalent National Code and equivalent JIS Code JIS R 5210
(b)	Reinforcing bars	:	ASTM A 615 and equivalent JIS Code JIS G 3112
(c)	Steel wire	:	ASTM A 185 and equivalent JIS Code JIS G 3551
(d)	Anchor bolts	:	KIC engineering standard A17-L151 or equivalent JIS code JIS B 1178
(e)	Sound concrete blocks	:	ASTM C 145 or equivalent National Code
(f)	Hollow concrete blocks	:	ASTM C 90 and equivalent National Code
(g)	Building lime	:	Locally available
(h)	Bitumen	:	Locally available

(4) Design strength

Concrete (except levelling concrete) will be designed for minimum allowable 28-days compressive strength of 175 kg/cm^2. Reinforcing bar will conform to JIS G 3112. In the case of using JIS G 3112, yield point will be 3,000 kg/cm^2 minimum.

(5) Proportioning and slump

(a)	Maximum aggregate size	:	37.5 mm
(b)	Water cement ratio	:	0.4 - 0.7 by weight
(c)	Fineness modulus	:	2.5 - 3.0
(d)	Ratio of coarse aggregate to fine aggregate	:	65 - 35

(6) Slump

	Type of construction	Slump (cm)
(a)	Mass concrete	2.5 - 7.5
(b)	Foundations	7.5 - 12.5
(c)	Superstructure	10 - 15
(d)	Paving	5 - 10

(7) Form-work

(a) Form-work will conform to the Specification Class A, A-CE-4, Para. 4 "Form-work".

(b) Forms will be made of wood, plywood or metal of the dimensions as called for in the drawings and be remained in place for the period as shown below.

Air Temperature	Age of Concrete Days: Foundation, Side of Beam, Column, Wall	Slab Bottom & Beam Bottom
15°C up	2 - 3	4 - 6
Up to 15°C	4 - 5	8 - 10

(8) Reinforcement

Reinforcement will conform to the above Specification, Para. 5 "Reinforcement".

(9) Mixing and placing

In principle, concrete will be mixed at the central plant and transported to the job site as specified ACI means.

(10) Joint

Joints will conform to the above Specification, Para. 3.7 "Joints".

(11) Finish

Finish will conform to the above Specification, Para. 3.8 "Finish".

9.4.4 Site preparation

(1) Elevation of each area inside the refinery has been determined by using "Topographical Site Survey" drawing (Dwg. No. 508-C-01) attached to TENDER DOCUMENTS Vol. VI so as to minimize soil movement.

(2) Top soil, excessive soil and other refuse such as concrete chips, etc., will be collected at a SCOP designated area. Within a distance of 1 km outside the refinery fence. No grading or levelling will be applied.

(3) Contour lines and intervals given in the topographical site survey drawing (Dwg. No. 508-C-1) has been prepared on an approximate basis and therefore must be detail surveyed before enter upon detailed design work.

9.5 Structural steel design

9.5.1 General

Structural steel design engineering involved in works such as pipe racks, equipment supporting structures, miscellaneous steel structures, industrial buildings, etc., are based on the following specifications which are given in TENDER DOCUMENTS Vol. III.

(1) Specification Class H

Steel structures, platforms and industrial buildings

(2) Specification Class P

Insulation and paint

Of these specifications, the requirements considered inadequate or incompatible with CONTRACTOR's engineering practice will be listed as "Deviation and Clarification" in Technical Proposal.

9.5.2 Codes and standards applicable to the design work

(1) AISC ..... American Institute of Steel Construction

(2) ASA ..... American Standard Association

(3) ASTM ..... American Society for Testing and Materials

(4) JIS ..... Japanese Industrial Standards

(5) AWS ..... American Welding Society

9.5.3 Structural steel work

(1) This paragraph covers the design in connection with steel structurs, inclusive of painting work and fireproofing work.

(2) Materials

The following standards will be applied with regard to materials to be used for structural steel construction.

(a) Structural steel	:	ASTM A 36 or equivalent JIS Code, JIS G 3101 SS 41 or equal
(b) Structural steel sections	:	JIS G 3192 or equal
(c) Structural steel pipes	:	ASTM A 53, types E or S Gr. B or JIS G 3444 STK 41 or equal
(d) Bolting		
High strength friction grip bolts	:	ASTM A 325 or equivalent JIS Code, JIS B 1186 Gr.F10T and Torque controlled bolts Gr.F10T
Black bolts	:	ASTM A 307 or equivalent JIS Code
		Quality ... JIS G 3101 SS 41
		Shapes, dimensions and permissible variations of hexagon head bolts and nuts ... JIS B 1180 and B 1181
(e) Welding rod	:	AWS A 5.1 or equivalent JIS Code, JIS Z 3211 Gr.43

(f) Painting and fireproofing

Painting and fireproofing will conform to the "Insulation and Painting" in Subsection 9.9 hereon

(3) Fabrication, erection and inspection

(a) The fabrication and election of structural

Steel will conform to the AISC specification.

(b) The inspection of structural steel will conform to the "Inspection Procedure for Construction Work".

9.6 Architectural design

9.6.1 General

Architectural design engineering involved in works such as administration type, process and industrial type buildings are based on the following specifications which are given in TENDER DOCUMENTS Vol. III.

(1) Specification Class A - Site preparation, foundations, structures and concrete structures

(2) Specification Class H - Steel structures, platforms and industrial buildings

(3) Specification Class K - Buildings

(4) Specification Class M - Piping

(5) Specification Class N - Electrical

(6) Specification Class O - Instruments

(7) Specification Class P - Insulation and paint

Of these specifications, the requirements considered inadequate, or incompatible with CONTRACTOR's engineering practice will be listed as "Deviation and Clarification" in Technical Proposal of CONTRACTOR.

9.6.2 Codes and standards applicable to the design work

(1) ACI ..... American Concrete Institute

(2) AISC ..... American Institute of Steel Construction

(3) ASA ..... American Standard Association

(4) National Plumbing Code

(5) ASHRAE ..... American Society of Heating, Refrigeration and Air Conditioning Engineers - Guide

(6) ASTM ..... American Society for Testing and Materials

(7) AASHO ..... American Association of State Highway Officials

(8) BS ..... British Standards

(9) JIS ..... Japanese Industrial Standards

9.6.3 Foundations

(1) Building foundations and floors for administration type and process buildings will be treated with 1.0 percent chlordane solution, this may be prepared by diluting a concentrated chlordane solution with water.

(2) References and codes

TENDER DOCUMENT Vol. III, Specification Class A, A-CE-4 Para. 2, Para. 2.1 "Termite Attack".

9.6.4 Concrete work

(1) Concrete work, inclusive of design strength, proportioning and slumps, slumps, form-work, reinforcement and applicable references and codes to be in accordance with the "Civil Design" in Subsection 9.4.3 "Concrete Work" hereon.

(2) Materials

The following standards will be applied for materials to be used for Buildings.

(a) Cement

ASTM C 150 or equivalent National Code or equivalent JIS Code JIS R 5210

(b) Reinforcing bars

ASTM A 615 or equivalent JIS Code JIS G 3112

(c) Structural steel

ASTM A 36 or equivalent JIS Code, JIS G 3101 SS 41 or equal

(d) Structural steel pipes

ASTM A 53, type E or S Gr.B or JIS G 3444 STK 41 or equal

(e) Steel wire

ASTM A 185 or equivalent JIS Code, JIS G 3551

(f) Material for covering of sheet roof and wall

Corrugated aluminium

Quality ..... JIS A 1100 P-H14

Shapes, dimensions, permissible variations and mechanical properties of aluminium plate ..... JIS H 4000

(g) Ceramic tile

JIS A 5209 or equivalent

(h) Accoustic boards

JIS A 6301 or equivalent

(i) Glass

JIS R 3201, 3202, 3203, 3204 and 3205 or equivalent

9.7 Electrical design

9.7.1 General

The following clauses cover the specific requirements for design, fabrication and testing of equipments and materials for the electrical facilities included in the scope of the Export Refinery Project.

9.7.2 Codes and standards to be applied

The following codes and standards will be applied for design, fabrication and testing of equipment and materials for electrical facilities:

(1) Where equipment and materials are manufactured in Japan, the following codes and standards will be applied:

JIS: Japanese Industrial Standards

JEC: Standards of the Japanese Electro-technical Commitee

JEM: Standards of the Japanese Electrical Machine Industry Association

JCS: Standards of the Japanese Cable Manufacturers' Association

(2) Where equipment and materials are manufactured in the countries other than Japan, the codes and standards of those countries will be applied.

(3) The area classification of hazardous areas will be in accordance with the latest edition of the American Petroleum Institute Recommended Practice RP-500A.

(4) The limits of the various dangerous areas will be defined in accordance with the requirements of API RP-500A.

(5) Where electrical equipment and materials in the various hazardous areas are manufactured in Japan, the following codes and standards will be applied:

JIS : Japanese Industrial Standards

JEC : Standards of the Japanese Electro-technical Committee

JEM : Standards of the Japanese Electrical Machine Industry Association

RIIS: Recommended Practice for Electrical Equipment for use in Explosive Gas Atmospheres for General Industries - 1974 (The Research Institute of Industrial Safety of Japanese Ministry of Labour).

(6) Where electrical equipment and materials in the various hazardous areas are manufactured in the countries other than Japan, the codes and standards of those countries will be applied.

9.7.3 System voltages

(1) Allowable limits of voltage and frequency regulation at power receiving point.

(a) Allowable limits of voltage and frequency regulation at power receiving point will be as follows:

Voltage regulation	:	Within ±10% of rated voltage
Frequency regulation	:	Within ±5% of rated frequency
Combined regulation in voltage and frequency	:	Up to 10% in sum at absolute value of voltage and frequency regulation

(2) Refinery site system voltage

		Phase	Wire	Voltage	Hz	Neutral Grounding System
(a)	Power receiving	3	3	33 KV	50	Resistance
(b)	Power distribution facilities					
	For secondary S/S	3	3	33 KV	50	Resistance
	For motors					
	Larger than 1,500 KW	3	3	11 KV	50	Resistance
	110 KW to 1,500 KW	3	3	3.3 KV	50	Resistance
	Smaller than 110 KW	3	3	380 V	50	Solid
(c)	Lighting facilities					
	For normal	3	4	380 - 220 V	50	Solid
	For normal/emergency	3	4	380 - 220 V	50	Solid
	For emergency	DC	2	110 V	-	Non

		Phase	Wire	Voltage	Hz	Neutral Grounding System
	For portable extension hand-lamps	1	2	50 V	50	Solid
	For welding socket outlets	3	4	380 - 220 V	50	Solid
	For power outlets (In safe areas or non-process areas)	1	4	380 - 220 V	50	Solid
(d)	For instruments	1	2	110 V	50	Non
(e)	For analyzer (Instrument)	3	4	380 - 220 V	50	Solid
(f)	For controlling					
	Switchgears	DC	2	110 V	-	Non
	L/V motor starters	1	2	110 V	50	Non
(g)	For emergency generators system	3	4	380 - 220 V	50	Solid

9.7.4 Design basis

(1) Equipment and materials will be designed in accordance with the following basic conditions:

(a)	Abrasive dust stroms.		
(b)	Maximum wind velocity	:	45 m/sec
(c)	Maximum ambient temperature	:	50°C
(d)	Minimum ambient temperature	:	-1°C
(e)	Relative humidity	:	85%
(f)	Altitude	:	Less than 1,000 m
(g)	Maximum exposed metal surface temperature in direct sun-light:		82°C

9.7.5 Description of power distribution system

(1) Refinery site

(a) The incoming power will be received by means of five (5) undergrounded feeders of 3-phase, 3-wire, 33 KV, 50 Hz, neutral resistance grounded, for a total power requirement of 152 MVA, which will be connected to the primary substation through five (5) receiving circuit breakers.
One of the above-mentioned feeders will be a spare for increased reliability.

(b) Power distribution system from the primary substation to each critical secondary substation such as process area substation or utility area substation will be by means of duplicated radial feeders of 3-phase, 3-wire, 33 KV, and single distribution feeder of 3-phase, 3-wire, 33 KV, will be used for non-critical off-site or administration area substations. The above-mentioned distribution feeder cables will be connected to the step-down power transformers directly in the secondary substations.

In each process and utility area substation, there will be two (2) sets of step-down power transformer, and each group of 11 KV, 3.3 KV and/or 380 V switchgears will consist of two (2) normally closed incoming breakers and one (1) normally opened bus section breaker with an automatic transfer facility between each incoming breaker and bus section breaker.

(c) Each group of 380 V critical motor control center (MCC) will consist of two (2) normally closed incoming disconnecting switches and one (1) normally opened bus section disconnecting switch with a interlock between them.

(d) Each substation in the utility and process areas will contain two (2) sets of main step-down power transformer according to the voltage requirements in each area. Each individual power transformer will be capable of supplying 100% of the required power consumption of failure or during maintenance of its counterpart.

(e) The following secondary substations will be served:

(i) Process area S/S : #01 - #06

(ii) Off-site area S/S: #07 - #13

(f) Generally, each motor starter will be divided into two (2) sections in cases where two (2) or more 11 KV, 3.3 KV and/or 380 V motors are provided for the same service. One (1) or more of such motors will be covered by one (1) section of the starter, with the other section serving the standby motor.

(g) The emergency generator will be a diesel engine driven unit rated at 3-phase, 380 V, 50 Hz, and will be installed in each substation in the utility and process areas. The unit will normally be stationary and will automatically start-up and operate upon power failure of a 380 V critical supply feeder.

Power supply to the critical loads such as normal/emergency lighting system, battery charger unit for switchgear controlling and emergency lighting system, battery charger unit for instrument DC/AC converter, will be fed from each emergency generator unit.

(h) Generally, 33 KV, 11 KV, 3.3 KV and 380 V power cables and control cables will be installed by the underground method.

Cables inside process or other well-defined operating areas will be laid in concrete trenches of adequate width and depth. Cable trenches will be filled with sand and covered with coloured concrete of adequate thickness.
Cable outside operating areas will be laid directly in the ground and protected by concrete cover tiles with route markers.

Single layer installation of cables in the concrete trenches or the ground will be performed, but where a number of cables are installed, the multi-layer arrangement will be adopted, taking into account cable amperge capacity.

9.8 Instrument design

9.8.1 General

(1) The instrument system has been fully considered in the process design with regard to the safe operation of the plant, easy operability, etc. This paragraph describes the instrument design as a whole.

(2) Though the design is, in principle, based on TENDER DOCUMENT Spec. Class 0, the deviations and clarifications will be shown in Technical Proposal.
The main item of deviation is that the explosionproof code is not restricted to B.S., and JIS and NEC codes are also adopted. As conformance TENDER DOCUMENTS would require a large number of control boards, the design provided for 4 rows of large type recorders.

Moreover, the fact that TENDER DOCUMENT Spec. Class 0 specifies the ambinet temperature at 65°C is inconsistent with the fact that Vol. III specifies the temperature at maximum 50°C. Therefore, considering the relation with the intrinsically-safe explosionproofing code, the ambient temperature has been decided at 50°C.

(3) The philosophy for the instrumentation design is that the bases as shown below are according to CONTRACTOR's past experiences and as based on TENDER DOCUMENTS.

9.8.2 Detail engineering design basis of instrumentation

Check mark: X ..... Applied fully
Y ..... Applied mostly
Z ..... Applied partially

(1) General

(a) Instrumentation system

(i) Transmitter

Y ..... Pneumatic (Signal: 0.2 - 1.0 kg/cm^{2}G)
X ..... Electronic (Signal: 4 - 20 mA, DC 24 V)

(ii) Local controller

X ..... Pneumatic: 0.2 - 1.0 kg/cm^{2}G

(iii) Local indicator or recorder

X ..... Pneumatic: 0.2 - 1.0 kg/cm^{2}G

(b) Applicable code and standard

(i)	Electrical equipment:	Z	... NEC	X	...	JIS
(ii)	Flange and fitting :	X	... ANSI	Z	...	JIS
(iii)	Thread :	X	... ANSI	Z	...	JIS
(iv)	Material :	Z	... ASTM	X	...	JIS
(v)	Installation :	X	... API RP			

(C) Instrument housing

(i) Transmitter (converter)

X ... Waterproof type (for intrinsic safety type)

Z ... Explosionproof type

(ii) Local indicator (gauge)

X ... Weaterproof type

(iii) Local switch

X ... Weatherproof type (for Intrinsic safety type)
Z ... Explosionproof type

(iv) Board instrument and equipment

X ... General type

(v) Others

X ... Barrier (for Intrinsically safe circuit)

(d) Colour

X ... Manufacturer's standard
Y ... Specified as follows

(i) Local instrument

- o Pressure gauge : Manufacturer's standard
- o Thermometer : ditto
- o Transmitter : ditto
- o Other local instrument: ditto
- o Control valve
  - Body : Silver
  - Actuator : Red or yellow

(ii) Board instrument : Manufacturer's standard

(iii) Control board

- o Board face : Light green finish
- o Channel base : Green
- o Inside : Light green

(e) Spare parts

(i) Complete spare instrument is not required.

(ii) General spare parts for 12 months use.

X ... Chart, X ... Pen, X ... Ink

(2) Instruments

(a) Pressure gauge

(i) Accuracy : X ... ±1.5%

(ii) Zero adjustable pointer is required.

(iii) Blow out disc is required.

(iv) Connection : X ... 1/2"
X ... Wrench flat
X ... Bottom
Z ... Back

(v) Dial size : Z ... 200 mm (8")ø
X ... 100 mm (4")ø
Z ... 75 mm (3")ø

(vi) Syphon type: Z ... JGS

(vii) Adapter : Z ... JGS

(b) Pressure instrument/differnetial pressure instrument

(i) Type : Z ... Bellows
X ... Diaphragms
X ... Bourdon

(ii) Connection : X ... 1/2" NPT
Z ... 1/4" NPT

(iii) Local indicator is required.

(c) Flow instrument

(i) Differential pressure type

- Orifice assembly -

o Design basis: X ... ASME

o Quantity expression :
Liquid : X ... kl/hr at 15°C
Gas/Vapor: X ... Nm^3/hr (at 0°C)
Steam : X ... kg/hr

o Orifice tap :
X ... Flange tap for up to 8 inches
Z ... Radius tap for above 10 inches slip-on flange

PROVISO: Weld neck type flanges shall be used flange tap.

o Standard differential pressure

X ... 2,500 mm (100") W.G

- Instrument -

o Connection :
X ... 1/2" NPT
Y ... 1/2" butt weld

o 3-valve manifold is required.

X ... Block type
Y ... Piping type

o Local indicator is required.

o Local recorder :
Z ... 24 hr spring chart drive
X ... 7 day spring chart drive

(ii) Positive displacement type

- o Accuracy : X ... ±0.5%
- o Transmitter is not required.
- o Temperature compensation is not required.
- o Strainer is required, if necessary.
- o Air releaser is not required.

(iii) Turbine type

- o Accuracy : X ... ±0.5%
- o Temperature compensation is not required.
- o Strainer is required, if necessary.

(iv) Area type

- o Accuracy : X ... ±2%
- o Taper tube: Y ... Metal
  Z ... Glass
- o Transmitter is required, if necessary.

(d) Temperature instrument

(i) Element : X ... Filled type

(ii) Instrument : X ... With temperature compensation

(iii) Well

- o Type : X ... Drilled bar-stock
- o Connection: X ... Flange 1", 1-1/2"*1 or 2"*2
  Y ... Screw 3/4"

Well type selection shall be in accordance with TENDER SPEC. VOLUME IV Para. 2.2

*1 1500# and over services will be used 1-1/2 flange.
*2 Flange 2" will be used for special service.

(e) Temperature gauge (thermometer)

(i) Element : Z ... Filled type
X ... Bimetal type

(ii) Type : X ... Direct
Z ... Capillary

(iii) Dial size : 100 mmØ

(iv) Gauge connection: X ... 1/2" NPT

(v) Well : Refer to Para. 4.3

(f) Thermocouple

(i) Applicable standard: X ... ANSI

(ii) Thermocouple

o Material: X ... CA
Y ... CC

o Type : Z ... General for flue gas service
X ... Metal sheath
(sheaths material: 304 .. generally)

o Diameter: Z ... 8 AWG for flue gas service
X ... 16 AWG for metal sheath type
Z ... Other for special service
(ex. RX temp.)

(iii) Well : Refer to Para. 4.3

(iv) Terminal head: X ... Weatherproof type

(v) Junction to be non-grounded type

(g) Resistance bulb

(i) Element

- o Material : X ... Pt 100 ohm at 0°C
- o Lead wire : X ... 3 wire
- o Type : X ... Metal sheath

(ii) Well : Refer to Para. 4.3

(iii) Terminal head: X ... Weatherproof type

(h) Level instrument

(i) Displacer type

- o Displacer : X ... External
  Z ... Internal
- o Connection: X ... 1-1/2"
  Z ... 4"

(ii) Differential pressure type

- o Instrument: Z ... Bellows
  X ... Diaphragm
- o Connection: X ... 1/2" NPT for both side
  Z ... 3" flange for high and 1/2" NPT for low side
  Z ... 3" flange for both side
- o Local indicator is required.

(iii) Ball float type

- o Float : X ... External
  Z ... Internal
  Flot size _____ mmØ (Mfr's stand'd)

- o Connection: X ... 1-1/2"
  Y ... 1"
  Y ... 4"
- o Alarm switch is required. If necessary.

(i) Tank gauge

(i) Indication: Z .. Direct
X .. Remote Z .. Pneumatic
X .. Electronic Z .. Analogue
X .. Digital

(ii) Alarm contact is not required.

(iii) Temperature measuring device is required for Remote type.

(j) Control valve

(i) Valve actuator : X ... Pneumatic diaphragm
Z ... Pneumatic cylinder
Z ... Electric motor for off-site area

(ii) Valve body

- o Connection : X ... Flange
- o Minimum size : 1 inch
- o Minimum rating: 300 lb ANSI

(iii) Type : X ... Globe type
Y ... Cage type
Z ... Angle type
Z ... Butterfly type
Z ... Comflex type
Z ... Parallel slide type

(iv) Positioner/converter: Z ... Pneumatic volume booster, if necessary

X ... Pneumatic positioner

X ... Elec. pneum. converter

(k) Board Instrument

(i) Controller

- o Type : Z ... Recording cntroller (if required)
  X ... Indicating controller
- o Location: X ... Built in
- o Computer cascade is not required.

(ii) Recorder : X ... Dedicated
Y ... Multipoint printing

(iii) Indicator : X ... Vertical type

(iv) Temperature indicator

- o Type : X ... Digital display
- o Selector switch : X ... Push button

(v) Annunciator

- o Type : X ... Centralized
- o Alarm : X ... Buzzer
- o Relay, lamp : X ... Separated

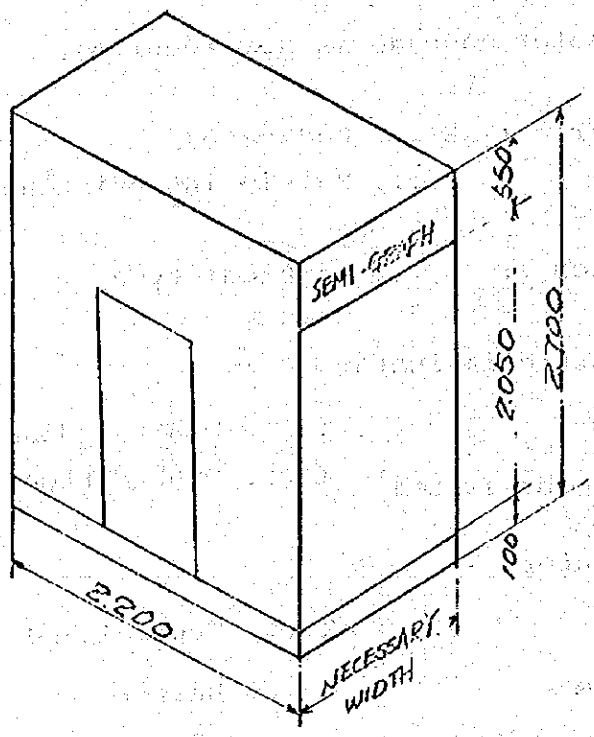
X ... DC 24 V

(1) Control board (in control room)

(i) Location: X ... Non-hazardous area
X ... Air conditioned

(ii) Type : X ... Semi-graphic

(iii) Constructionand approx. dimensions



Miniature type Indicators and Indicating controllers shall generally be located in the top row of Instruments on the panel with recorders located in a lower row.

The number of rows of electronic analog instruments shall not exceed three but shall be commensurate with good operator visibility and operation.
The multi-point recorder may be located in a fourth row.

(iv) External connection

Wiring: X ... Lower section

(v) Master air set is not required.

(iv) Power supply diagram for board instruments

As per Tender Spec. Class 0 Sect. 2, 2.15.5.

(m) Local Board

(i) Location: Y ... Hazardous area for process plants
Y ... Non-hazardous area for UTILITY plants

(ii) Explosionproof equipment is required, if the local panel is installed in Hazardous area.

(iii) Pressurizing is required, in case, if it is not able to apply explosionproof equipments.

(iv) Constructionand approx. dimensions

By Package Vendor

(v) Master air set is required, if necessary.

(Two sets in parallel)

(n) Operator's console desk is required as follows.

(i) Equipments: X ... Temperature indicator with selector switch

X ... Tank level indicator with selector switch (off-site CCR only)

X ... Telephone and paging system

(ii) Construction and approx. dimensions

Later

(o) Gage glass

(i) Type : X ... Armord

(ii) Lighting housing: X ... Vapor tight type

(iii) Connection : X ... 3/4"

Z ... 1"

(p) Safety valve

(i) Code : X ... Pressure vessel

X ... Boiler

(ii) Connection: X ... Flange

Z ... Screwed

(q) Instrument utility

(i) Instrument air

- o Pressure at B/L: Min 7, max. 8 (kg/cm^2G)
- o Dew point : -20°C
- o Pressure regulator for local instruments

X ... Individual

(ii) Electric power supply

o Supply from electric facility

X ... AC 110 V, 50 Hz, 1ϕ

o Emergency power supply is required

AC 110 V, 60 minutes hold
Interruption: Non-interruption

9.9 Insulation and painting

9.9.1 Insulation

(1) General

This paragraph describes the thermal insulation work including personnel protection, sound control and fireproofing for piping, fitting, equipment and instrumentation of Export Refinery Project.

(2) Applicable specification

All insulation work shall be carried out in accordance with the following Tender Specification except as set forth in the Proposed Deviations and Exceptions and technical description described herein.

Design Specification P40-LID-73 for Thermal Insulation.

(3) Technical description

(a) Basically, the application of insulation will be provided in accordance with the requirements of process and mechanical operating conditions for metal temperature control.

(b) The insulation will not be provided for flare and blowdown system, unless otherwise specified.

(4) Personnel protection

Insulation for personnel protection will be provided for uninsulated lines design temperature over 95°C and to 2 m aboveground level or operating platform.

(5) Material and application

All insulation material will be subject to "Insulation Material List" attached to Technical Proposal. For cold insulation, basically foamed polyurethane is selected as the material of cold insulation depending on the superior properties of lesser thermal conductivity and bulk density as compared to foam glass.

Detailed application and procedure for hot and cold insulation will be submitted later at the commencement of project.

9.9.2 Painting

(1) General

This paragraph covers the Painting Work for the Export Refinery Project.

(2) Applicable specification

The painting work will be done, as a rule, in accordance with KIC Spec. P42-LID-72 of TENDER DOCUMENT, Matters not specified clearly by the same will conform to this.

(a) The following items will be painted.

			Type No.
(i)	Structural steel, support (Internal, and external)	Colored	No. 1-1
		Silver	No. 1-2
(ii)	Piping	Colored	No. 1-1
		Silver	No. 1-2
(iii)	Piping on the sea	Colored	No. 6
(iv)	Stack & furnaces, heat exchanger		
	Below 150°C		No. 2-1
	150°C to 400°C		No. 2-2
	Below 600°C		No. 2-3
(v)	Vessels and tanks, stairways, ladders	Colored	No. 1-1
		Silver	No. 1-2
(vi)	Floating roofs and spheres		No. 3
(vii)	Under the insulation		No. 4

		Type No.
(viii)	Immersed to water, etc.	No. 5
(ix)	Under sea water, etc.	No. 5
(x)	Piping, ducts, supports of instruments : by others	
(xi)	Piping, ducts, supports of electrical equipment : by others	
(xii)	Touch-up of equipment which are finish coated by the fabricator. (e.g. pump, comp. & driver, instrument, electric equip. and package equip., etc. : by others	

(b) "Type No." will conform to "Coating Type List" attached to proposal. As a rule, priming and finish coating will be applied twice respectively and their classification will be as follows.

(i) Items already primer-coated by the equipment fabricator will conform to the procedures indicated in "At Site" and will be subject to surface preparation, touch-up, primer, middle, and finish coat respectively.

(ii) Those to be fabricated at the site will be in accordance with the procedures indicated in "At Site" and two primer coats, one middle and finish coat will be applied.

(3) Instructions for application

(a) Surface preparation (Steel surface preparation)

(i) Surface preparation will be in accordance with one of the following methods.
(The method to be used for each item is indicated in the Painting Specification).

- o Near white blast cleaning
- o Power tool cleaning
- o Hand tool cleaning

The following are definition of various methods of surface cleaning.

- Near white blast cleaning -

The surfaces to be painted are cleaned by blast cleaning before painting in accordance with the Steel Structure Painting Council SSPC-SP-10-63T.
The surface to be painted is cleaned by blast cleaning, until at least 95% of each element of surface area is free from all visible residues.

- Power tool cleaning -

The surfaces to be painted are cleaned by power tools cleaning before painting in accordance with the Steel Structure Painting Council SSPC-SP-3-63.
Removal of loose millscale, loose rust, loose paint, and other foreign matter to the degree specified by power tool cleaning; (power wire brushes, power impact tools, power grinders, power sanders, or a combination of these methods).

- Hand tool cleaning -

The surfaces of galvanized metal to be painted are cleaned by hand tool cleaning, before painting in accordance with the Steel Structure Painting Council SSPC-SP-2-63.
Remove of white rust by sanding.

(ii) Cautions for surface preparation

- o Work will be done carefully not to injure the materials.
- o Work on edges, corners, angles and other complicated parts of shaped steel will be done with special care.
- o Grease occurring in welding or rivetting will be scraped off carefully.
- o Welding spatter and flux will be removed.

(b) Painting

Painting method will be selected according to type of paints and materials to be coated.

(i) Brushing or roller coating

- o Brush or roller coating will be used for paint whose "Dry to Touch" is slow.
  In painting, brush or roller will be applied in lengthwise direction throughout till all the area is once covered, then recoated out broadwise, and finished lengthwise.
  Care will be taken not to allow paint to "Sag" or "Flow".
  At areas where application is joined, the borderline will be lapped one-forth the width of the brush.

- Brushing operation will be as follows:

  Soak the brush with sufficient paint. First place the paint at several parts of the area and then spread it uniformly with as wide an action of the brush as possible. In finishing, the paint will be applied light.

(ii) Air spraying

Air spraying may be used to apply paints which dry quickly.

- It is often used in painting parts of machines and small articles.

Air pressure will be around 3.5 - 5 kg/cm2G and will depend on the viscosity of the paints.

- Air spraying is performed vertically on the surface at a distance of 20 - 30 cm from the surface.
- Moving speed of the spraygun will depend on paint viscosity, but it will be moved parallel to the surface at a speed of around 50 cm/sec.

(iii) Airless spraying

Airless spraying is preferable for all applications wherever possible.
Careful attention is paid to select the most suitable nozzle tip.
In general, operation conditions of spraying are as follows:

- Primary pressure : 4 - 5 kg/cm2G
- Spraying distance: 30 - 40 cm
- The gun to be moved in parallel with and vertically to the surface.

(iv) Touch-up painting

Touch-up painting for finish coat is applied as a minimum in the following cases.

- o Spots
- o Swells
- o Cracks
- o Strip-off
- o Creases
- o Discoloration
- o Other improper painting

Touch-up painting of the prime coat is applied to portions damaged during transportation, handling and/or construction, before application of successive coats.

(c) Application

(i) Painting is done with the most suitable method such as brush painting, airless spraying or roller coating in accordance with paints, materials, painting conditions, etc.

(ii) Paints will be stored in special areas with careful consideration to fire prevention, ventilation, screening from direct rays of the sun and rearrangement after use.

(iii) Mixture of paint

- o Paints are used after thorough stirring.

- o In mixing multi-component paints, it is necessary to mix them according to exact mixing ratios in accordance with the manufacturer's standards.
  And the mixed paints will be used for painting within the regulated pot life.

- o Thinner to dilute paints will be used within the regulated quantity.

- o Paints with a different base will not be mixed together.

(iv) Painting work will not be done under the following conditions:

- o Bad weather such as rain or fog
- o Sandstorms or strong sea winds
- o Temperature +5°C or below
- o High temperatures of material surfaces which are inappropriate for applying paint

(v) The first prime coat is applied as soon as the surface preparation is done. If application of the prime coat is impossible due to bad weather or schedule, surface preparation will be done again before the prime coat is applied.

(vi) Successive coats will be applied after confirming the dryness of the former coat and also repairing parts where it is injured, omitted from painting, abnormal film of paint or marked by foreign substances.

(vii) Surface where dew is deposited or expected to be deposited will not be painted. If the painting of such surfaces unavoidable, it will be done after the surfaces are wiped clean and dry.

(viii) Painting will be done carefully to be of an even thickness not forming droplets, holes, unevenness or holidays.

(ix) Special attention will be paid to complicated parts such as edges, corners, angles, welded points, bolted points, etc.

(x) Parts which are difficult to paint after assembly will be painted with the specified paint before assembly.

9.9.3 Fireproofing

(1) General

This paragraph describes the fireproofing work for structures, equipments, skirts and supports.

(2) Applicable specification

The fireproofing work will be done in accordance with KIC Spec. P41-ID69.

(3) Materials

(a) Mortar and concrete

Components ratio of mortar and concrete will be as follows:

	Portland Cement	River Sand	Gravel
Mortar	1	3	
Concrete	1	2	3

(b) Reinforcements for mortar and concrete

Expanded metal 50 mm mesh, or galvanized wire netting 20 x 40 mm mesh.
Annealed steel wire or galvanized steel wire.
Nuts

(4) Application

(a) Surfaces to be fireproofed will be free from oils, scales and any other foreign matters.

(b) Water used for mortar and concrete will be free from foreign matter.

(c) When ambient temperature are in the range of 5°C and less, fireproofing will not be applied.

(d) After application of concrete or mortar, the surfaces of concrete or mortar will be kept out of the sun and in wet condition at least 3 days.

(e) The thickness of fireproofing will be 50 mm standard.

(f) Fireproofing of skirts will be applied with mortar.

(g) Fireproofing of legs will be applied with concrete.

9.10 Fire fighting system design

(1) Fire fighting system will be designed based on the specifications attached to TENDER DOCUMENT Vol. III.
Deviationes and exceptiones therefrom will be explained in Technical Proposal, but the following are their supplementary notes.

(2) Piping

(a) Piping materials shall conform to piping Specification Class A111 and A112 given in Technical Proposal.

(b) Pipe surface corrosion protection for buried pipe will be used POLYKEN PIPELINE TAPE #900, half-width over wrapped spiral wound.

(c) Cathodic protection will not be applied to buried pipe.

9.11 Sewer and effluent design

(1) Sewer and effluent system will be designed based on the specifications attached to TENDER DOCUMENT. Deviations and Exceptions therefrom will be explained in Technical Proposal but the following are their supplementary notes.

(2) Sewer piping

(a) Piping materials shall conform to Piping Specification Class A111 and A112 given in Technical Proposal.

(b) Pipe surface corrosion protection materials are to be polyken pipeline Tape #900, half-width over wrapped spiral wound, with protective Tape #955 and primer coating.

(c) Vent pipe at the manhole is to be 4 inch.

(d) Soil coverage on piping will be 30 cm minimum.

(e) All underground piping will be directly buried.

(f) Catch basin will be elbow sealed piping.

(g) K-value of sewer pipe (carbon steel) is to be 0.6.

(h) Cathodic protection will not be applied to carbon steel piping.

(3) Open ditch

K-value of the ditch is to be 0.15.

(4) Rainfall intensity

Rainfall intensity shall be 25 mm/hr.

APPENDICES

APPENDIX I

NORTH RUMAILA
CRUDE OIL ASSAY

INSTITUT FRANCAIS DU PÉTROLE

BRANCHE CHIMIE RAFFINAGE
Division Physico-Chimie appliquee

IRAQ CRUDE OIL ANALYSIS
IRAQ NATIONAL OIL COMPANY
(BAGHDAD - IRAQ)

Ref. 21 029

February 1973

INSTITUT FRANCAIS DU PETROLE
Branche Chimie-Raffinage
Division Physico-Chimie Appliquée
MM/ml - N° de projet : C 86/31 814
Février 1973 - Rapport IFP N° 21 029

IRAQ CRUDE OIL ANALYSIS

IRAQ NATIONAL OIL COMPANY

(BAGHDAD - IRAQ)

M. MADEC

IRAQ crude oil analysis including the following determinations :

- Crude oil characteristics.
- TBP distillation narrow cuts with analysis of fractions.
- TBP distillation into wide cuts approximating commercial fractions.
- Analysis of one condensate, six gasolines, three naphthas, one white spirit, one jet fuel, two kerosines, four diesel oils, two heavy diesel oils, four heavy distillates, six residua.

The analytical methods used in this crude study are shown in the back of this report.

At the request of the IRAQ NATIONAL OIL COMPANY, BAGHDAD, IRAQ, letters n° B 12/6/15731 dated 3rd July 1972 and n° B 12/6/18213 dated 2nd August 1972, the INSTITUT FRANCAIS DU PETROLE has made the following crude oil evaluation.

Three drums 42 U.S. Gallon, respectively numbered 1, 2 and 3 were received in our laboratories on 31st August 1972 and were registered under the numbers E 2047-1, E 2047-2, E 2047-3.

The analysis is carried out on drum number 3 according to the program given in our on letter n° 8469 dated 10th May 1972 - Appendix 1.

Engineer in Charge,

M. MADEC

Head of Division,

J. DURANDET

C O N T E N T

SAMPLING DETAILS

Field : Rumaila North

Station : Rumaila Degassing Station

Nature of sample : Stock tank oil from Fao outgoing line

Sample container : Three 42 U.S. Gallon drums

Date of sampling : 27th June, 1972

Time of sampling : 14.30 to 18.00 hours

Method of sampling : Cooling the oil by passing 1/2 inch coil in ice water in intermediate drum and overflowing the collecting drum equivalent to its capacity

Pressure at sampling point : 17 kg/cm^2

Ambient temperature : 45 °C

Crude oil temperature (after cooling) : 26 °C

Wells on stream during sampling

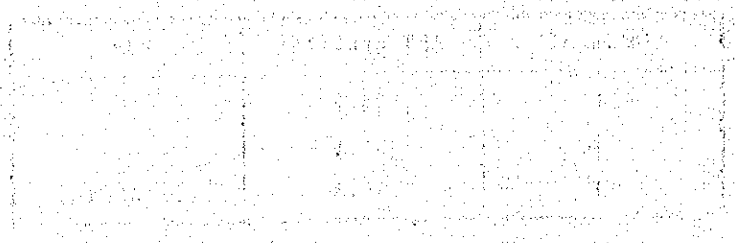
R-2	3500	m^3/day
R-4	4050	m^3/day
R-8	3950	m^3/day
R-37	3100	m^3/day
Total production rate	14600	m^3/day

Separation conditions are the following

	Pressure kg/cm^2				Temperature °C			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Bank A...	42.5	15.6	1.9	0.85	51	48	43	40
Bank B...	41.5	15.0	1.9	0.88	54	52	47	44

The API gravity and Reid Vapour Pressure of crude oil samples in drums are the following :

Drum n°	API gravity	RVP
1	34.2	-
2	34.1	-
3	34.3	7.5 lbf/in^2



CRUDE OIL GENERAL CHARACTERISTICS

CRUDE OIL GENERAL CHARACTERISTICS

Characteristics	Results
Specific gravity 15/4 °C	0.853
Specific gravity 20/4 °C	0.850
API gravity	34.3
Kinematic viscosity	
at 20 °C (cS)	9.72
at 37.8 °C (cS)	6.04
Pour point (°C)	- 42
Flash point (°C)	< 20
Reid vapor pressure at 37.8 °C (bar)	0.515
Reid vapor pressure at 37.8 °C (psi)	7.5
Water by distillation (vol. %)	< 0.10
B.S. and W (centrifuge) (vol. %)	< 0.10
Total sulfur (wt %)	1.92
Mercaptan sulfur (wt %)	< 0.001
Hydrogen sulfide (w	nil
Salt content (NaCl)	< 0.0020
Total salinity (w	0.0020
Nitrogen (wt %)	0.12
Conradson Carbon residue (wt %)	5.0
Wax content (wt %)	3.7
Melting point of waxes (°C)	53
Asphalt content (wt %)	0.98
Total acid number (mg KOH/g)	0.03
Strong acid number (mg KOH/g)	nil
Ash content (wt %)	0.008
Calculated cetane index	57
Lower heating value (mth/kg)	10.004
Gross heating value (mth/kg)	10.690
Characterisation factor KUOP	11.75

CANCEL
SEE TABLE - 1

METALS CONTENT

Methods applied = atomic absorption

Element	Content (mg/kg)
Sodium.....	0.5
Potassium.....	nil
Calcium.....	< 0.2
Magnesium.....	< 0.1
Manganese.	
Copper....	
Chromium	
Nickel.....	8.0
Vanadium.....	32.0
Lead.....	2.0
Iron.....	1.5

CANCEL
SEE TABLE -2

LIGHT HYDROCARBONS ANALYSIS ON CRUDE

Hydrocarbons	Weight %	Volume %
Ethane.....	0.05	0.10
Propane.....	0.41	0.69
Isobutane.		0.35
Normal bu		1.88
Isopentan.....		1.28
Normal pentane.....	1.64	2.22

CANCEL
SEE TABLE -3

"TRUE BOILING POINT" DISTILLATIONS - NARROW CUTS

"TRUE BOILING POINT" DISTILLATIONS - NARROW CUTS

Narrow cuts TBP distillations are performed on two samples of crude oil : height liters and two liters.

Oldershaw perforated plates columns with the following characteristics are used for fractionating :

- plate diameter = one inch
- column height = 100 centimeters for thirty plates
  50 centimeters for ten plates

To convert temperatures observed at pressures other than 760 mm Hg to equivalent temperatures at 760 mm Hg, Maxwell and Bonnel vapor pressure-temperature chart is used.

Every fraction is weighed and its specific gravity determined at 15 °C. The volume yields are calculed from these values.

Due to expansion in volume observed when fractionating crude oils, the cumulative percentages in volume are higher than 100 %, the expansion being here of about 0,4 %. This last value has been deduced from the effective volume of the condensate.

TBP DISTILLATIONS - NARROW CUTS

	Fractions	Distillation temperature at 760 mm Hg °C	Pressure mm Hg	Reflux ratio	Apparatus
TBP distillation number 1 feed = 8 liters	Condensate	< 20	760	20	30 plates Oldershaw column
	1 at 35	20 - 250	760	20	" " "
	36 at 45	250 - 350	40	15	" " "
	46 at 50	350 - 400	1	10	" " "
	51 at 54	-	<1	5	10 plates Oldershaw column
	55 at 59	-	<1	5	Empty column 50 centimeters in height and 2.5 centimeters in diameter
	60 at 62	-	<1	2	Evaporation still without column
TBP distillation number 2 feed = 2 liters	Condensate	< 20	760	20	30 plates Oldershaw column
	1 at 29	20 - 200	760	20	" " "
	30 at 41	200 - 320	40	15	" " "
	42 at 46	320 - 370	10	10	" " "
	47 at 49	370 - 400	1	10	" " "
	50 at 51	-	<1	5	10 plates Oldershaw column
	52 at 54	-	<1	5	Empty column 50 centimeters in height and 2.5 centimeters in diameter
	55 at 56	-	<1	2	Evaporation still without column

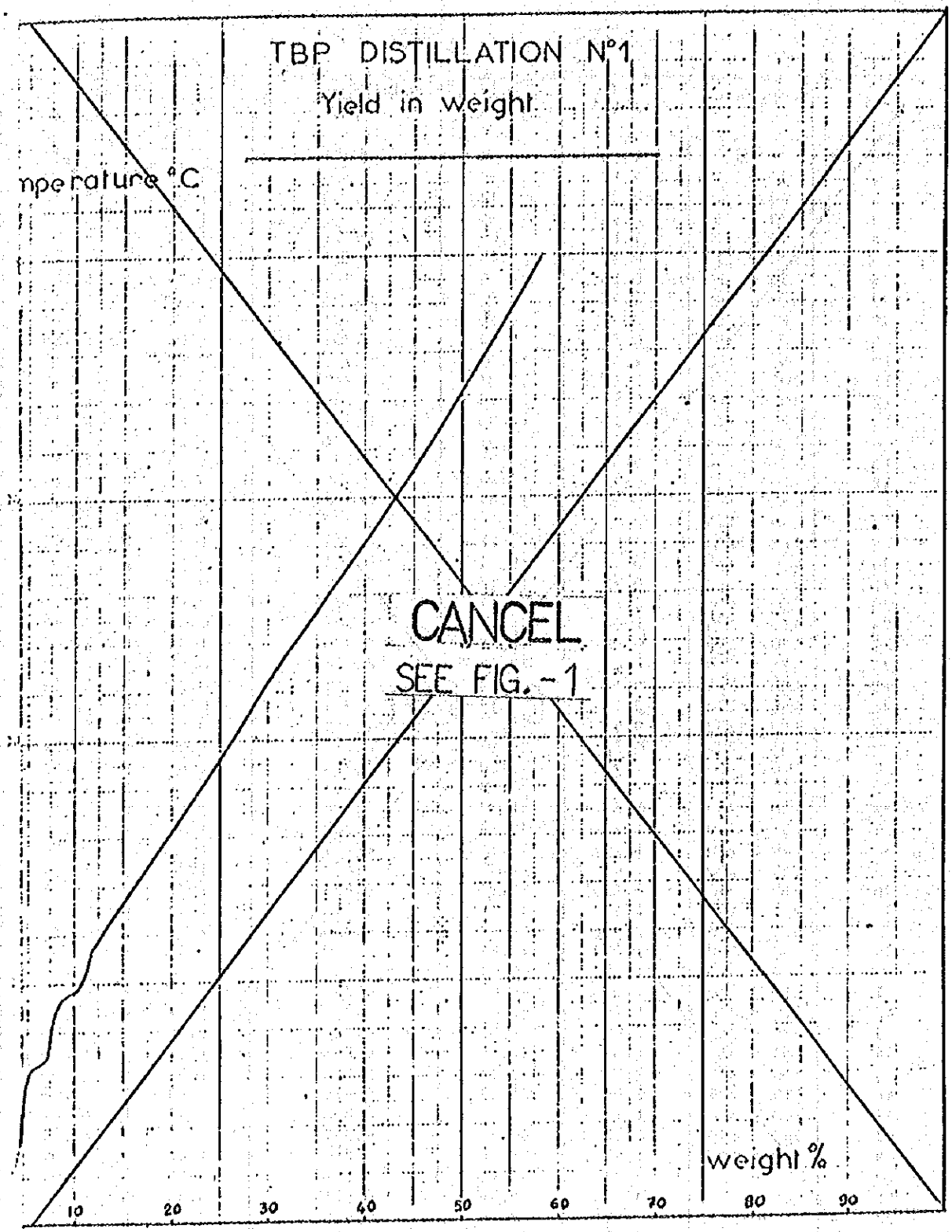
TBP DISTILLATION - RUNNER 1 - NARROW CUTS

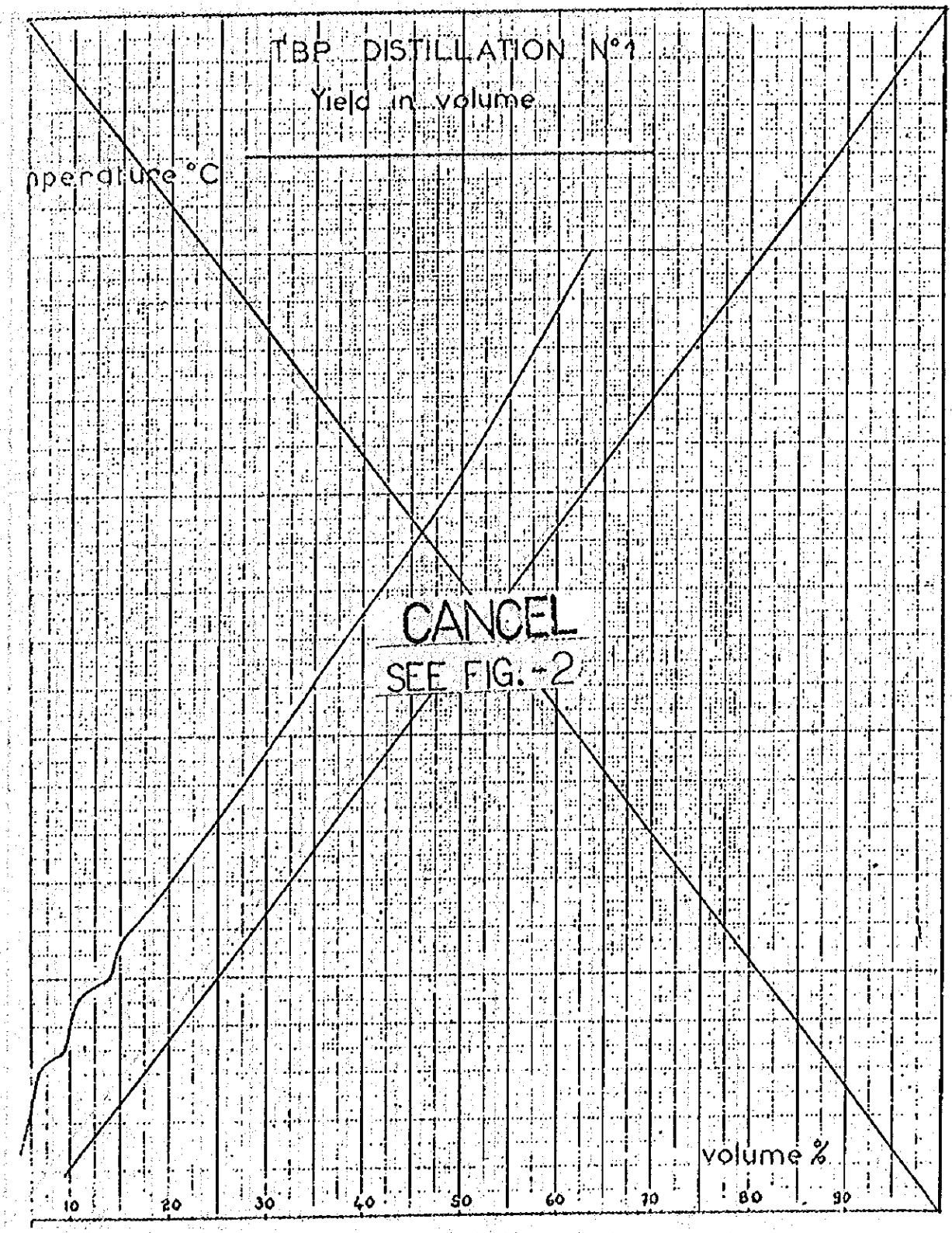
Cut	Temperature °C	Weight %	Cumulated weight %	Specific gravity 15/4	Volume %	Cumulated volume %
Condensate	< 20	1.96	1.96	0.552	2.56	2.56
1	20 - 40	2.23	4.19	0.627	3.03	5.59
2	40 - 60	0.77	4.96	0.658	1.00	6.59
3	60 - 65	0.67	5.63	0.665	0.86	7.45
4	65 - 70	1.60	7.23	0.676	2.02	9.47
5	70 - 75	0.22	7.45	0.704	0.27	9.74
6	75 - 80	0.15	7.60	0.714	0.18	9.92
7	80 - 85	0.35	7.95	0.713	0.42	10.34
8	85 - 90	0.22	8.17	0.709	0.26	10.60
9	90 - 95	1.10	9.27	0.705	1.33	11.93
10	95 - 100	1.55	10.82	0.709	1.86	13.79
11	100 - 105	0.47	11.29	0.751	0.53	14.32
12	105 - 110	0.33	11.62	0.756	0.37	14.69
13	110 - 115	0.34	11.96	0.738	0.39	15.08
14	115 - 120	0.93	12.89	0.726	1.09	16.17
15	120 - 125	0.95	13.84	0.725	1.12	17.29
16	125 - 130	0.84	14.68	0.730	0.98	18.27
17	130 - 135	0.70	15.38	0.766	0.78	19.05
18	135 - 140	0.97	16.35	0.775	1.07	20.12
19	140 - 145	0.98	17.33	0.761	1.10	21.22
20	145 - 150	0.68	18.01	0.766	0.78	22.00
21	150 - 155	0.87	18.88	0.749	0.99	22.99
22	155 - 160	0.68	19.56	0.772	0.75	23.74
23	160 - 165	1.02	20.58	0.781	1.11	24.85
24	165 - 170	0.86	21.44	0.782	0.94	25.79
25	170 - 175	0.97	22.41	0.772	1.07	26.86
26	175 - 180	0.85	23.26	0.774	0.94	27.80
27	180 - 185	0.65	23.91	0.785	0.71	28.51
28	185 - 190	0.74	24.65	0.786	0.80	29.31
29	190 - 195	1.04		.781	1.13	30.44
30	195 - 200	0.77		785	0.84	31.28
31	200 - 210	1.39		.796	1.39	32.67
32	210 - 220	1.71		91	1.84	34.51
33	220 - 230	1.48		01	1.58	36.09
34	230 - 240	1.76	32.71	0.802	1.87	37.96
35	240 - 250	2.16	34.87	0.808	2.28	40.24
36	250 - 260	1.49	36.36	0.838	1.52	41.76
37	260 - 270	2.19	38.55	0.832	2.25	44.01
38	270 - 280	1.44	39.99	0.842	1.46	45.47
39	280 - 290	1.65	41.64	0.837	1.68	47.15
40	290 - 300	1.56	43.20	0.842	1.58	48.73
41	300 - 310	1.43	44.63	0.842	1.45	50.71
42	310 - 320	1.64	46.27	0.845	1.56	51.84
43	320 - 330	1.34	47.61	0.859	1.33	53.17
44	330 - 340	1.78	49.39	0.861	1.76	54.93
45	340 - 350	1.61	51.00	0.873	1.57	56.50
46	350 - 360	1.64	52.64	0.890	1.57	58.07
47	360 - 370	1.51	54.15	0.888	1.45	59.52
48	370 - 380	1.33	55.48	0.882	1.29	60.81
49	380 - 390	1.31	56.79	0.887	1.26	62.07
50	390 - 400	1.56	58.35	0.897	1.48	63.55
51	-	1.86	60.21	0.902	1.76	65.31
52	-	1.89	62.10	0.909	1.77	67.08
53	-	1.90	64.00	0.914	1.77	68.85
54	-	1.91	65.91	0.927	1.76	70.61
55	-	1.88	67.79	0.927	1.73	72.34
56	-	1.89	69.68	0.930	1.73	74.07
57	-	1.95	71.63	0.935	1.78	75.85
58	-	1.71	73.34	0.937	1.56	77.41
59	-	2.01	75.35	0.941	1.82	79.23
60	-	1.86	77.21	0.944	1.68	80.91
61	-	1.88	79.09	0.947	1.69	82.60
62	-	1.31	80.40	0.948	1.18	83.78
Residue	-	19.60	100.00	1.031	16.22	100.00

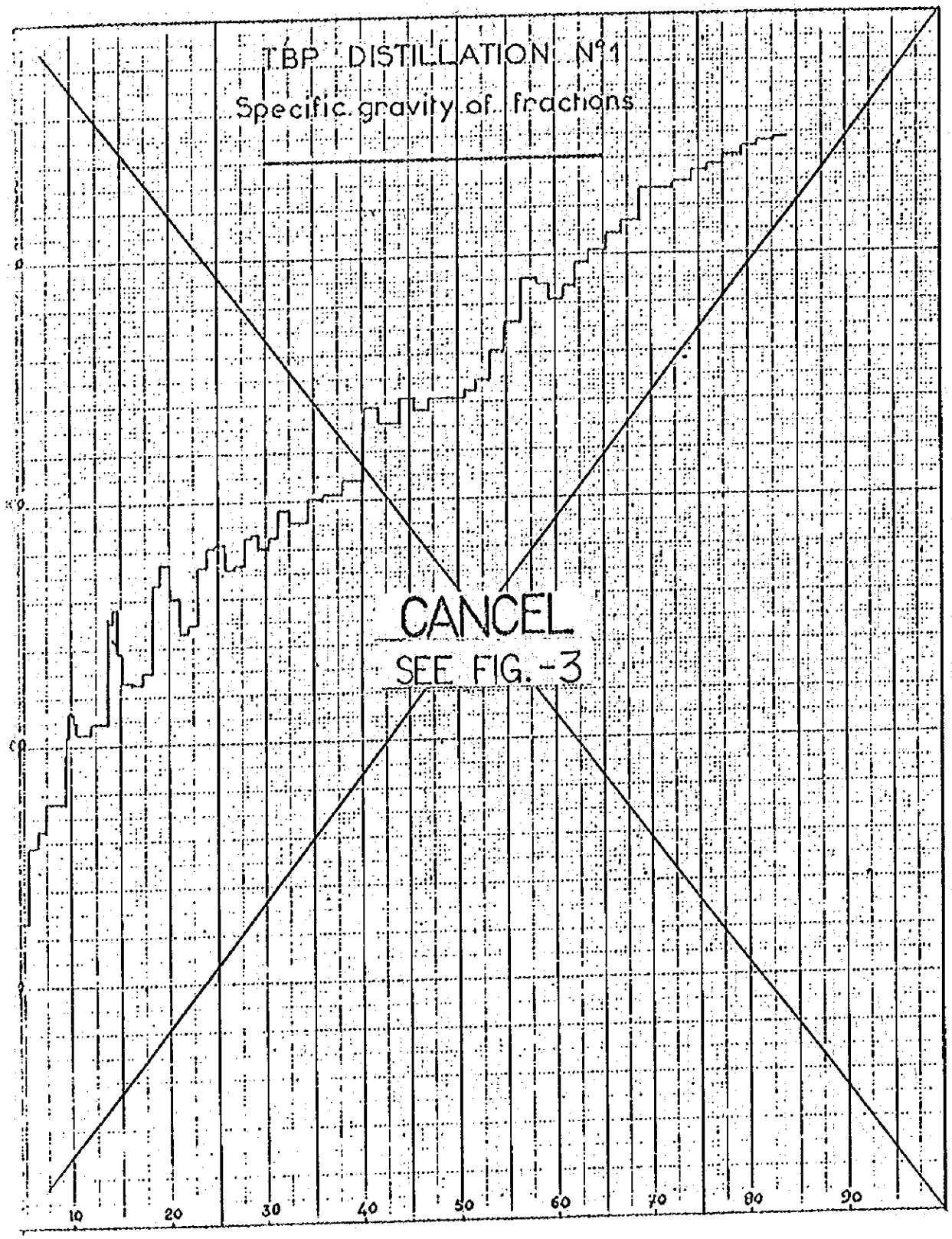
CANCEL
SEE TABLE -4

TBP DISTILLATION - NUMBER 2 - NARROW CUTS

Cut	Temperature °C	Weight %	Cumulated weight %	Specific gravity 15/4	Volume %	Cumulated volume %
Condensate	< 20	1.98	1.98	0.558	2.54	2.54
1	20 - 40	2.17	4.15	0.623	2.97	5.51
2	40 - 60	0.80	4.95	0.653	1.04	6.55
3	60 - 65	0.95	5.90	0.665	1.22	7.77
4	65 - 70	1.17	7.07	0.676	1.48	9.25
5	70 - 75	0.37	7.44	0.692	0.46	9.71
6	75 - 80	0.25	7.69	0.702	0.30	10.01
7	80 - 85	0.25	7.94	0.706	0.30	10.31
8	85 - 90	0.41	8.35	0.706	0.50	10.81
9	90 - 95	0.89	9.24	0.703	1.08	11.89
10	95 - 100	1.41	10.65	0.712	1.69	13.58
11	100 - 105	0.61	11.26	0.733	0.71	14.29
12	105 - 115	0.89	12.15	0.738	1.03	15.32
13	115 - 120	0.70	12.85	0.728	0.82	16.14
14	120 - 125	1.06	13.91	0.726	1.25	17.39
15	125 - 130	0.86	14.77	0.737	1.00	18.39
16	130 - 135	0.70	15.47	0.758	0.79	19.18
17	135 - 140	0.87	16.34	0.770	0.96	20.14
18	140 - 145	0.88	17.22	0.762	0.98	21.12
19	145 - 150	0.89	18.11	0.751	1.01	22.13
20	150 - 155	0.81	18.92	0.754	0.92	23.05
21	155 - 160	0.74	19.66	0.767	0.82	23.87
22	160 - 165	0.81	20.47	0.777	0.89	24.76
23	165 - 170	1.00	21.47	0.779	1.09	25.85
24	170 - 175	0.94	22.41	0.774	1.04	26.89
25	175 - 180	0.83	23.24	0.775	0.91	27.80
26	180 - 185	0.69	[illegible]	0.781	0.75	28.55
27	185 - 190	0.72	[illegible]	0.784	0.78	29.33
28	190 - 195	0.90	[illegible]	0.783	0.98	30.31
29	195 - 200	0.92	26.47	0.785	1.00	31.31
30	200 - 210	1.73	28.20	0.799	1.85	33.16
31	210 - 220	1.60	29.80	0.792	1.72	34.88
32	220 - 230	1.57	31.37	0.804	1.67	36.55
33	230 - 240	1.76	33.13	0.803	1.87	38.42
34	240 - 250	1.72	34.85	0.817	1.80	40.22
35	250 - 260	1.45	36.30	0.822	1.50	41.72
36	260 - 270	1.66	37.96	0.828	1.71	43.43
37	270 - 280	1.41	39.37	0.835	1.43	44.86
38	280 - 290	2.05	41.42	0.839	2.07	46.93
39	290 - 300	1.42	42.84	0.840	1.43	48.36
40	300 - 310	1.59	44.43	0.842	1.60	49.96
41	310 - 320	1.62	46.05	0.846	1.63	51.59
42	320 - 330	1.79	47.84	0.861	1.77	53.36
43	330 - 343	2.02	49.86	0.868	1.99	55.35
44	343 - 350	1.55	51.41	0.876	1.51	56.86
45	350 - 360	2.14	53.55	0.882	2.07	58.93
46	360 - 370	1.48	55.03	0.884	1.43	60.36
47	370 - 380	1.16	56.19	0.892	1.11	61.47
48	380 - 390	1.12	57.31	0.887	1.08	62.55
49	390 - 400	1.53	58.84	0.893	1.46	64.01
50	-	3.27	62.11	0.905	3.08	67.09
51	-	3.25	65.36	0.915	3.03	70.12
52	-	3.42	68.78	0.925	3.15	73.27
53	-	2.79	71.57	0.933	2.55	75.82
54	-	2.66	74.23	0.934	2.43	78.25
55	-	3.15	77.38	0.945	2.84	81.09
56	-	3.40	80.78	0.955	3.04	84.13
Residue	-	19.22	100.00	1.033	15.87	100.00


TBP DISTILLATION N°1
Yield in weight
npe rature °C
CANCEL
SEE FIG. - 1
weight %
10
20
30
40
50
60
70
80
90


T.B.P. DISTILLATION N°1
Yield in volume
pperature °C
CANCEL
SEE FIG.-2
volume %
10
20
30
40
50
60
70
80
90


TBP DISTILLATION N°1
Specific gravity of fractions
CANCEL
SEE FIG. -3
10
20
30
40
50
60
70
80
90

TBP DISTILLATION - NARROW CUTS ANALYSIS

Several determinations are made on TBP cuts distillation number one.

- Pour points :

14 cuts are tested according to the ASTM method D 97, in the diesel oils and lube oils range.

- Aniline points :

The 10 first determinations are made by the NF method M 07-021, and the last 5 by the ASTM method D 611.

- Aromatic hydrocarbons content :

Cuts from 23 to 37 are tested by the ASTM method D 1319 and following cuts by the ASTM method D 1019.

- Sulfur content :

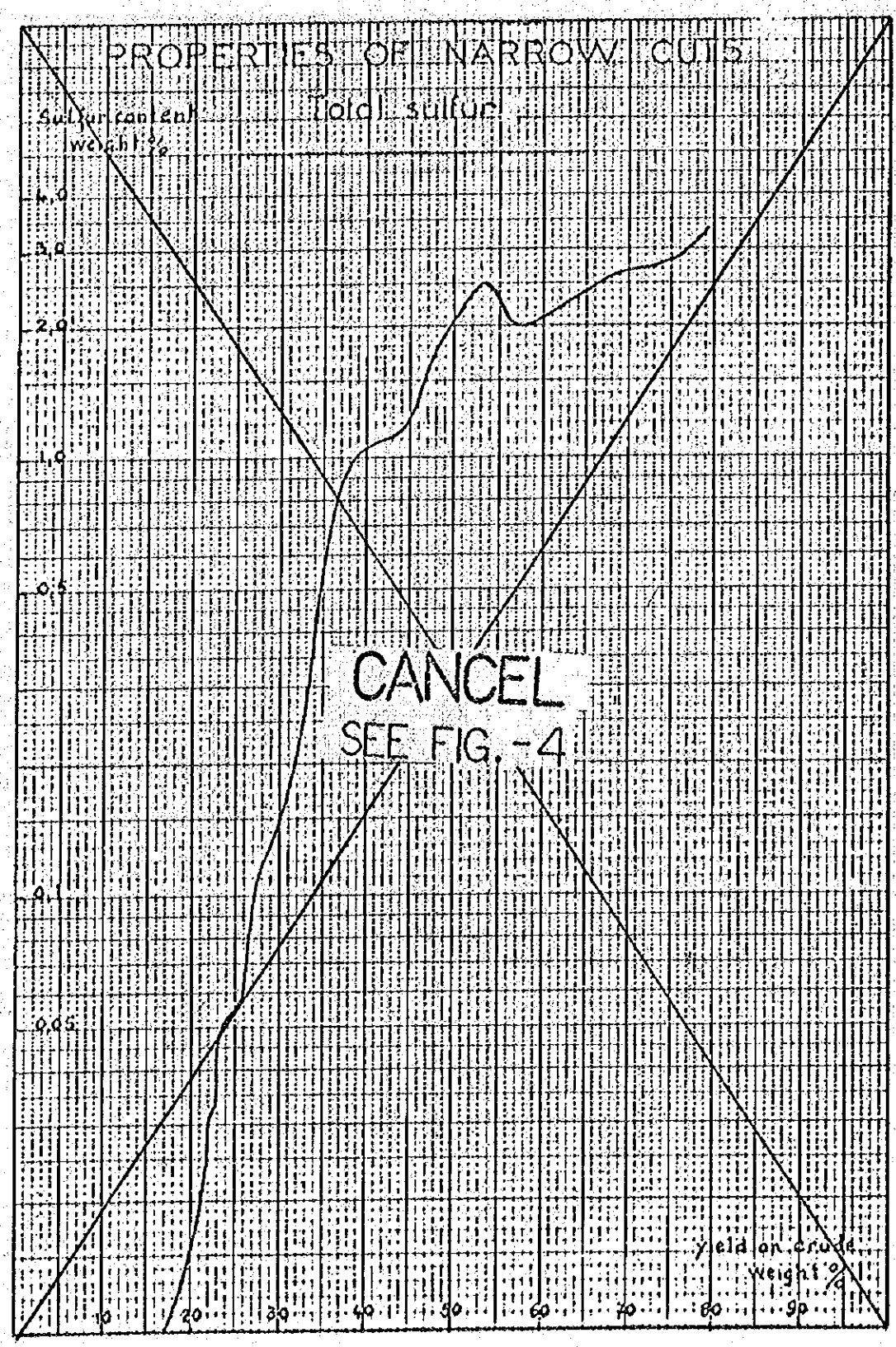
Determination of sulfur content is made by UOP method 727-72 until cut number 35 and then by ASTM method D 1551.

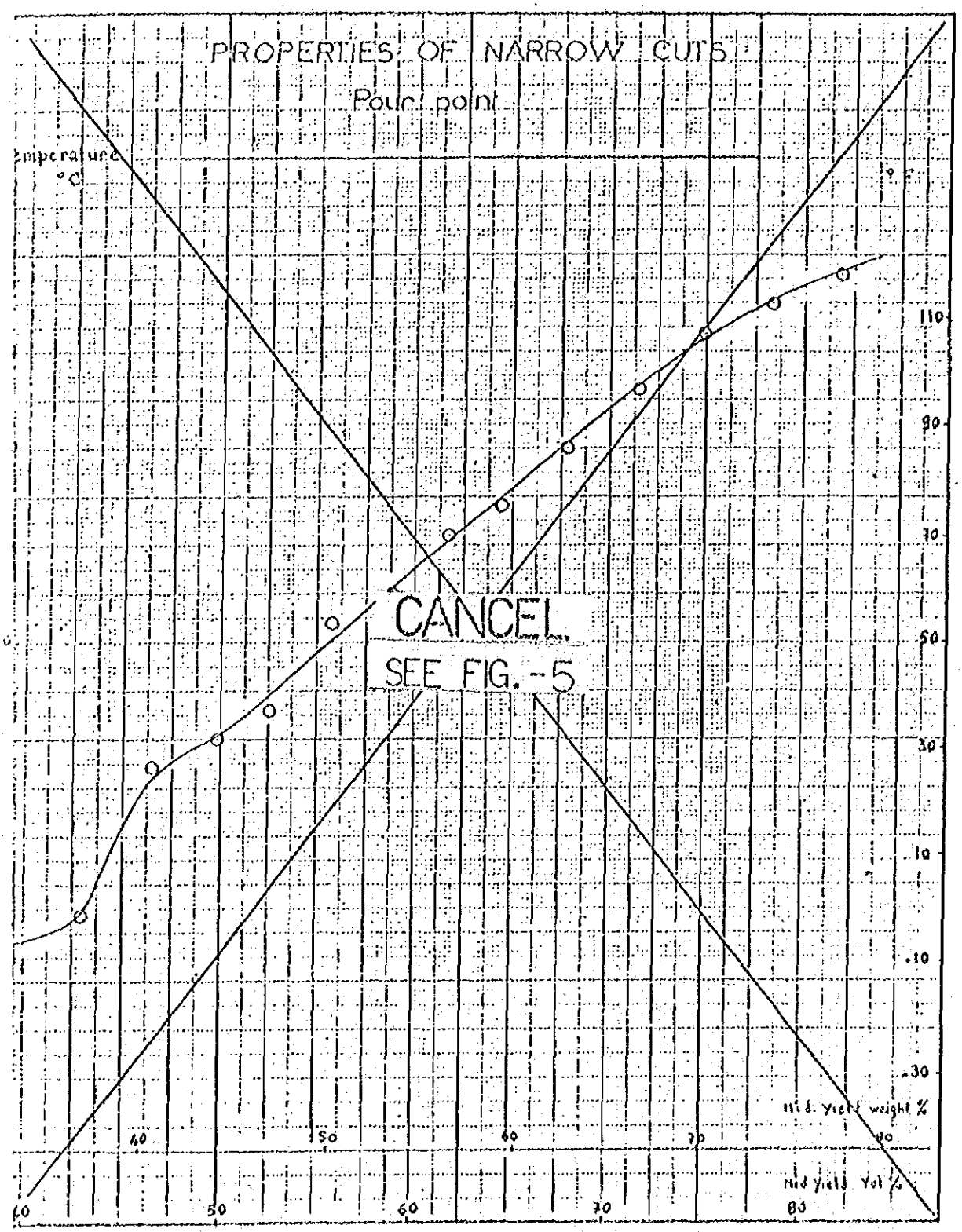
- Kinematic viscosity :

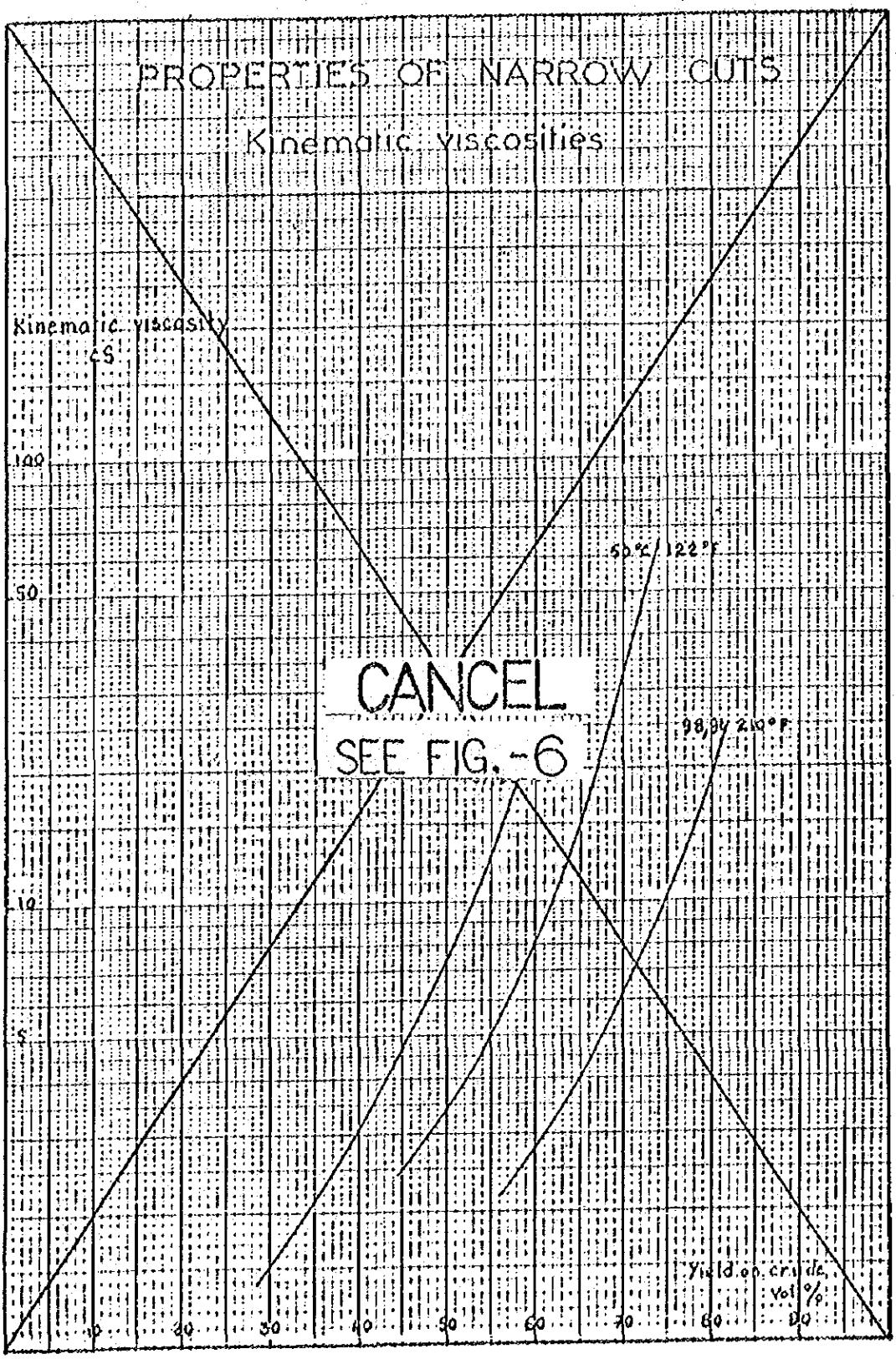
9 determinations are made at 20 °C, 9 at 50 °C and 7 at 98.9 °C (210 °F) according to the ASTM method D 445.

NARROW CUTS ANALYSIS

Temperature °C	Sulfur content weight %	Aniline point °C	Aromatics content % volume	Pour point °C	Kinematic viscosity (cS) 20 °C	50 °C	98.9 °C	Kuop	Refractive index at 20 °C
< 20								13.00	1.3560
20 - 40								12.70	1.3720
40 - 60	0.00014							12.70	1.3760
60 - 65								12.55	1.3803
65 - 70								12.10	1.3938
70 - 75								12.00	1.3976
75 - 80								12.10	1.3960
80 - 85	0.00013							12.20	1.3953
85 - 90								12.35	1.3970
90 - 95								12.30	1.3972
95 - 100	0.00011							11.70	1.4195
100 - 105								11.65	1.4230
105 - 110								12.00	1.4132
110 - 115	0.00058							12.25	1.4066
115 - 120								12.30	1.4060
120 - 125								12.30	1.4035
125 - 130	0.0022							11.75	1.4300
130 - 135								11.65	1.4350
135 - 140								11.90	1.4261
140 - 145		52.6						12.20	1.4175
145 - 150								12.20	1.4150
150 - 155	0.0117	52.8						11.85	1.4330
155 - 160								11.80	1.4380
160 - 165		48.5	24.0					11.85	1.4380
165 - 170								12.05	1.4370
170 - 175	0.0310	56.5	15.3					12.05	1.4330
175 - 180								11.90	1.4390
180 - 185	0.0550	56 6	19.8					11.95	1.4388
185 - 190								12.05	1.4360
190 - 195	0.0565	63.2	14.1					12.05	1.4380
195 - 200					1.56			11.95	1.4440
200 - 210	0.103	61.1	18.8					12.10	1.4407
210 - 220					1.92			12.05	1.4460
220 - 230	0.164	66.3	17.2					12.10	1.4470
230 - 240					2.40			12.10	1.4512
240 - 250	0.45	69.6	18.4	- 21				11.75	1.4690
250 - 260					3.35			11.90	1.4650
260 - 270	0.98	69.7	29.6	- 18				11.80	1.4710
270 - 280					4.50			11.95	1.4660
280 - 290	1.11	72.1	25.0	- 3				11.95	1.4688
290 - 300					6.35	3.06		12.05	1.4690
300 - 310	1.18	76.1	25.0	0				12.05	1.4700
310 - 320					8.54	3.82		11.90	1.4785
320 - 330	1.65	75.8	29.0	+ 3				11.95	1.4796
330 - 340					11.43	4.76		11.85	1.4872
340 - 350	2.06	75.1		+ 12	13.24			11.70	-
350 - 360						6.63		11.80	-
360 - 370	2.50	75.1		+ 15				11.95	-
370 - 380						8.29	2.82	11.90	-
380 - 390	1.99			+ 21				11.85	-
390 - 400						10.72	3.39		-
-	2.15			+ 24					-
-						17.00	4.58		-
-	2.24			+ 30					-
-						33.90	6.10		-
-	2.64			+ 36					-
-						53.09	9.00		-
-	2.64			+ 42					-
-							12.58		-
-	2.79			+ 45					-
-							19.80		-
-	3.27			+ 48					-
-									-
-	4.85								


PROPERTIES OF NARROW CUTS
Sulfur content weight %
total sulfur
4.0
3.0
2.0
1.0
0.5
0.1
0.05
CANCEL
SEE FIG. -4
10
20
30
40
50
60
70
80
90
yield on crude weight %


PROPERTIES OF NARROW CUTS
Pour point
Temperature °C
°F
110
90
70
50
30
10
-10
-30
CANCEL
SEE FIG. -5
Mid. Yield weight %
Mid Yield Vol %
40
50
60
70
80
90


PROPERTIES OF NARROW CUTS
Kinematic viscosities
Kinematic viscosity
cS
100
50
10
5
1
50°C / 122°F
98,89 210°F
CANCEL
SEE FIG.-6
Yield on crude
Vol %
10
20
30
40
50
60
70
80
90

TRUE BOILING POINT" DISTILLATIONS - WIDE CUTS

WIDE CUTS DISTILLATIONS

The crude oil is fractionated into cuts approximating commercial fractions with perforated plates Oldershaw column, two inches in diameter.

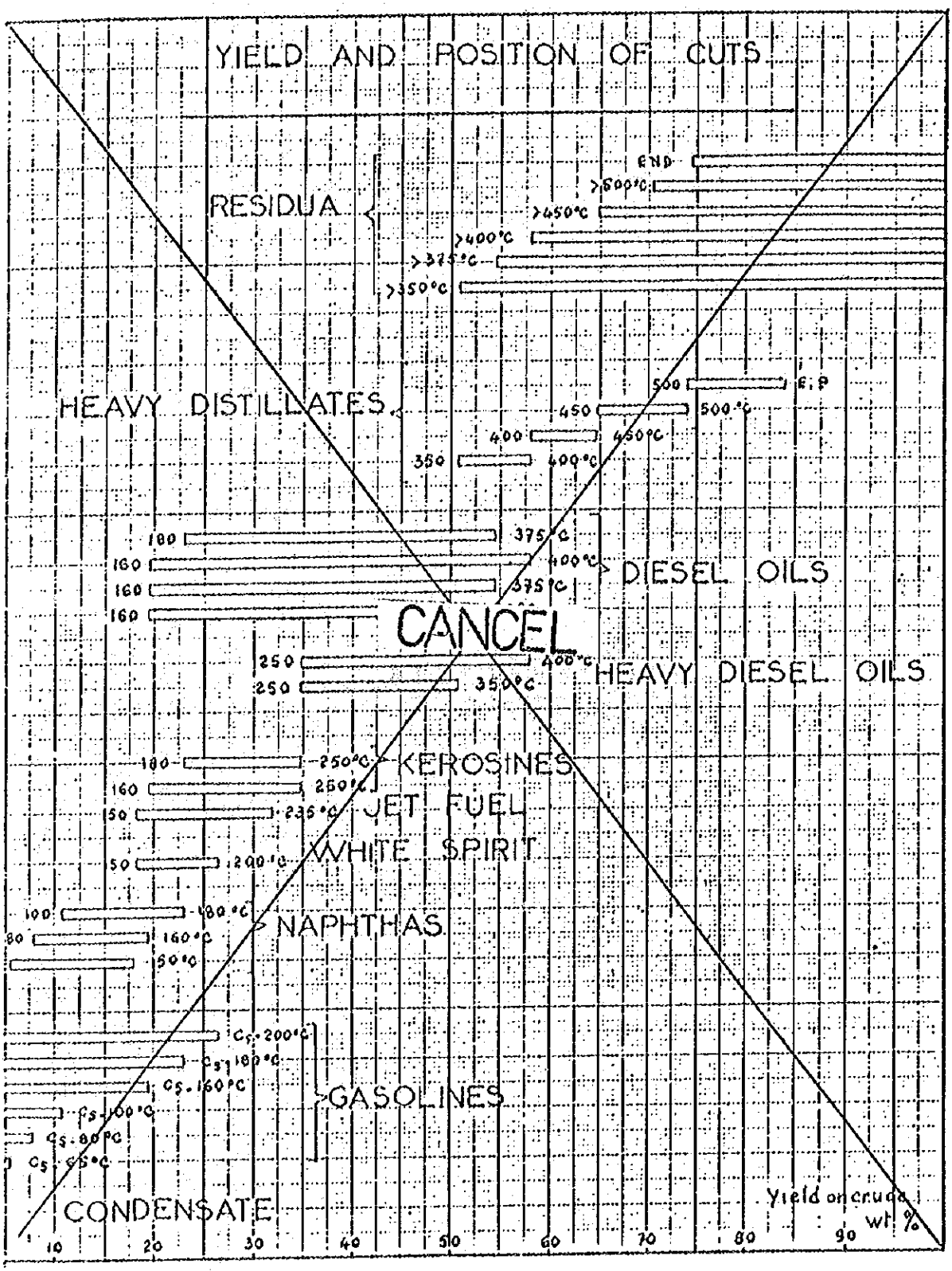
The distillations are performed so :

- Gasolines, naphthas and kerosines with thirty plates Oldershaw columns, 170 centimeters in lenght, at atmospheric pressure and with a 15/1 reflux ratio.
- Diesel oils with the same thirty plates column under an absolute pressure of 40 mm Hg and with a 10/1 reflux ratio.
- 350 - 400 °C heavy distillate with a thirty plates Oldershaw column, under 10 mm Hg and with a 5/1 reflux ratio.
- 400 - 450 °C heavy distillate with a ten plates Oldershaw column, 70 centimeters in lenght, under 1 mm Hg.
- 450 - 500 °C heavy distillate with an empty column 5 centimeters in diameter and 50 centimeters in lenght under 1 mm Hg.
- 500 °C.end point heavy distillate with an evaporation still under a pressure reduced to the lowest level possible.

Detailed analysis of the fractions and blends of fractions prepared in the described manner are shown in the following tables and figures.

BALANCE OF WIDE CUTS DISTILLATIONS

TBP cuts °C	Specific gravity 15/4	Weight %	Position on crude weight %	Volume %	Position on crude volume %	TBP cuts °F
Condensate	0.55	2.1	0 - 2.1	2.8	0 - 2.8	Condensate
Gasolines						Gasolines
C_5 - 65	0.640	3.4	2.1 - 5.5	4.5	2.8 - 7.3	C_5-149
C_5 - 80	0.657	5.6	2.1 - 7.7	7.2	2.8 - 10.0	C_5-176
C_5-100	0.674	8.7	2.1 - 10.8	11.0	2.8 - 13.8	C_5-212
C_5-160	0.711	17.5	2.1 - 19.6	20.9	2.8 - 23.7	C_5-320
C_5-180	0.721	21.1	2.1 - 23.2	24.9	2.8 - 27.7	C_5-356
C_5-200	0.729	24.2	2.1 - 26.3	28.3	2.8 - 31.1	C_5-392
Naphthas						Naphthas
65-150	0.724	12.3	5.5 - 17.8	14.5	7.3 - 21.8	149-302
80-160	0.737	11.9	7.7 - 19.6	13.7	10.0 - 2.37	176-320
100-180	0.758	12.4	10.8 - 23.2	13.9	13.8 - 27.7	212-356
White-spirit						White-spirit
150-200	0.777	8.5	17.8 - 26.3	9.3	21.8 - 31.1	302-392
Jet-Fuel						Jet-Fuel
150-235	0.783	14.0	17.8 - 31.8	15.3	21.8 - 37.1	302-455
Kerosines						Kerosines
160-250	0.792	15.2	19.6 - 34.8	16.8	23.7 - 40.1	320-482
180-250	0.797	11.6	23.2 - 34.8	12.4	27.7 - 40.1	356-482
Diesel-oils						Diesel-oils
160-350	0.817	31.2	19.6 - 50.8	32.6	23.7 - 56.3	320-662
160-375	0.825	35.0	19.6 - 54.6	36.2	23.7 - 59.9	320-707
160-400	0.830	38.6	19.6 - 58.2	39.7	23.7 - 63.4	320-752
180-375	0.831	31.4	23.2 - 54.6	32.2	27.7 - 59.9	356-707
Heavy Diesel-oils						Heavy Diesel-oils
250-350	0.845	16.0	34.8 - 50.8	16.2	40.1 - 56.3	482-662
250-400	0.858	23.4	34.8 - 58.2	23.3	40.1 - 63.4	482-752
Heavy distillates						Heavy distillates
350-400	0.885	7.4	50.8 - 58.2	7.1	56.3 - 63.4	662-752
400-450	0.913	6.5	58.2 - 64.7	6.1	63.4 - 69.5	752-842
450-500	0.924	5.7	64.7 - 70.4	5.3	69.5 - 74.8	842-932
500-End point	0.938	8.6	70.4 - 79.0	7.8	74.8 - 82.6	932-End point
Residua						Residua
> 350	0.960	49.2	50.8 - 100.0	43.7	56.9 - 100.0	> 662
> 375	0.966	45.4	54.6 - 100.0	40.1	59.9 - 100.0	> 707
> 400	0.975	41.8	58.2 - 100.0	36.6	63.4 - 100.0	> 752
> 450	0.985	35.3	64.7 - 100.0	30.5	69.5 - 100.0	> 842
> 500	0.998	29.6	70.4 - 100.0	25.2	74.8 - 100.0	> 932
End point	1.027	21.0	79.0 - 100.0	17.4	82.6 - 100.0	End point


YIELD AND POSITION OF CUTS
RESIDUA
END
>500°C
>450°C
>400°C
>375°C
>350°C
HEAVY DISTILLATES
500
E.P
450
500°C
400
450°C
350
400°C
180
375°C
160
400°C
DIESEL OILS
160
375°C
160
CANCEL
250
400°C
250
350°C
HEAVY DIESEL OILS
180
250°C
KEROSINES
160
250°C
150
235°C
JET FUEL
50
200°C
WHITE SPIRIT
100
180°C
80
160°C
NAPHTHAS
50°C
C5-200°C
C5-180°C
C5-160°C
GASOLINES
C5-100°C
C5-80°C
C5-C5°C
CONDENSATE
Yield on crude wt %
10
20
30
40
50
60
70
80
90

CUTS ANALYSIS

CONDENSATE

To obtain debutanized gasolines, the distillation column is put for two hours at total reflux before collecting the condensate. The column head is cooled by circulation of alcool at a temperature about - 40 °C.

Yields of condensates obtained by this way are 2.1 weight % on crude.

The condensates are analyzed by gas chromatography. The average of several distillations gives the composition shown below.

Specific gravity calculated from this composition is 0.550.

Composition	Weight %	Volume %
Ethane.....	1.9	2.9
Propane...	CANCEL	29.2
Isobutane.....	[illegible]	12.1
Normal butane.....	55.2	52.4
Isopentane.....	3.8	3.4

GASOLINES

CHARACTERISTICS

TBP cuts °C / °F	C_5- 65 / C_5-149	C_5- 80 / C_5-176	C_5-100 / C_5-212	C_5-160 / C_5-320	C_5-180 / C_5-356	C_5-200 / C_5-392
] on crude (wt %)	3.4	5.6	8.7	17.5	21.1	24.2
] on crude (vol. %)	4.5	7.2			24.9	28.3
ing range (wt %)	2.1-5.5	2.1- 7.7			2.1-23.2	2.1-26.3
ng range (vol. %)	2.8-7.3	2.8-10.0	2.8-13.8	2.8-23.7	2.8-27.7	2.8-31.1
fic gravity 15/4	0.640	0.65			0.721	0.729
gravity	89.6	83.8			64.7	62.5
ctive index at 20 °C	1.3665	1.3720	1.3801	1.4002	1.4050	1.4100
cterisation factor KUOP	12.95	12.75	12.60	12.30	12.20	12.10
Saybolt	> + 30	> + 30	> + 30	> + 30	> + 30	> + 30
vapor pressure at 100 °F (bar)	1.01	0.83	0.59	0.39	0.34	0.31
(psi)	14.7	12.0	8.5	5.6	4.9	4.5
r content (wt %)	0.00020	0.0		35	0.0073	0.0145
ptan sulfur content (wt %)	nil	nil	nil	nil	nil	nil
r test	negative	negative	negative	negative	positive	positive
ent gum content (mg/100 ml)	1	1	1	1	1	1
r strip corrosion urs at 50 °C)	1 a	1 a	1 a	2 b	2 d	2 c
gen sulfide content (wt %)	nil	nil	nil	nil	0.0003	0.0005
tics content (vol. %)	< 0.5	1.0	1.5	6.3	7.4	9.2
ne point (°C)	71.1	67.3	64.9	59.2	58.4	58.2
es content (vol. %)	2.5	1.1	0.9	0.5	-	-
rch octane number	72	66	59	46	45	42
4 cm^3/US gal. TEL.(0.3 ‰)	84	78	70	60	57	53
7 cm^3/US gal. TEL.(0.6 ‰)	89	83	78	68	65	62
octane number	70	64	57	47	45	42
4 cc/US gal. TEL.(0.3 ‰)	82	77*	71*	62	58	54
7 cc/US gal. TEL.(0.6 ‰)	87	84	78	70	67	62

CANCEL

SEE FIG. - 7

SEE FIG. - 9

se values are obtained graphically

CHROMATOGRAPHIC ANALYSIS OF C_5 - 65 °C GASOLINE

Hydrocarbons	Boiling* point °C	Specific gravity* 15/4 °C	Weight % on cut
Propane	- 42.07	0.508	0.15
Isobutane	- 11.73	0.563	0.24
Normal butane	- 0.50	0.584	1.98
Isopentane	27.85	0.624	20.76
Normal pentane	36.05	0.631	38.79
Cyclopentane	49.26	0.750	1.89
2-2 Dimethylbutane	49.74	0.654	0.49
2-3 Dimethylbutane	57.99	0.666	2.31
2 Methylpentane	60.27	0.658	14.71
3 Methylpentane	63.28	0.669	9.40
Normal hexane	68.74	0.664	8.13
Methylcyclopentane	71.81	0.753	0.61
Benzene	80.10	0.884	0.45
Cyclohexane	80.74	0.783	0.02
2-3 Dimethylpentane	89.78	0.699	0.01
2 Methylhexane	90.05	0.683	0.02
3 Methylhexane	91.85	0.691	0.01
Normal heptane	98.43	0.688	0.03

x From API Technical Data Book

CHROMATOGRAPHIC ANALYSIS

of C_5-80 °C and C_5-100 °C gasolines

Hydrocarbons	Boiling* point °C	Specific* gravity 15/4 °C	Weight % on C_5-80 °C cut	Weight % on C_5-100 °C cut
Isobutane	- 11.73	0.563	0.06	0.05
Normal butane	- 0.50	0.584	0.82	0.73
Isopentane	27.85	0.624	15.00	9.40
Normal pentane	36.05	0.631	25.60	16.39
Cyclopentane	49.26	0.750	1.42	0.84
2-2 Dimethylbutane	49.74	0.654	0.31	0.20
2-3 Dimethylbutane	57.98	0.666	1.89	1.38
2 Methylpentane	60.27	0.658	11.91	7.53
3 Methylpentane	63.28	0.669	9.94	6.41
Normal hexane	68.74	0.664	24.60	16.30
Methylcyclopentane	63.28	0.753	3.49	2.60
2-2 Dimethylpentane	79.20	0.678	0.77	0.60
Benzene	80.10	0.884	1.40	1.05
2-4 Dimethylpentane	80.50	0.677	0.36	0.57
Cyclohexane	80.74	0.783	1.30	2.49
2-2-3 Trimethylbutane	80.88	0.694	0.08	0.01
3-3 Dimethylpentane	86.06	0.697	0.17	0.09
1-1 Dimethylcyclopentane	87.85	0.759	0.04	0.58
2-3 Dimethylpentane	89.78	0.699	0.12	1.46
2 Methylhexane	90.05	0.683	0.32	4.45
1 cis 3 Dimethylcyclopentane	90.77	0.749	0.04	0.63
1 trans 3 Dimethylcyclopentane	91.73	0.753	0.02	0.82
3 Methylhexane	91.85	0.691	0.23	5.82
1 trans 2 Dimethylcyclopentane	91.87	0.756	0.02	0.75
3 Ethylpentane	93.48	0.702	0.04	1.17
Normal heptane	98.43	0.688	0.04	13.50
1 cis 2 Dimethylcyclopentane	99.53	0.777	-	0.15
Methylcyclohexane	100.93	0.773	0.01	2.62
Ethylcyclopentane	103.47	0.771	-	0.31
Toluene	110.63	0.871	-	0.99
Ethylbenzene	136.20	0.872	-	0.01
Σ Xylenes	138.36 at 144.43	0.865 at 0.884	-	0.10

* From API Technical Data Book

CHROMATOGRAPHIC ANALYSIS

of C_5-160 °C gasoline

HYDROCARBONS ARRANGED IN GROUPS OF THE SAME CARBON NUMBER

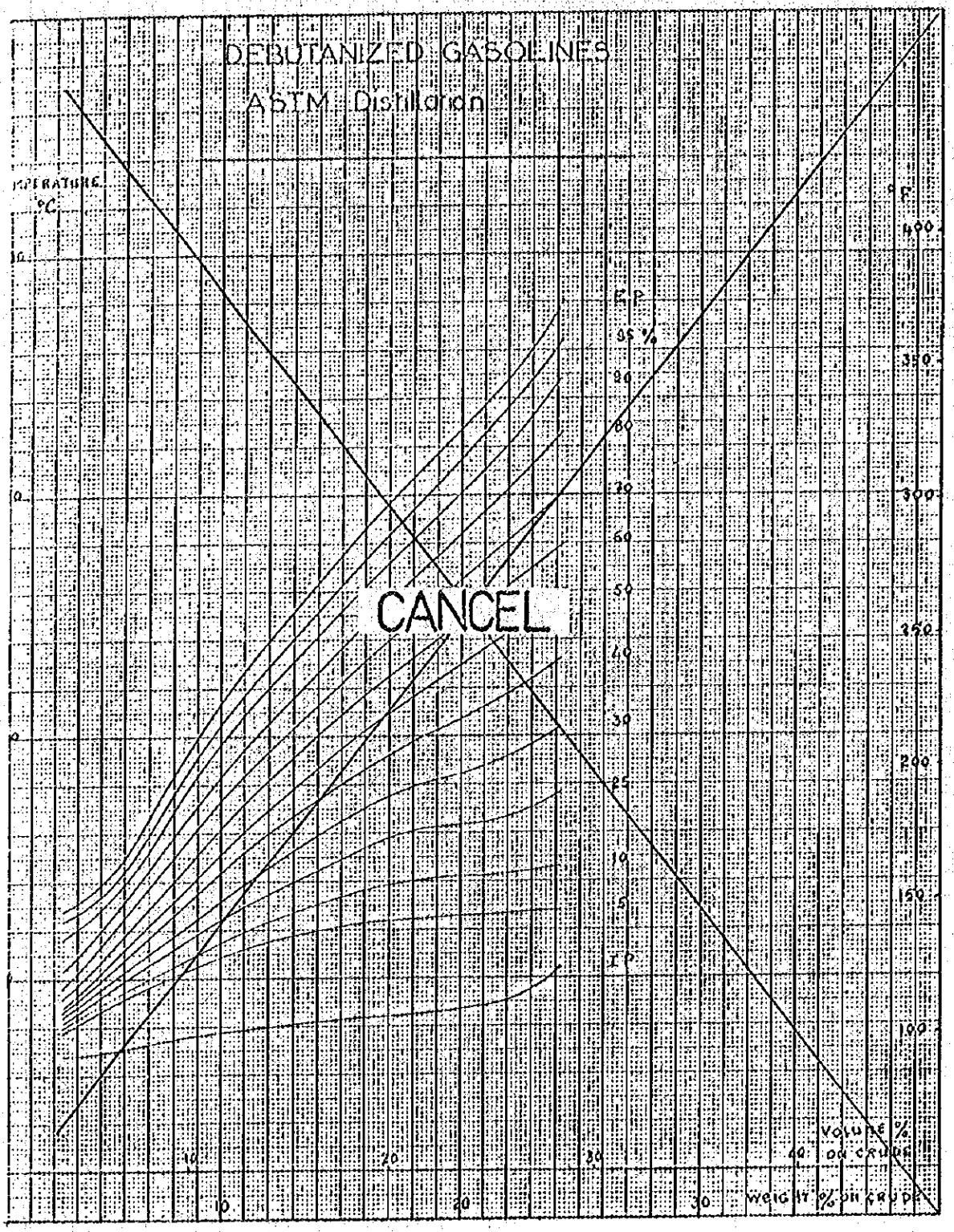
Carbon number	Hydrocarbons by groups	Weight % on cut
C_4	Normal butane	0.37
	Isobutane	0.03
C_5	Normal pentane	10.85
	Isopentane	5.80
	Cyclopentane	0.46
C_6	Normal hexane	8.07
	Isoparaffins	7.71
	Naphtènes	2.25
	Benzene	0.55
C_7	Normal heptane	7.57
	Isoparaffins	7.22
	Naphtenes	4.11
	Toluene	2.13
C_8	Normal octane	6.25
	Isoparaffins	7.66
	Naphtenes	4.02
	Aromatics	3.98
C_9	Normal nonane	5.40
	Isoparaffins	7.56
	Naphtenes	3.92
	Aromatics	1.36
C_{10}	Paraffins (Normal + iso)	1.17
	Naphtenes	1.56
	Aromatics	nil

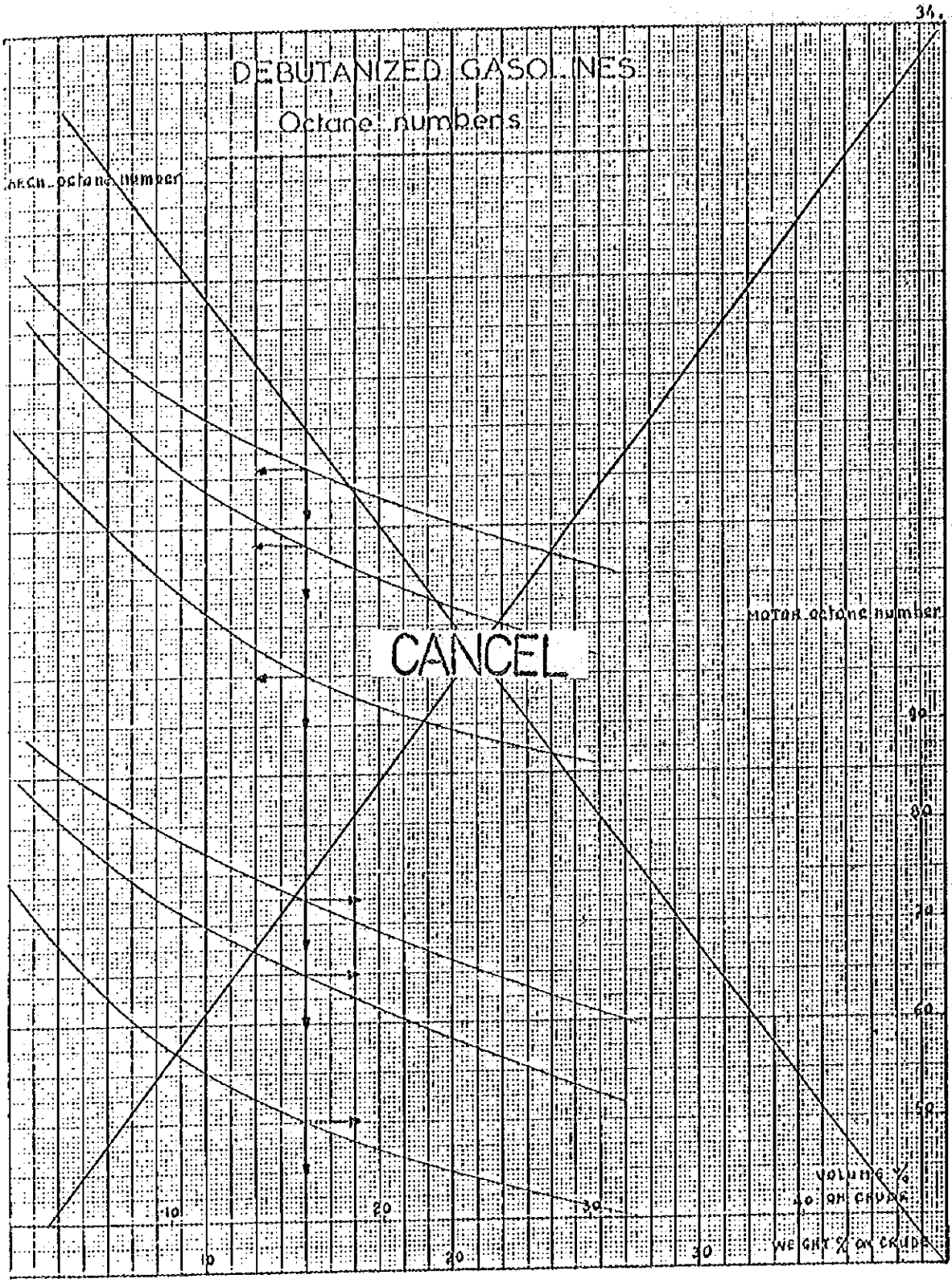
GASOLINES

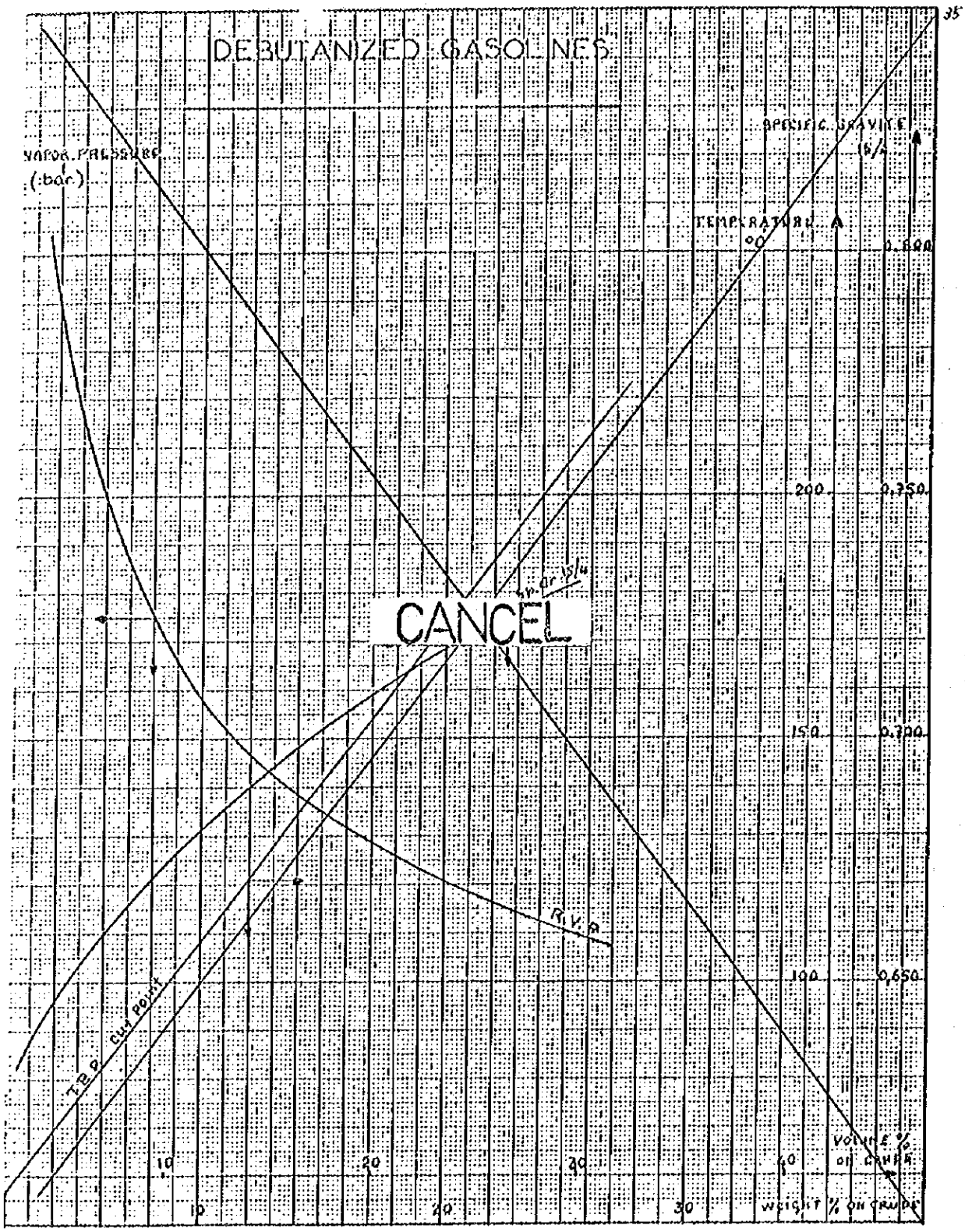
ASTM DISTILLATION

TBP cuts °C / °F	C_5- 65 C_5-149	C_5- 80 C_5-176	C_5-100 C_5-212	C_5-160 C_5-320	C_5-180 C_5-356	C_5-200 C_5-390
eld on crude (wt %)	3.4	5.6	8.7	17.5	21.1	24.2
eld on crude (vol. %)	4.5	7.2			24.9	28.3
tting range (wt %)	2.1- 5.5	2.1- 7.7			2.1-23.2	2.1-26.3
tting range (vol. %)	2.8- 7.3	2.8-10.0	2.8-13.8	2.8-23.7	2.8-27.7	2.8-31.1
ASTM DISTILLATION						
itial boiling point (°C)	34	35	38	43	44	52
5 vol. %	39	45	52	62	63	64
10 vol. %	40	46	54	70	71	73
20 vol. %	41	48	58	80	82	88
30 vol. %	42	50	61	89	94	102
40 vol. %	43	52	65	98	106	116
50 vol. %	44	54	69	107	117	129
60 vol. %	46	56	74	115	127	140
70 vol. %	48	59	79	123	136	151
80 vol. %	52	63	84	131	146	163
90 vol. %	58	67	91	139	156	174
95 vol. %	62	69	94	145	164	182
d point (°C)	64	72	98	152	168	190
covery (vol. %)	98	98.5	98.5	98.5	98.5	98.5
sidue (vol. %)	0	0	0.5	1.0	1.0	1.0
ss (vol. %)	2	1.5	1.0	0.5	0.5	0.5

CANCEL


DEBUTANIZED GASOLINES
ASTM Distillation
°C
°F
400
350
300
250
200
150
100
EP
95 %
90
80
70
60
50
40
30
25
10
5
IP
CANCEL
10
20
30
40
VOLUME % OR CRUDE
10
20
30
WEIGHT % OR CRUDE


DEBUTANIZED GASOLINES
Octane numbers
RESEARCH octane number
MOTOR octane number
CANCEL
10
20
30
40
50
60
70
80
90
10
20
30
VOLUME % OF CRUDE
WEIGHT % OF CRUDE


DEBUTANIZED GASOLINES
VAPOR PRESSURE (:bar)
SPECIFIC GRAVITY (g/l)
TEMPERATURE °C
0,800
200
0,750
150
0,700
100
0,650
R.V.P
TBP CUT POINT
10
20
30
40
VOLUME % OR WEIGHT % ON CRUDE
CANCEL

NAPHTHAS AND WHITE-SPIRIT

CHARACTERISTICS

TBP cuts	65-150 149-302	80-160 176-320	100-180 212-356	150-200 302-392
Yield on crude (wt %)	12.3	11.9	12.4	8.5
Yield on crude (vol. %)	14.5	[illegible]	[illegible]	9.3
Cutting range (wt %)	5.5-17.8	CANCEL		7.8-26.3
Cutting range (vol. %)	7.3-21.8	10.0-23.7	13.8-27.7	21.8-31.1
Specific gravity 15/4	0.724			1777
API gravity	63.9	SEE FIG.-7,8		1.5
Refractive index at 20 °C	1.4058	1.4128	1.4248	1.4350
Characterisation factor KUOP	12.15	12.15	12.05	11.90
Color Saybolt	> + 30	> + 30	> + 30	> + 30
Reid vapor pressure at 100 °F				
(bar)	0.160	0.093	-	-
(psi)	2.32	1.35	-	-
Sulfur content (wt %)	0.001	SEE FIG.-9,10		1.040
Hydrogen sulfide content (wt %)	-	0.00034	0.00065	0.0030
Mercaptan sulfur content (wt %)	nil	nil	nil	0.00025
Doctor test	negative	positive	positive	positive
Copper strip corrosion (3 hours at 50 °C)	1 a	2 b	2 d	3 b
Aniline point (°C)	56.6	56.8	55.5	57.2
Freezing point (°C)				< - 63
Flash point (°C)				46
Arsenic content (ppb)		< 5	< 5	
Lead content (ppb)		< 5	< 5	
Total acid number (mg KOH/g)	-	0.01	0.03	0.04
Research octane number				
Clear	43	38	32	20
+ 1.14 cm^3/US gal. TEL	55	50	45	33
+ 2.27 cm^3/US gal. TEL	65	60	54	45

CHROMATOGRAPHIC ANALYSIS

of naphtha 65 - 150 °C

HYDROCARBONS ARRANGED IN GROUPS OF THE SAME CARBON NUMBER

Carbon number	Hydrocarbons by groups	Weight % on cut
C_5	Normal paraffin (pentane)	0.36
	Isoparaffin (isopentane)	0.10
	Cycloparaffin (cyclopentane)	0.25
C_6	Normal paraffin (hexane)	9.69
	Isoparaffins	4.91
	Cycloparaffins	3.14
	Aromatic (benzene)	0.62
C_7	Normal paraffin (heptane)	11.50
	Isoparaffins	10.70
	Cycloparaffins	6.10
	Aromatic (toluene)	3.06
C_8	Normal paraffin (octane)	8.98
	Isoparaffins	11.34
	Cycloparaffins	6.84
	Aromatics (ethylbenzene + xylenes)	5.78
C_9	Normal paraffin (nonane)	4.05
	Isoparaffins	9.19
	Cycloparaffins	2.68
	Aromatics	0.00
C_{10}	Total hydrocarbons	0.51

CHROMATOGRAPHIC ANALYSIS

of naphtha 80 - 160 °C

HYDROCARBONS ARRANGED IN GROUPS OF THE SAME CARBON NUMBER

Carbon number	Hydrocarbons by groups	Weight % on cut
C_6	Normal paraffin (hexane)	0.61
	Isoparaffins	0.14
	Cycloparaffins	1.22
	Aromatic (benzene)	0.13
C_7	Normal paraffin (heptane)	11.71
	Isoparaffins	9.42
	Cycloparaffins	6.75
	Aromatic (toluene)	3.14
C_8	Normal paraffin (octane)	9.48
	Isoparaffins	11.09
	Cycloparaffins	6.44
	Aromatics (ethylbenzene + xylenes)	7.57
C_9	Normal paraffin (nonane)	8.91
	Isoparaffins	10.34
	Cycloparaffins	4.78
	Aromatics	2.06
C_{10}	Normal paraffin (décane)	0.23
	Isoparaffins	1.99
	Cycloparaffins	3.99
	Aromatics	-

NAPHTHAS AND WHITE-SPIRIT

ASTM DISTILLATION

TBP cuts °C / °F	65-150 149-302	80-160 176-320	100-180 212-356	150-200 302-392
Yield on crude (wt %).....	12.3	11.9	12.4	8.5
Yield on crude (vol. %).....	14.5	[illegible]	[illegible]	9.3
Cutting range (wt %).....	5.5-17.8	[illegible]	[illegible]	17.8-26.3
Cutting range (vol. %).....	7.8-21.8	10.0-23.7	13.8-27.7	21.8-31.1
ASTM DISTILLATION				
Initial boiling point (°C)...	77	95	119	154
5 vol. %.....	87	105	128	159
10 vol. %.....	91	107	130	161
20 vol. %.....	94	110	132	163
30 vol. %.....	98	112	134	165
40 vol. %.....	102	115	137	166
50 vol. %.....	107	119	140	168
60 vol. %.....	113	123	143	170
70 vol. %.....	118	128	148	172
80 vol. %.....	125	134	153	175
90 vol. %.....	131	140	158	180
95 vol. %.....	136	145	163	184
End point (°C).....	147	148	167	187
Recovery (vol. %).....	99	99	99	99
Residue (vol. %).....	1	1	1	1
Loss (vol. %).....	0	0	0	0

MASS SPECTROMETRY PONA ANALYSIS

Cuts °C / °F	65-150 / 149-302	80-160 / 176-320	100-180 / 212-356	150-200 / 302-392	65-200 / 149-392
Paraffins content (vol. %)...	73.98	71.68	67.17	67.90	70.00
Naphtenes content (vol. %)...	17.80	17.92	18.48	16.73	15.55
Aromatics content (vol. %)...	8.22	10.40	14.35	15.37	12.45

NORMAL PARAFFINS

Method applied = gas chromatography

Cuts °C / °F	100-180 / 212-356	200-260 / 392-500
N-Paraffins weight % on cut..	38.4	33.5
nC_7 - Weight % on cut.....	2.1	-
nC_8 - Weight % on cut.....	15.7	-
nC_9 - Weight % on cut.....	10.2	-
nC_{10} - Weight % on cut.....	10.4	-
nC_{11} - Weight % on cut.....	-	2.3
nC_{12} - Weight % on cut.....	-	10.8
nC_{13} - Weight % on cut.....	-	11.3
nC_{14} - Weight % on cut.....	-	7.9
nC_{15} - Weight % on cut.....	-	1.2

KEROSINES AND JET-FUEL

CHARACTERISTICS

TBP cuts °C / °F	150-235 / 302-455	160-250 / 320-482	180-250 / 356-482
Yield on crude (wt %)	14.0	15.2	11.6
Yield on crude (vol. %)	15.	CANCEL	12.4
Cutting range (wt %)	17.8-31.0	[illegible]	4.8
Cutting range (vol. %)	21.8-37.1	23.7-40.1	23.7-40.1
Specific gravity 15/4	0.	SEE FIG.-8	97
API gravity	49.		
Refractive index at 20 °C	1.4378	1.4430	1.4450
Characterisation factor KUOP	11.95	11.95	11.95
Color Saybolt	> + 30	+ 25	+ 24
Kinematic viscosity at - 17.8 °C (Cs)	3.13	3.93	4.67
Freezing point (°C)	- 59	- 50	- 45
Flash point (°C)	52	59	63
Aniline point (°C)	60.2	62.5	64.0
Aromatics content (vol. %)	15.6	17.3	17.6
Naphtalenes content (vol. %)	0.22	0.60	0.68
Smoke point (mm)	26	24	24
Luminometer number	53.8	"	"
Sulfur content (wt %)	0.	SEE FIG.-10	82
Doctor test	positive	positive	negative
Corrosion copper strip (3 hours at 50 °C)	1 b	1 a	1 a
(2 hours at 100 °C)	1 b	"	"
Total acid number (mg KOH/g)	0.04	0.03	0.03
Existent gum content (mg/100 ml)	"	3	"
Gross heating value (mth/kg)	11.110	11.060	11.045

KEROSINES AND JET-FUEL

MASS SPECTROMETRY PONA ANALYSIS

Cuts °C / °F	150-235 / 302-455	160-250 / 320-482	180-250 / 356-482
Paraffins content (vol. %)...	65.96	66.42	66.68
Naphtenes content (vol. %)...	19.37	19.06	19.84
Aromatics content (vol. %)...	14.66	14.52	13.48

KEROSINES AND JET-FUEL

ASTM DISTILLATION OF CUTS

TBP cuts °C	150-235	160-250	180-250
TBP cuts °F	302-455	320-482	356-482
Yield on crude (wt %)	14.0	15.2	11.5
Yield on crude (vol. %)	15		3
Cutting range (wt %)	17.8-31.8	19.6-34.8	25.2-34.8
Cutting range (vol. %)	21.8-37.1	23.7-40.1	23.7-40.1
ASTM DISTILLATION			
Initial boiling point (°C)	152	171	183
5 vol. %	167	182	195
10 vol. %	170	184	197
20 vol. %	174	186	199
30 vol. %	176	189	201
40 vol. %	180	193	204
50 vol. %	183	197	207
60 vol. %	188	203	210
70 vol. %	194	209	213
80 vol. %	200	215	218
90 vol. %	208	223	224
95 vol. %	213	228	229
End point (°C)	218	233	234
Recovery (vol. %)	98.3	99	99
Residue (vol. %)	1.4	1	1
Loss (vol. %)	0.3	0	0

DIESEL-OILS

CHARACTERISTICS

TBP cuts °C / °F	160-350 / 320-662	160-375 / 320-707	160-400 / 320-752	180-375 / 356-707
Yield on crude (wt %)	31.2	35.0	38.6	31.4
Yield on crude (vol. %)	32.6			32.2
Cutting range (wt %)	19.6-50.8			23.2-54.6
Cutting range (vol. %)	23.7-56.3	23.7-59.9	23.7-63.4	27.7-59.9
Specific gravity 15/4	0.81	SEE FIG.-12		0.831
API gravity	41.6			38.7
Refractive index at 20 °C	1.4564	1.4606	1.4622	1.4464
Characterisation factor KUOP	11.90	11.85	11.85	11.90
ASTM color	< 0.5	0.5	0.5	0.5
Kinematic viscosity				
at 20 °C (cS)	3.03	3.52	3.83	4.25
at 50 °C (cS)	1.75	1.95	2.08	2.27
Cloud point (°C)	- 19	- 14	- 9	- 11
Pour point (°C)	- 24	SEE FIG.-11		- 24
Flash point (°C)	77	81	82	93
Aniline point (°C)	68.2	SEE FIG.-11		70.3
Aromatic content (vol. %)	21	23	24	23
Sulfur content (wt %)	0.74	SEE FIG.-13		0.96
Corrosion copper strip (3 hours at 50 °C)	1 b	1 a	1 a	1 a
(2 hours at 100 °C)	2 a	1 a	1 a	1 b
Total acid number (mg KOH/g)	0.04	0.02	0.03	0.04
Conradson carbon residue on 10 % distillation residue (wt %)	0.04	0.06	0.09	0.04
Diesel index	64.4	62.0	60.9	61.3
Calculated cetane index	55.5	54.5	55.5	55.7

CANCEL

DIESEL-OILS

ASTM DISTILLATION

TBP cuts °C / °F	160-350 / 320-662	160-375 / 320-707	160-400 / 320-752	180-375 / 356-707
Yield on crude (wt %).....	31.2	35.0	38.6	31.4
Yield on crude (vol. %).....	32.6			32.2
Cutting range (wt %).....	19.6-50.8	19.6-54.5	19.6-58.2	23.2-54.6
Cutting range (vol. %).....	23.7-56.3	23.7-59.9	23.7-63.4	27.7-59.9
ASTM DISTILLATION				
Initial boiling point (°C)...	179	179	179	202
5 vol. %.....	190	190	193	213
10 vol. %.....	195	195	198	217
20 vol. %.....	203	204	206	225
30 vol. %.....	214	217	222	235
40 vol. %.....	229	233	242	248
50 vol. %.....	244	251	262	264
60 vol. %.....	259	269	282	279
70 vol. %.....	273	286	304	293
80 vol. %.....	288	303	322	310
90 vol. %.....	303	323	345	327
95 vol. %.....	311	330	354	332
End point (°C).....	316	335	358	336
Recovery (vol. %).....	98.5	98.5	98.5	98.5
Residue (vol. %).....	1.5	1.5	1.5	1.5
Loss (vol. %).....	0	0	0	0

HEAVY DIESEL-OILS

CHARACTERISTICS

TBP cuts °C / °F	250-350 / 482-662	250-400 / 482-752
Yield on crude (wt %)	16.0	23.4
Yield on crude (vol. %)	CANCEL	
Cutting range (wt %)	34.0-40.0	34.0-58.2
Cutting range (vol. %)	40.1-56.3	40.1-63.4
Specific gravity 15/4	SEE FIG.-12	
API gravity		
Refractive index at 20 °C	1.4733	1.4788
Characterisation factor KUOP	11.95	11.90
ASTM color	2	2
Kinematic viscosity		
at 20 °C (cS)	6.78	9.82
at 50 °C (cS)	3.21	4.24
Cloud point (°C)	- 5	+ 7
Pour point (°C)	SEE FIG.-11	
Flash point (°C)	136	140
Aniline point (°C)	SEE FIG.-11	
Aromatics content (vol. %)	26.1	29.1
Wax content (wt %)	< 1	2.3
Wax melting point (°C)	-	47
Sulfur content (wt %)	SEE FIG.-13	
Corrosion copper strip (3 hours at 50 °C)	1 a	1 a
(2 hours at 100 °C)	1 b	1 a
Total acid number (mg KOH/g)	0.05	0.04
Conradson carbon residue on 10 % distillation residue (wt %)	0.06	0.07
Diesel index	59.2	55.8
Calculated cetane index	57.0	56.0

HEAVY DIESEL-OILS

ASTM DISTILLATION

TBP cuts °C / °F	250-350 / 482-662	250-400 / 482-752
Yield on crude (wt %)	16.0	23.4
Yield on crude (vol. %)		
Cutting range (wt %)	34.8-50.0	
Cutting range (vol. %)	40.1-56.3	40.1-63.4
ASTM DISTILLATION		
Initial boiling point (°C)	248	266
5 vol. %	273	278
10 vol. %	276	281
20 vol. %	280	287
30 vol. %	282	293
40 vol. %	285	299
50 vol. %	290	307
60 vol. %	295	317
70 vol. %	301	329
80 vol. %	308	340
90 vol. %	316	354
95 vol. %	322	363
End point (°C)	325	370
Recovery (vol. %)	99	99
Residue (vol. %)	1	1
Loss (vol. %)	0	0

CANCEL

HEAVY DISTILLATES

CHARACTERISTICS

TBP cuts °C / °F	350-400 / 662-752	400-450 / 752-842	450-500 / 842-932	500-End point / 932-End point	Cracking feed 350 °C-End point / 662 °F-End point
Yield on crude (wt %)	7.4	6.5	5.7	8.6	28.2
Yield on crude (vol. %)	7.1	6.1	5.		26.3
Cutting range (wt %)	50.8-58.2	58.2-64.7	64.7-70..	CANCEL	50.8-79.0
Cutting range (vol. %)	56.3-63.4	63.4-69.5	69.5-74.8	74.8-82.6	56.3-82.6
Specific gravity 15/4	0.885	0.913	0.924	0.938	0.915
API gravity	28.3	23.4	21.6	19.3	23.1
Kinematic viscosity					
at 37.8 °C (cS)	12.94	29.8	-	-	
at 50 °C (cS)	8.77	18.35	48.2	100	
at 98.9 °C (cS)	2.95	4.77	9.04	14.72	
Viscosity index V.I.	83	81	-	-	
Pour point (°C)	+ 18	+ 27	+ 39	+ 45	
Sulfur content (wt %)	2.16	2.35	2.44	2.83	2.48
Conradson carbon residue (wt %)	0.01	0.02	0.08	0.35	
Nitrogen content (wt %)	0.052	0.075	0.095	0.125	0.088
Vanadium content (mg/kg)					< 0.5
Nickel content (mg/kg)					< 0.5

HEAVY DISTILLATES DEWAXING

Dewaxing is achieved on 200 g samples of distillates with 400 % volume of methylisobutylketone.

Oil and solvent are cooled slowly to - 20 °C (with a decreasing rate of 1 °C/minute). The waxes are separated by filtration in a thermostated Büchner funnel. The paraffins obtained are solubilized in warm methylisobutylketone with the same ratio solvent, crystallised and filtered at - 20 °C.

The filtrates are cleansed of solvent, then weighed in order to determine the yield of the operation.

Final waxes are also collected on the filter, stripped on a sand bath with nitrogen stream, and weighed. The melting point is determined according to the ASTM method D 87.

The weight balances of dewaxing and characteristics of dewaxed oils are shown in the following tables.

HEAVY DISTILLATES DEWAXING

TBP cuts °C / °F	350-400 / 662-752	400-450 / 752-842	450-500 / 842-932	500-End point / 932-End point
Dewaxed oil wt % on crude....	6.5	5,8	5,1	7,8
Dewaxed oil wt % on cut.....	88.0	90.0	90.0	90.3
Wax wt % on cut.....	10.6	CANCEL		9.5
Loss wt % on cut.....	1.4	1.1	0	0.2
Wax melting point (°C).....	43	52	59	61

DEWAXED HEAVY DISTILLATES

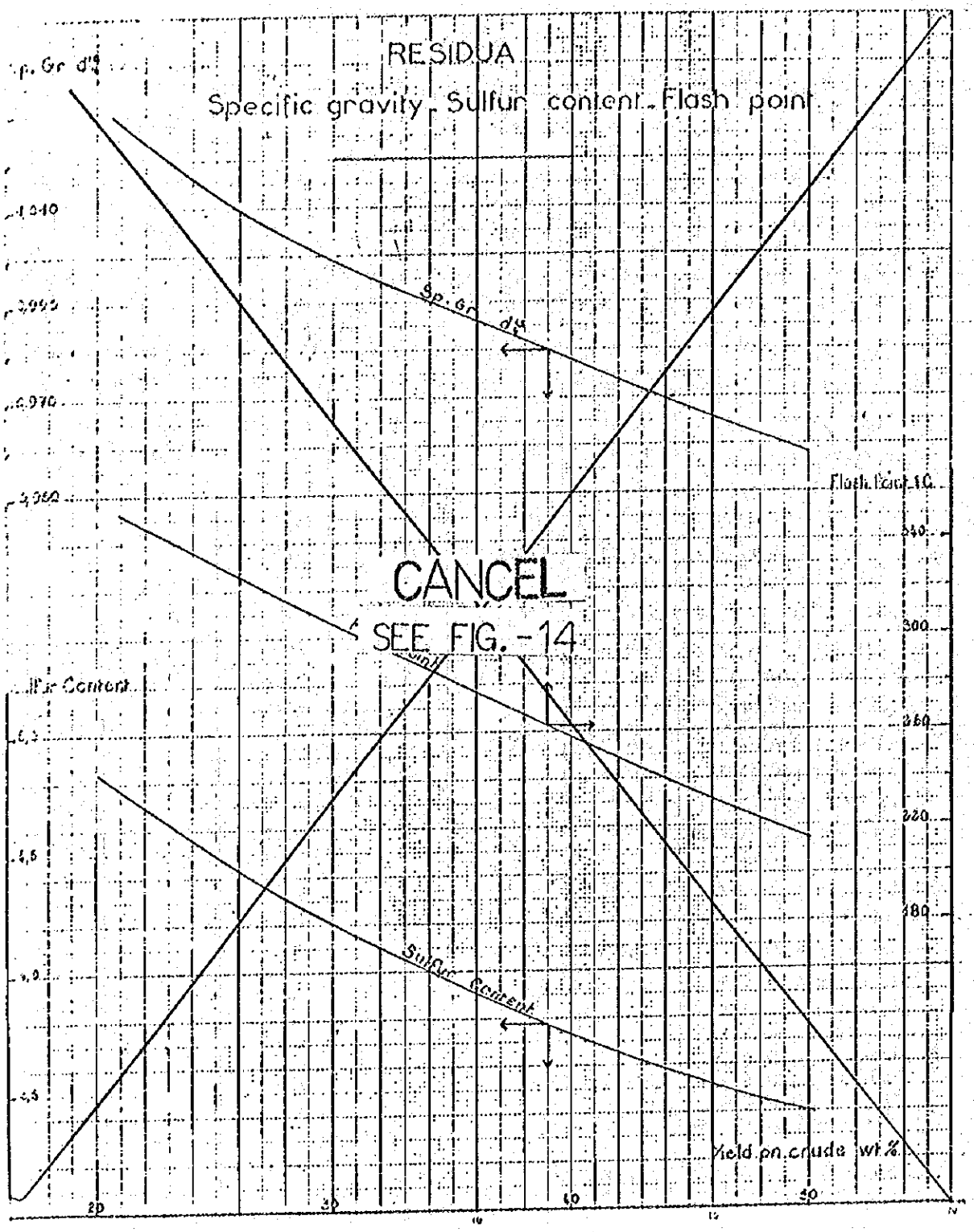
TBP cuts °C / °F	350-400 / 662-752	400-450 / 752-842	450-500 / 842-932	500-End point / 932-End point
Specific gravity 15/4.....	0.895	0.920	0.935	0.947
API gravity.....	26.5	22.2	19.8	17.8
Kinematic viscosity				
at 37.8 °C (cS).....	15.21	39.8	124	308
at 50 °C (cS).....	10.03	23.1	63.4	142
at 98.9 °C (cS).....	3.14	5.38	10.34	17.38
Viscosity index V.I.....	63	64	61	53
Pour point (°C).....	- 27	- 18	- 15	- 15
Sulfur content (wt %).....	2.45	2.65	2.75	3.01
Conradson carbon residue (wt %).....	0.04	0.10	0.30	1.50

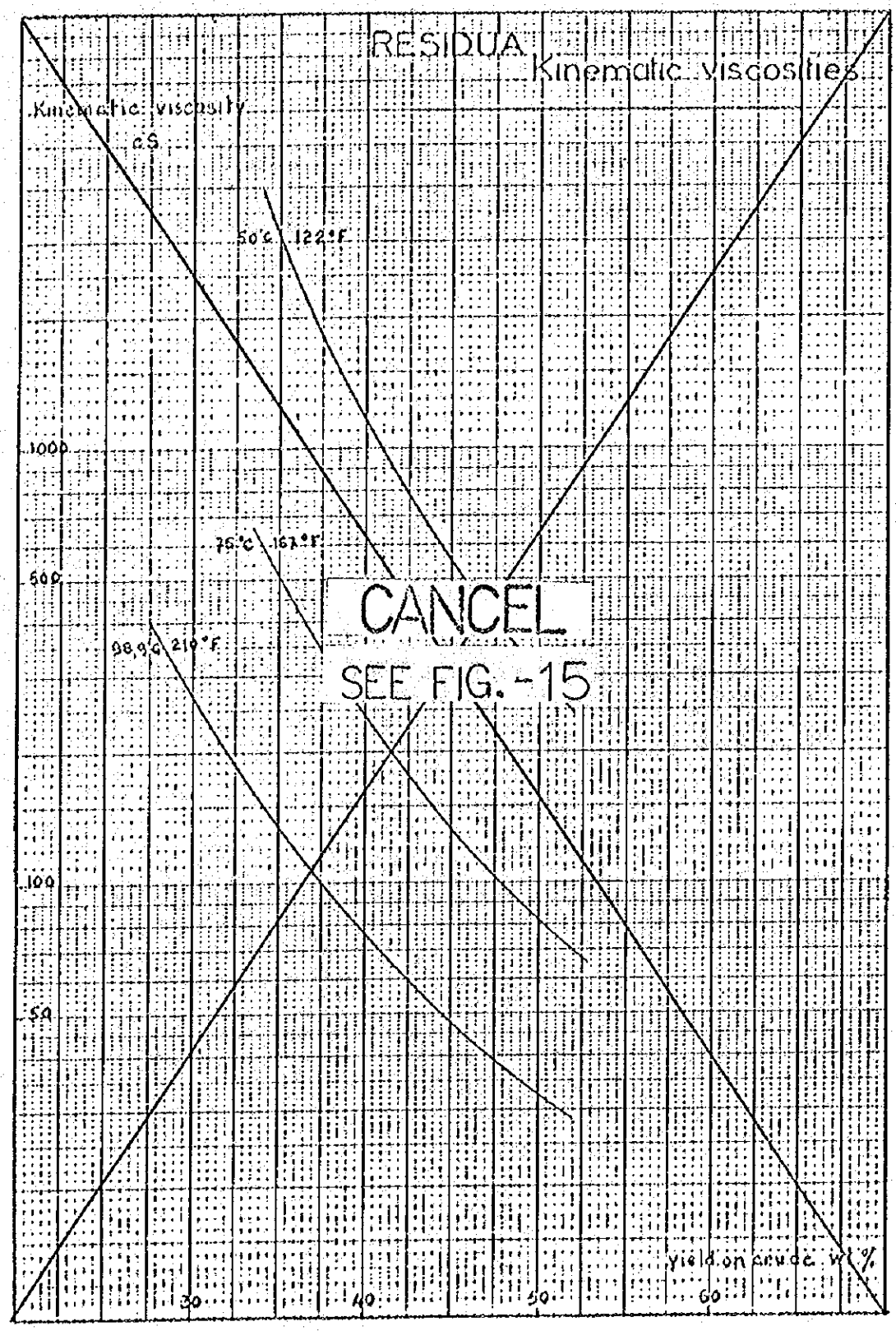
RESIDUA

CHARACTERISTICS

Residue after °C / °F	350 / 662	375 / 707	400 / 752	450 / 842	500 / 932	End point
;ld on crude (wt %)	49.2	45.4	41.8	35.3	29.6	21.0
;ld on crude (vol. %) ..	43.7	40.1	[illegible]	[illegible]	25.2	17.4
lling range (wt %)	50.8-100.0	54.6-100.0	[illegible]	[illegible]	70.4-100.0	79.0-100.0
;ling range (vol. %) ...	56.3-100.0	59.9-100.0	63.4-100.0	69.5-100.0	74.8-100.0	82.6-100.0
;ecific gravity 15/4	0.960	0.966	0.975	0.985	0.998	1.027
I gravity	15.8	14.9	13.5	12.1	10.2	6.2
;matic viscosity						
at 50 °C (Cst)	307	526	875	2877	-	
at 75 °C (Cst)	84.2	126.4	191	476	-	
at 98.9 °C (Cst)	33.2	45.2	63.4	136.2	279.0	
;r point (°C)	15	18	12	18	27	33
;sh point (°C)	216	238	254	285	307	350
;lfur content (wt %)	3.42	3.55	3.65	3.92	4.20	4.77
;rogen content (wt %) ..	0.25	-	-	-	-	-
; content (wt %)	5.2					
; melting point (°C) ...	53					
;tration (mm)						116
;ening point (R and B) ;)					18.5	43.2
;halt content (wt %) ...	2.70					
liments content (wt %).	nil					
; content (wt %)	0.018					
;adson carbon residue ; %)	10.2	11.2	-	15.1	-	23.0
;vy metals content :						
Iron (mg/kg) ...	3					
Vanadium (mg/kg) ...	50					
Nickel (mg/kg) ...	12					
lium content (mg/kg) ...	0.5					
;ss heating value ;h/kg)	10,235					

CANCEL


RESIDUA
Specific gravity - Sulfur content - Flash point
Sp. Gr d 15
Sp. Gr d 15
Flash (oc) °C
CANCEL
SEE FIG. -14
Sulfur Content
Sulfur Content
Yield on crude wt %



CANCEL

SEE FIG. -15

TEST METHODS APPLIED

TEST METHODS APPLIED

Determinations	Methods
I. - CRUDE OIL	
Specific gravity	IP 190
API gravity	ASTM - IP - Tables
Kinematic viscosity	NF T 60-100 - ASTM D 445
Pour point	NF T 60-105 - ASTM D 97
Flash point	NF M 07-011 - IP 170
Reid vapor pressure	NF M 07-007 - ASTM D 323
Water by distillation	NF T 60-113 - ASTM D 95
B.S. and W (centrifuge)	NF M 07-020 - ASTM D 96
Sulfur content	NF T 60-108 - ASTM D 1551
Mercaptan sulfur content	NF M 07-022 - ASTM D 1323
Hydrogen sulfide content	UOP 163 - IP 103
Chlorides content (as NaCl)	NF M 07-023 - IP 77
Total salinity	
Conradson carbon residue	NF T 60-116 - ASTM D 189
Wax content	Alcool-Ether (50/50) mixture
Asphalt content	NF T 60-115 - IP 143
Total acid number	ASTM D 664
Strong acid number	ASTM D 664
Ash content	ASTM D 482
Calculated cetane index	ASTM D 976
Gross heating value	NF M 03-005 - ASTM D 240
Characterisation factor KUOP	UOP 375
Light hydrocarbons	Gas chromatography
Metals content	Atomic absorption

Determinations	Methods
II. - GASOLINES - NAPHTHAS - WHITE-SPIRIT	
Specific gravity	IP 190
API gravity	ASTM - IP - Tables
Characterisation factor KUOP	UOP 375
Color Saybolt	NF M 07-003 - ASTM D 156
Reid vapor pressure	NF M 07-007 - ASTM D 323
Sulfur content	UOP 727-72 - ASTM D 1266
Mercaptan sulfur content	NF M 07-022 - ASTM D 1323
Doctor test	NF M 07-029 - IP 30
Hydrogen sulfide content	UOP 163 - IP 103
Existent gum content	NF M 07-004 - ASTM D 381
Corrosion copper strip	NF M 07-015 - ASTM D 130
Aniline point	NF M 07-021 - ASTM D 611
Aromatics content	NF M 07-024 - ASTM D 1319
Butanes content	Gas chromatography
Research octane number	NF M 07-026 - ASTM D 908
Motor octane number	NF M 07-026 - ASTM D 357
Freezing point	ASTM D 1477
Flash point	NF M 07-011 - IP 170
Arsenic content	Neutron activation
Lead content	Atomic absorption
Total acid number	NF T 60-112 - ASTM D 974
PONA analysis	I.F.P. method Mass spectrometer
Normal paraffins content	Gas chromatography
Distillation	NF M 07-002 - ASTM D 86

Determinations	Methods
III. - KEROSINES AND JET-FUEL	
Specific gravity	IP 190
API gravity	ASTM - IP - Tables
Color Saybolt	NF M 07-003 - ASTM D 156
Characterisation factor KUOP	UOP 375
Kinematic viscosity at - 17.8 °C	ASTM D 445
Freezing point	ASTM D 1477
Flash point	NF M 07-019 - ASTM D 93
Aniline point	NF M 07-021 - ASTM D 611
Aromatics content	NF M 07-024 - ASTM D 1319
Smoke point	NF M 07-028 - ASTM D 1322
Luminometer number	ASTM D 1740
Sulfur content	UOP 727-72 - ASTM D 1266
Doctor test	NF M 07-029 - IP 30
Corrosion copper strip	NF M 07-015 - ASTM D 130
Total acid number	NF T 60-112 - ASTM D 974
Existent gum content	NF M 07-004 - ASTM D 381
Gross heating value	NF M 03-005 - ASTM D 240
Distillation	NF M 07-002 - ASTM D 86

Determinations	Methods
IV. - DIESEL OILS	
Specific gravity	IP 190
API gravity	ASTM - IP - Tables
Characterisation factor KUOP	UOP 375
ASTM Color	NF T 60-104 - ASTM D 1500
Kinematic viscosity	NF T 60-100 - ASTM D 445
Cloud point	NF T 60-105 - ASTM D 97
Pour point	NF T 60-105 - ASTM D 97
Flash point	NF M 07-019 - ASTM D 93
Aniline point	NF M 07-021 - ASTM D 611
Aromatics content	NF M 07-016 - ASTM D 1019
Sulfur content	NF T 60-108 - ASTM D 1551
Corrosion copper strip	NF M 07-015 - ASTM D 130
Total acid number	NF T 60-112 - ASTM D 974
Conradson carbon residue	NF T 60-116 - ASTM D 189
Diesel index	IP 21
Calculated cetane index	ASTM D 976
Wax content	Alcool-Ether (50/50) mixture
Distillation	NF M 07-002 - ASTM D 86

Determinations	Methods
V. - HEAVY DISTILLATES - CRACKING FEED	
Specific gravity.....	IP 190
API gravity.....	ASTM - IP - Tables
Kinematic viscosity.....	NF T 60-100 - ASTM D 445
Viscosity index.....	ASTM D 567
Pour point.....	NF T 60-105 - ASTM D 97
Sulfur content.....	NF T 60-108 - ASTM D 1551
Conradson carbon residue.....	NF T 60-116 - ASTM D 189
Nitrogen content.....	UOP 120
Vanadium and nickel content.....	Atomic absorption

Determinations	Methods
VI. - RESIDUA	
Specific gravity.....	IP 190
API gravity.....	ASTM - IP - Tables
Kinematic viscosity.....	NF T 60-100 - ASTM D 445
Pour point.....	NF T 60-105 - ASTM D 97
Flash point.....	NF M 07-019 - ASTM D 93 (PM)
Sulfur content.....	NF T 60-108 - ASTM D 1551
Wax content.....	Alcool-Ether (50/50) mixture
Melting point of wax.....	NF T 60-114 - ASTM D 87
Penetration.....	NF T 66-004 - ASTM D 5
Softening point.....	NF T 66-008 - ASTM D 36
Asphalt content.....	NF T 60-115 - IP 143
Sediments content.....	NF M 07-010 - ASTM D 473
Ash content.....	NF T 60-111 - ASTM D 482
Conradson carbon residue.....	NF T 60-116 - ASTM D 189
Heavy metals content.....	Atomic absorption
Sodium content.....	Atomic absorption
Gross heating value.....	NF M 03-005 - ASTM D 240

APPENDIX II

MODIFIED TABLE/FIGURE FOR NORTH RUMAILA CRUDE OIL ASSAY

CRUDE OIL GENERAL CHARACTERISTICS

Characteristics	Results
Specific gravity 15/4 °C	~~0.853~~ 0.868
Specific gravity 20/4 °C	~~0.850~~ 0,805
API gravity	~~34.3~~ 31.5
Kinematic viscosity	
at 20 °C (cS)	9.72
at 37.8 °C (cS)	6,04
Pour point (°C)	- 42
Flash point (°C)	< 20
Reid vapor pressure at 37.8 °C (bar)	0.515
Reid vapor pressure at 37.8 °C (psi)	7.5
Water by distillation (vol. %)	< 0.10
B.S. and W (centrifuge) (vol. %)	< 0.10
Total sulfur (wt %)	~~1.92~~ 2.19
Mercaptan sulfur (wt %)	< 0.001
Hydrogen sulfide (wt %)	nil
Salt content (NaCl) (wt %)	< 0.0020
Total salinity (wt %)	0.0020
Nitrogen (wt %)	0.12
Conradson Carbon residue (wt %)	5,0
Wax content (wt %)	3.7
Melting point of waxes (°C)	53
Asphalt content (wt %)	0.98
Total acid number (mg KOH/g)	0.03
Strong acid number (mg KOH/g)	nil
Ash content (wt %)	0.008
Calculated cetane index	57
Lower heating value (mth/kg)	10.004
Gross heating value (mth/kg)	10.690
Characterisation factor KUOP	11.75

TABLE-2

METALS CONTENT

Methods applied = atomic absorption

Element	Content (mg/kg)
Sodium	HOLD
Potassium	
Calcium	
Magnesium	
Manganese	
Copper	
Chromium	
Nickel	
Vanadium	
Lead	
Iron	

TABLE-3

LIGHT HYDROCARBONS ANALYSIS ON CRUDE

Hydrocarbons	Weight %	Volume %
Ethane	0.03	0.08
Propane	0.33	0.57
Isobutane	0.19	0.29
Normal butane	1.05	1.56
Isopentane	0.76	1.06
Normal pentane	1.34	1.84

TABLE-4

TBP DISTILLATION - NARROW CUT

Cut	Temperature Range (°C)	wt%	Cumulated wt%	Sp.Gr. (15/4)	°API	vol%	Cumulated vol%
Cond.	> 20	1.60	1.60	0.557	122.3	2.5	2.5
1	20 - 40	1.52	3.12	0.627	94.0	2.1	4.6
2	40 - 60	0.83	3.95	0.658	83.3	1.1	5.7
3	60 - 65	0.69	4.64	0.665	81.1	0.9	6.6
4	65 - 70	1.01	5.65	0.676	77.6	1.3	7.9
5	70 - 75	0.24	5.89	0.704	69.3	0.3	8.2
6	75 - 80	0.25	6.14	0.714	66.5	0.3	8.5
7	80 - 85	0.16	6.30	0.713	66.8	0.2	8.7
8	85 - 90	0.33	6.63	0.709	67.9	0.4	9.1
9	90 - 95	0.65	7.28	0.705	69.0	0.8	9.9
10	95 - 100	1.23	8.51	0.709	67.9	1.5	11.4
11	100 - 105	0.52	9.03	0.751	56.7	0.6	12.0
12	105 - 110	0.17	9.20	0.756	55.5	0.2	12.2
13	110 - 115	0.43	9.63	0.738	60.0	0.5	12.7
14	115 - 120	0.67	10.30	0.726	63.2	0.8	13.5
15	120 - 125	0.84	11.14	0.725	63.5	1.0	14.5
16	125 - 130	0.67	11.81	0.730	62.1	0.8	15.3
17	130 - 135	0.62	12.43	0.766	53.0	0.7	16.0
18	135 - 140	0.71	13.14	0.775	50.9	0.8	16.8
19	140 - 145	0.70	13.84	0.761	54.3	0.8	17.6
20	145 - 150	0.69	14.53	0.746	58.0	0.8	18.4
21	150 - 155	0.52	15.05	0.749	57.2	0.6	19.0

TABLE-4 (Continued)

Cut	Temperature Range (°C)	wt%	Cumulated wt%	Sp.Gr. (15/4)	°API	vol%	Cumulated vol%
22	155 - 160	0.62	15.67	0.773	51.4	0.7	19.7
23	160 - 165	0.72	16.39	0.781	49.5	0.8	20.5
24	165 - 170	0.72	17.11	0.782	49.3	0.8	21.3
25	170 - 175	0.62	17.73	0.772	51.6	0.7	22.0
26	175 - 180	0.62	18.35	0.774	51.1	0.7	22.7
27	180 - 185	0.72	19.07	0.785	48.6	0.8	23.5
28	185 - 190	0.72	19.79	0.786	48.4	0.8	24.3
29	190 - 195	0.63	20.42	0.781	49.5	0.7	25.0
30	195 - 200	0.72	21.14	0.785	48.6	0.8	25.8
31	200 - 210	1.19	22.33	0.796	46.1	1.3	27.1
32	210 - 220	1.37	23.70	0.791	47.2	1.5	28.6
33	220 - 230	1.20	24.90	0.801	45.0	1.3	29.9
34	230 - 240	1.48	26.38	0.802	44.8	1.6	31.5
35	240 - 250	1.40	27.78	0.808	43.5	1.5	33.0
36	250 - 260	1.35	29.13	0.838	37.2	1.4	34.4
37	260 - 270	1.25	30.38	0.832	38.4	1.3	35.7
38	270 - 280	1.46	31.84	0.842	36.4	1.5	37.2
39	280 - 290	1.35	33.19	0.837	37.4	1.4	38.6
40	290 - 300	1.46	34.65	0.842	36.4	1.5	40.1
41	300 - 310	1.46	36.11	0.842	36.4	1.5	41.6
42	310 - 320	1.27	37.38	0.845	35.8	1.3	42.9
43	320 - 330	1.19	38.57	0.859	33.1	1.2	44.1
44	330 - 340	1.19	39.76	0.861	32.7	1.2	45.3
45	340 - 350	1.31	41.07	0.873	30.4	1.3	46.6

TABLE-4 (Continued)

Cut	Temperature Range (°C)	wt%	Cumulated wt%	Sp.Gr. (15/4)	°API	vol%	Cumulated vol%
46	350 - 360	1.33	42.40	0.890	27.3	1.3	47.9
47	360 - 370	1.33	43.73	0.888	27.7	1.3	49.2
48	370 - 380	1.42	45.15	0.882	28.8	1.4	50.6
49	380 - 390	1.43	46.58	0.887	27.9	1.4	52.0
50	390 - 400	1.45	48.03	0.897	26.1	1.4	53.4
51	400 +	51.97	100.00	0.968	14.5	46.6	100.0

FIG. - 1

RUMAILA POOL 'C' CRUDE TBP v.s. wt% DISTIL CURVE

	wt %
C_2	0.03
C_3	0.33
iC_4	0.19
nC_4	1.05
iC_5	0.76
nC_5	1.34
	3.70

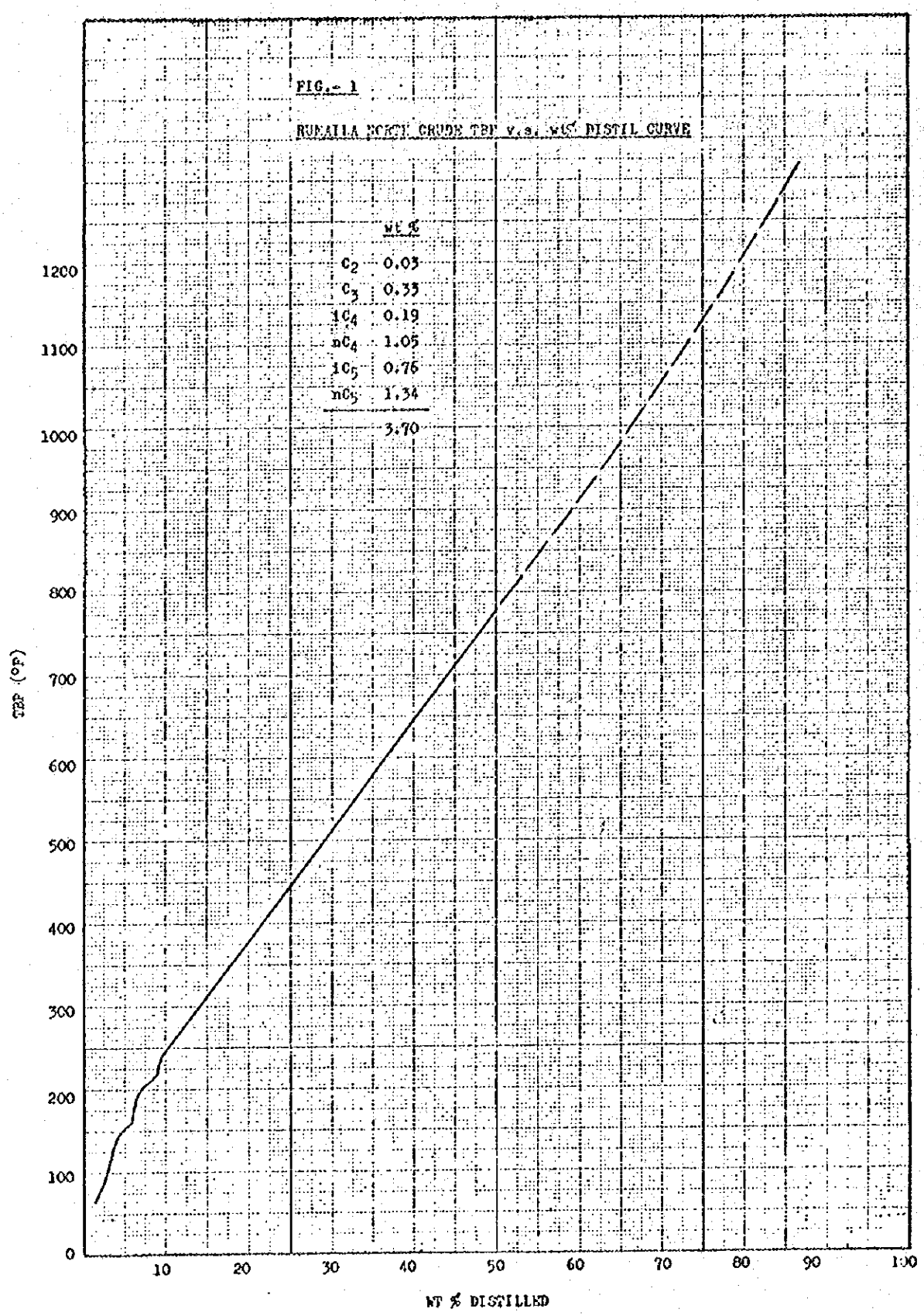
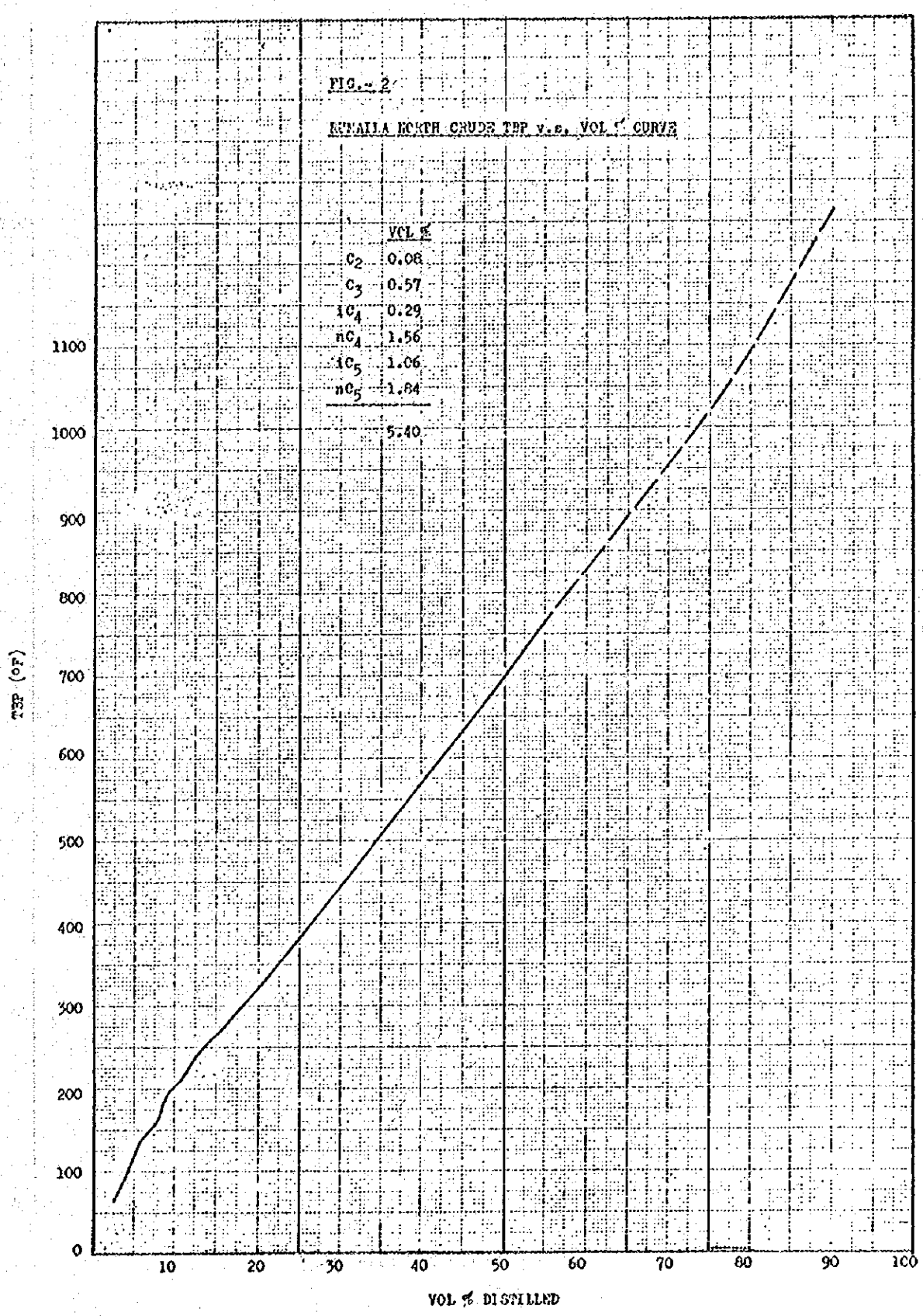


FIG. - 2

KUWAIT NORTH CRUDE TBP v.s. VOL % CURVE

	VOL %
C_2	0.08
C_3	0.57
iC_4	0.29
nC_4	1.56
iC_5	1.06
nC_5	1.84
	5.40



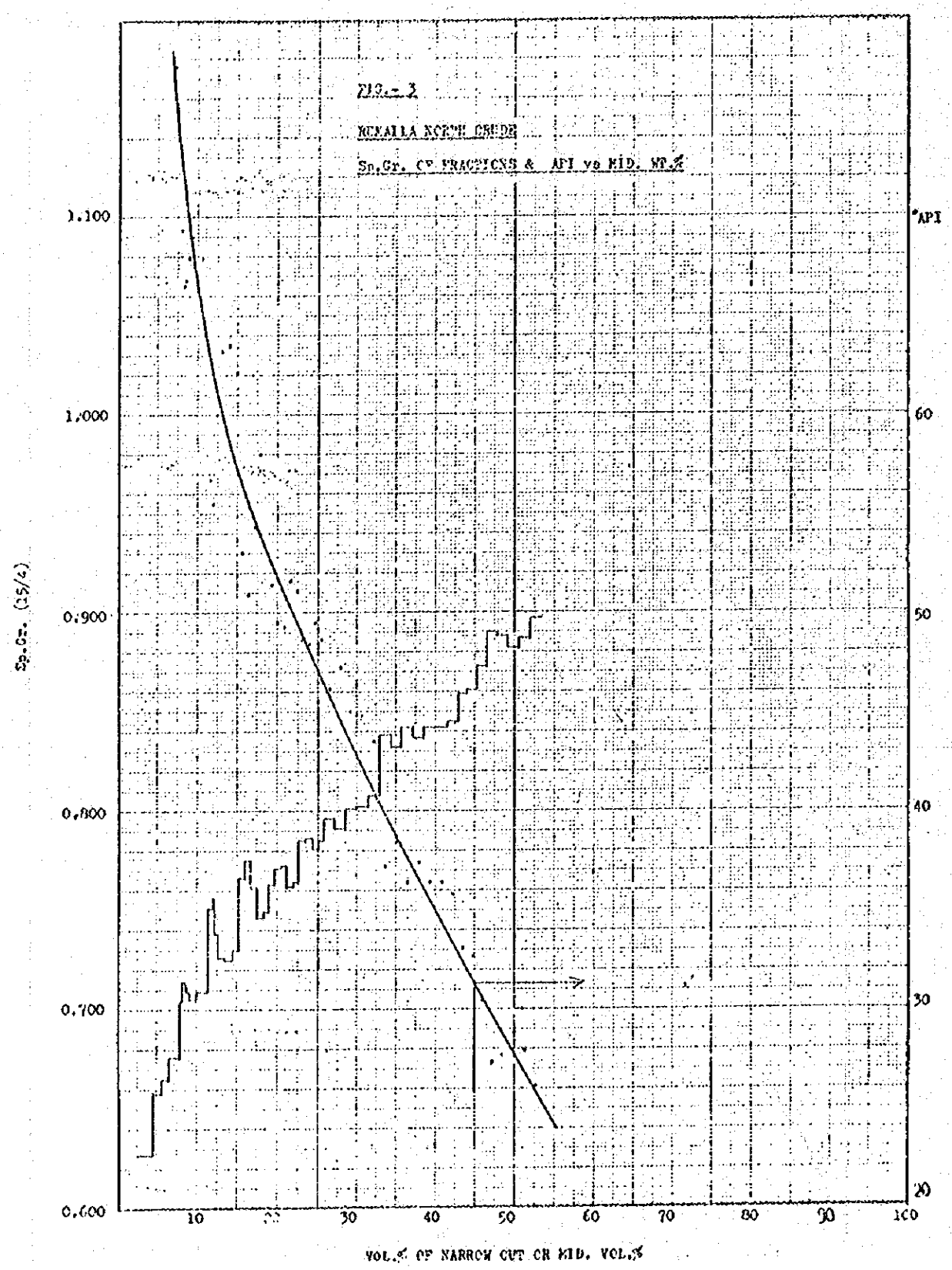


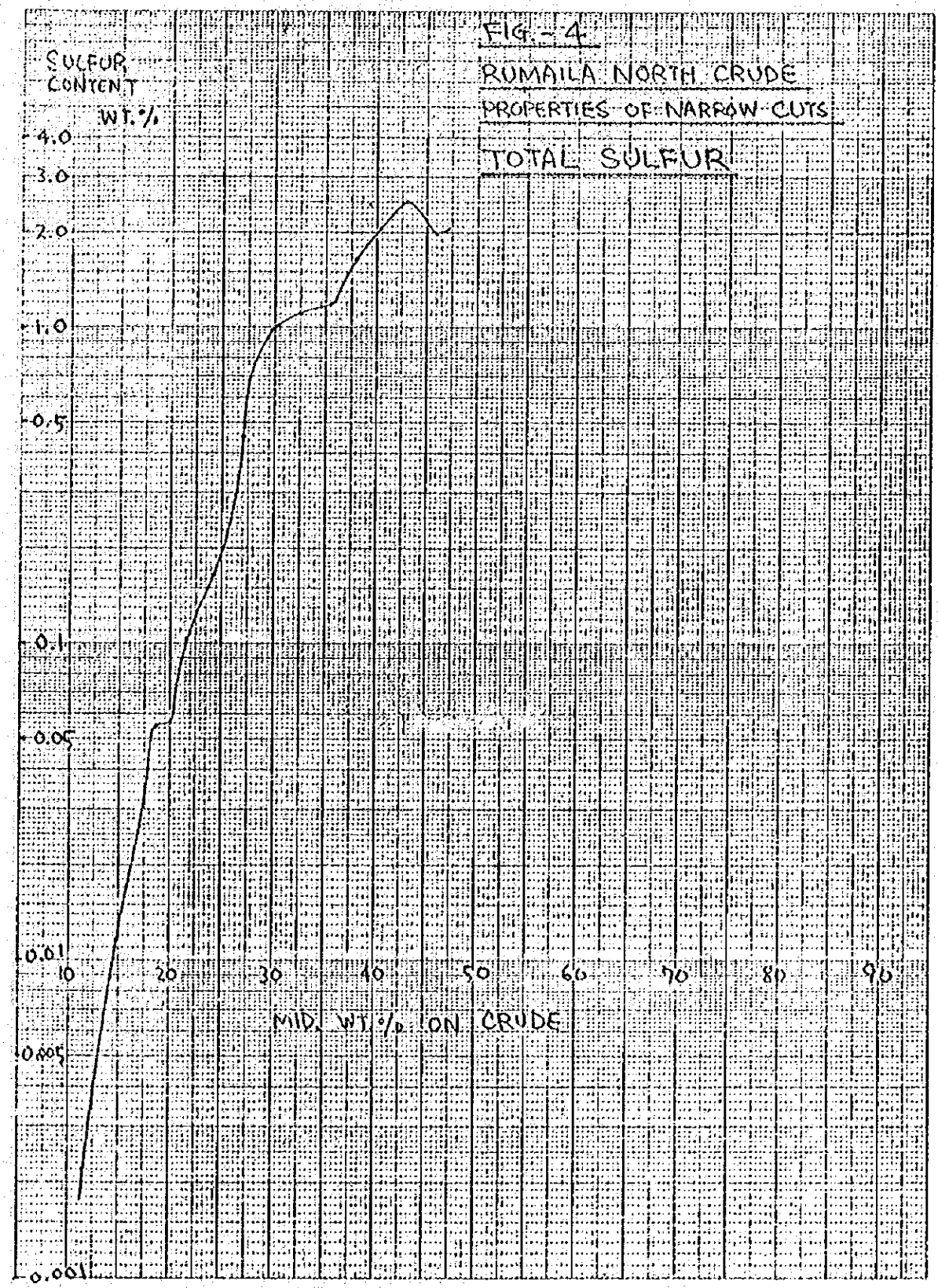
FIG. 3
KUWAITA NORTH CRUDE
Sp.Gr. OF FRACTIONS & API vs MID. WT.%
1.100
1.000
0.900
0.800
0.700
0.600
Sp.Gr. (15/4)
°API
60
50
40
30
20
10
20
30
40
50
60
70
80
90
100
VOL.% OF NARROW CUT OR MID. VOL.%

FIG.-4

RUMAILA NORTH CRUDE

PROPERTIES OF NARROW CUTS

TOTAL SULFUR



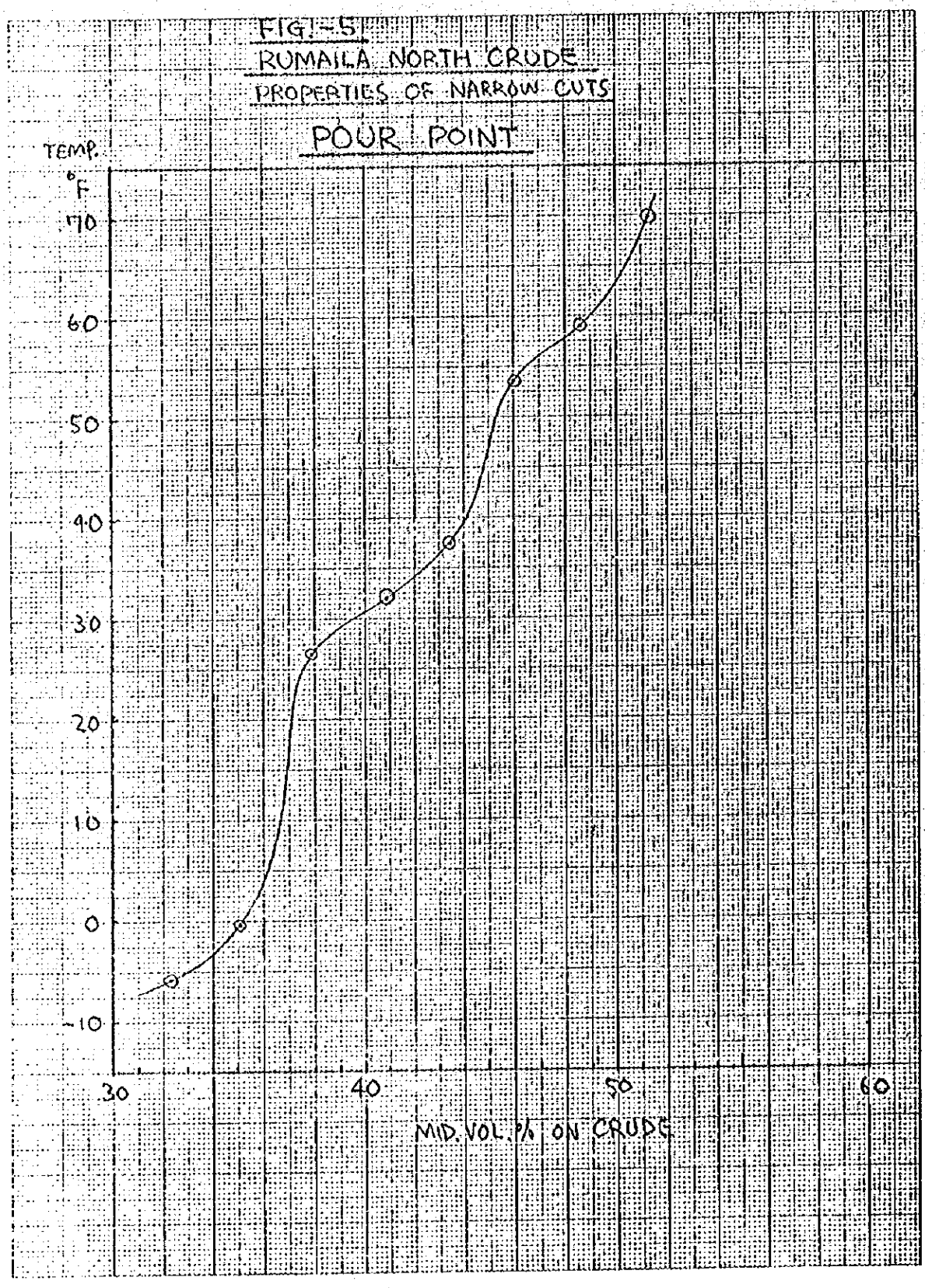


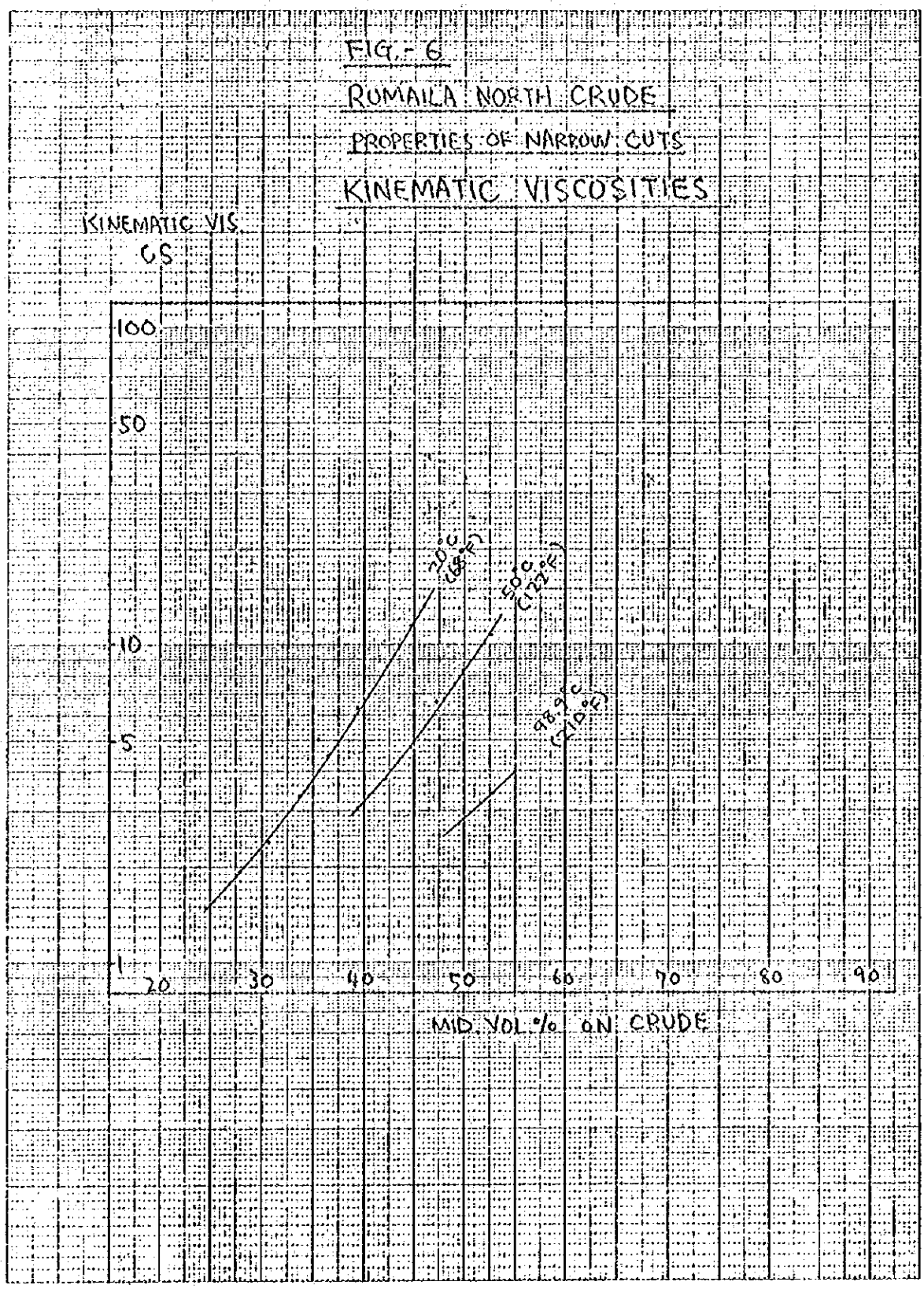
FIG. 5
RUMAILA NORTH CRUDE
PROPERTIES OF NARROW CUTS
POUR POINT
TEMP. °F
70
60
50
40
30
20
10
0
-10
30
40
50
60
MID. VOL. % ON CRUDE

FIG. - 6

ROMAILA NORTH CRUDE

PROPERTIES OF NARROW CUTS

KINEMATIC VISCOSITIES



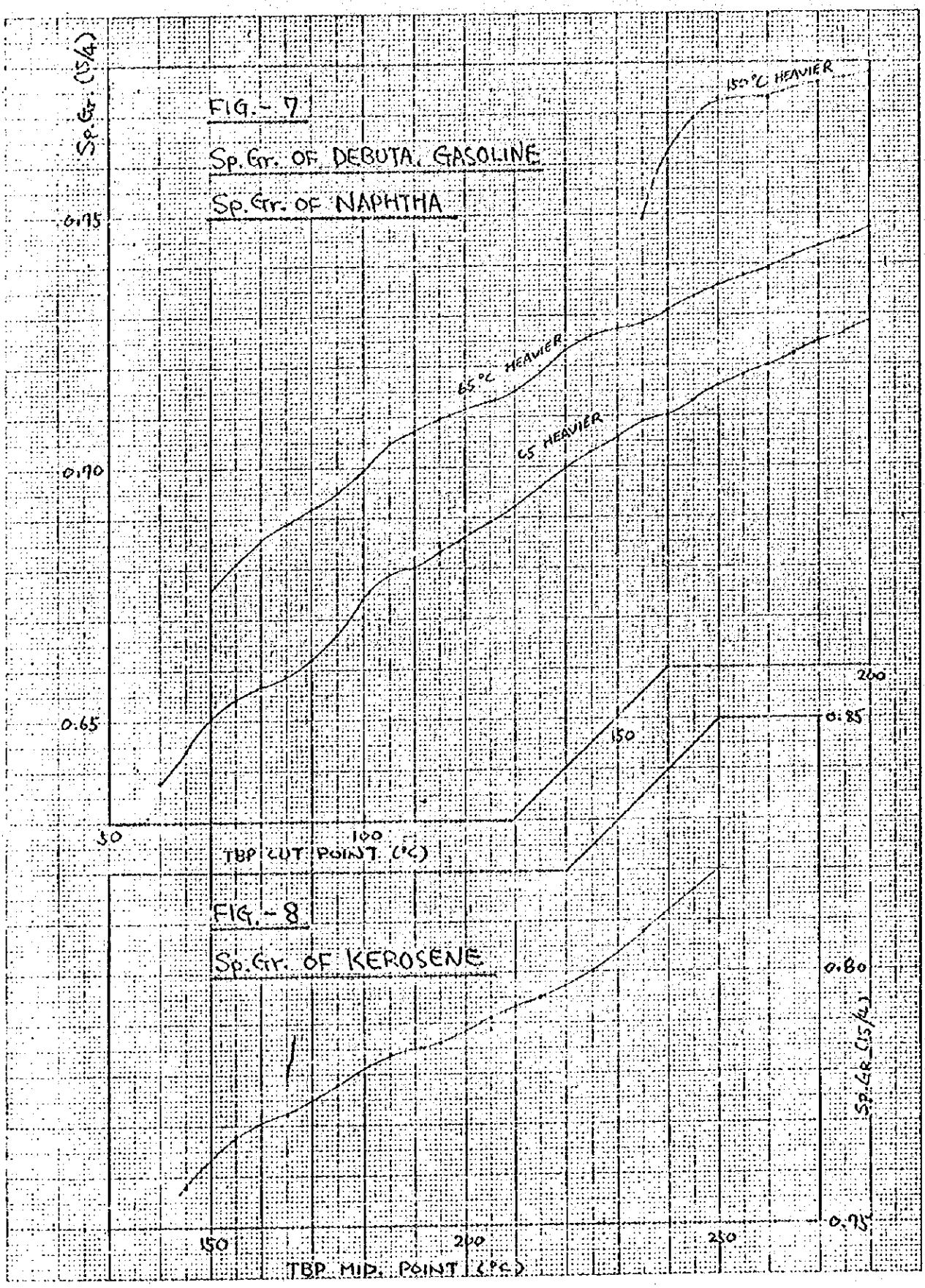


FIG.- 7

Sp. Gr. OF DEBUTA. GASOLINE

Sp. Gr. OF NAPHTHA

FIG.- 8

Sp. Gr. OF KEROSENE

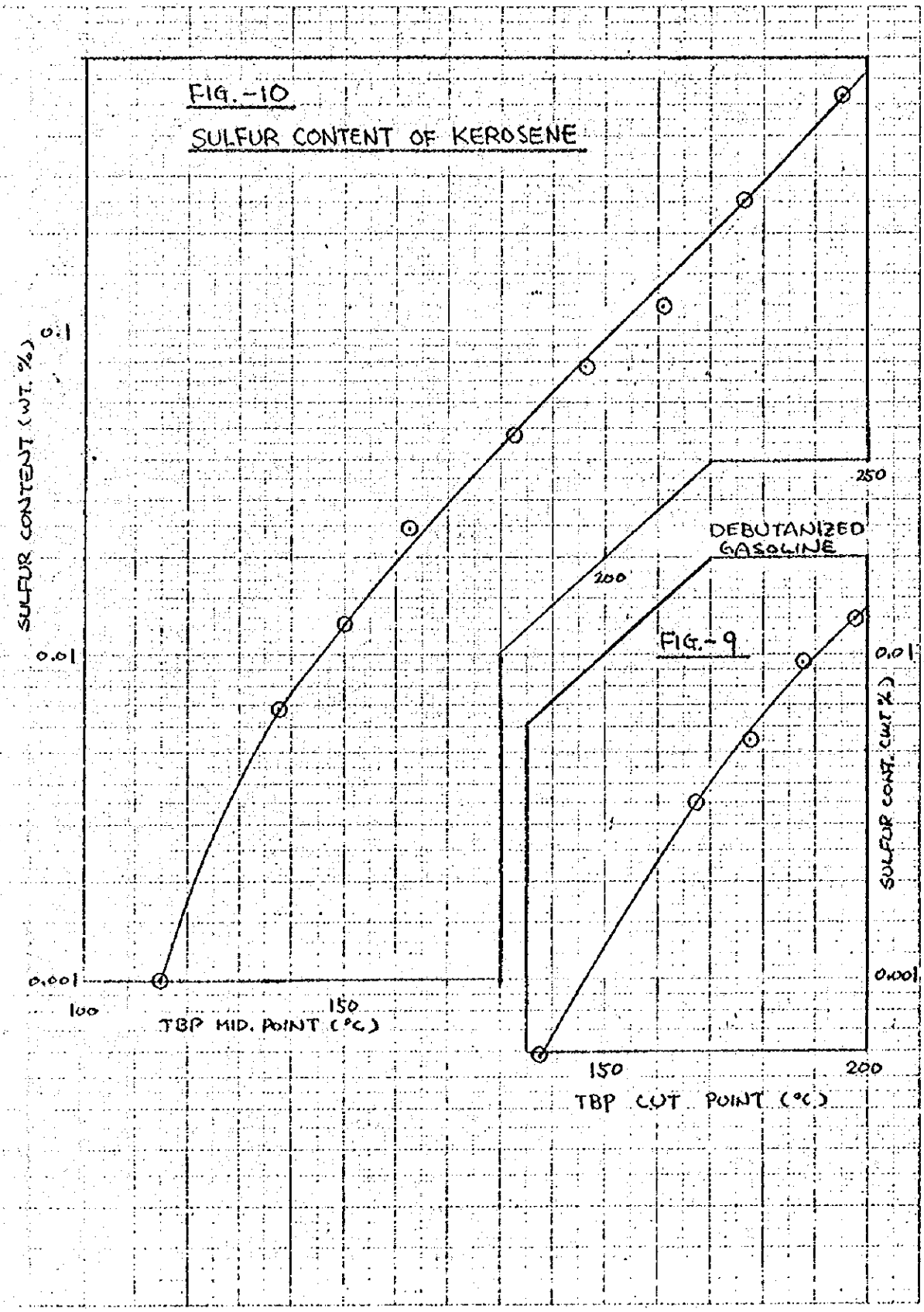


FIG.-10
SULFUR CONTENT OF KEROSENE
SULFUR CONTENT (WT. %)
0.1
0.01
0.001
100
150
TBP MID. POINT (°C)
250
200
DEBUTANIZED GASOLINE
FIG.-9
0.01
0.001
SULFUR CONT. (WT %)
150
200
TBP CUT POINT (°C)

FIG.-11

POUR POINT & ANILINE POINT OF GAS OIL

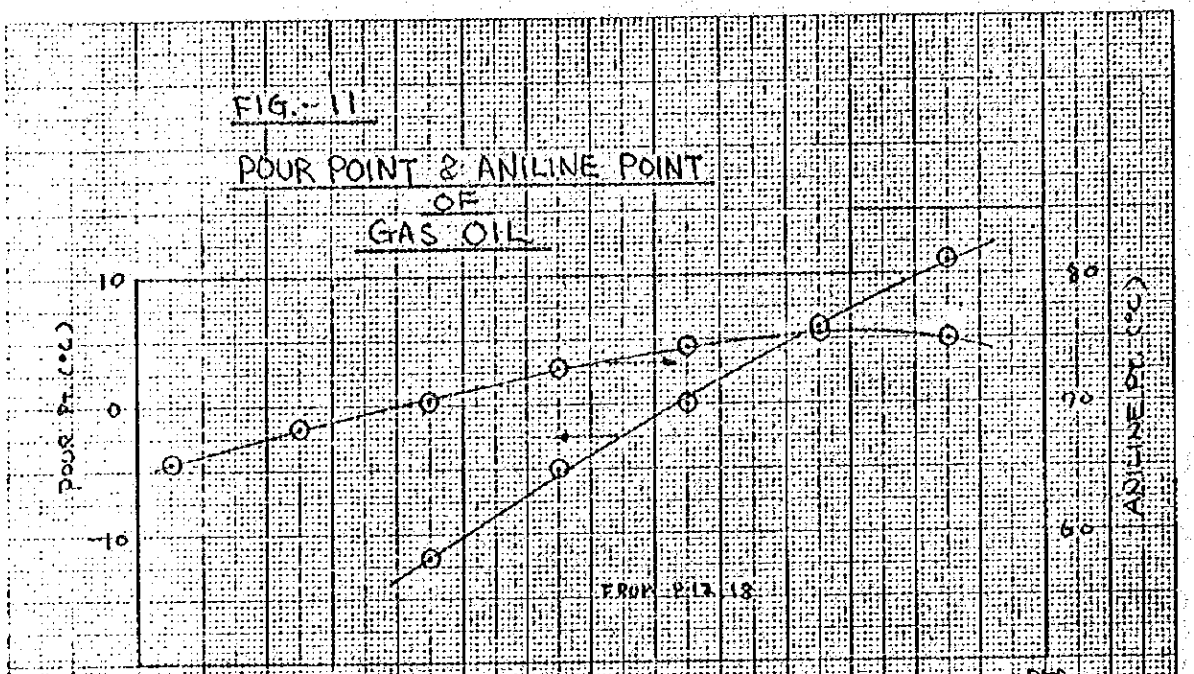


FIG.-12

Sp.Gr. OF GAS OIL

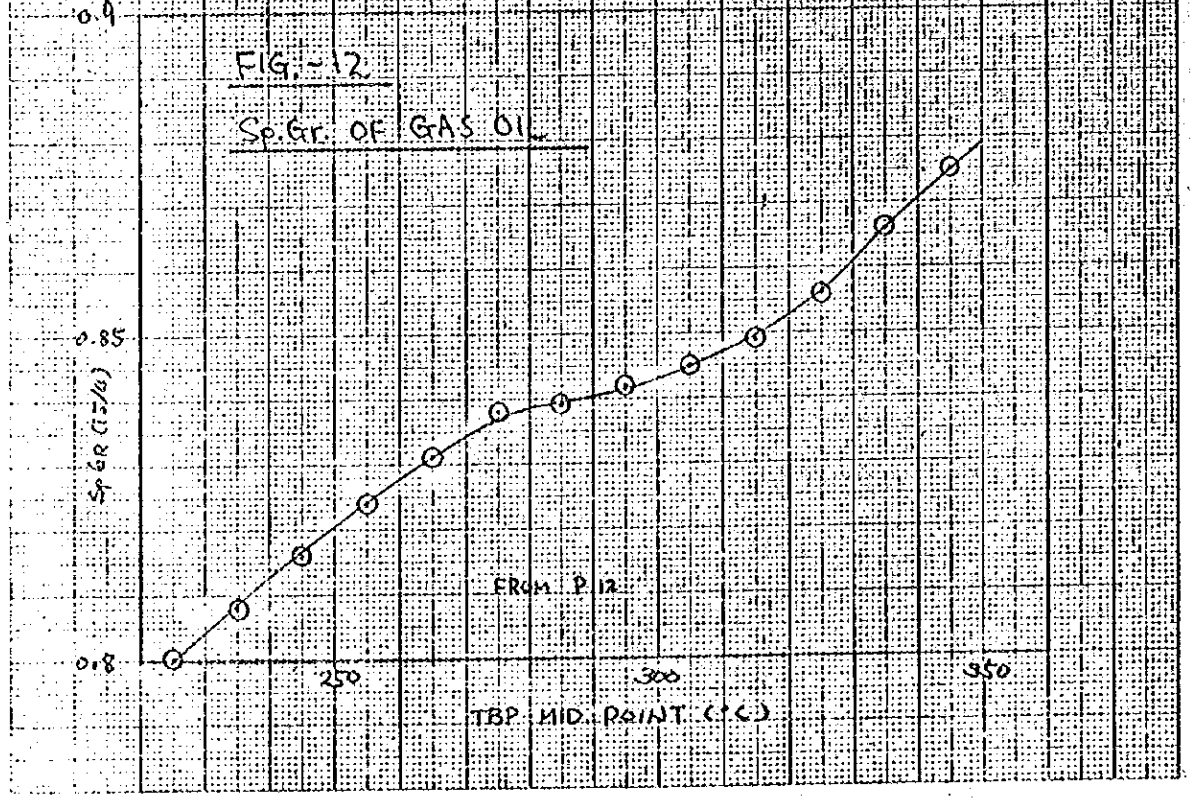


FIG. -13

SULFUR CONTENT OF GAS OIL

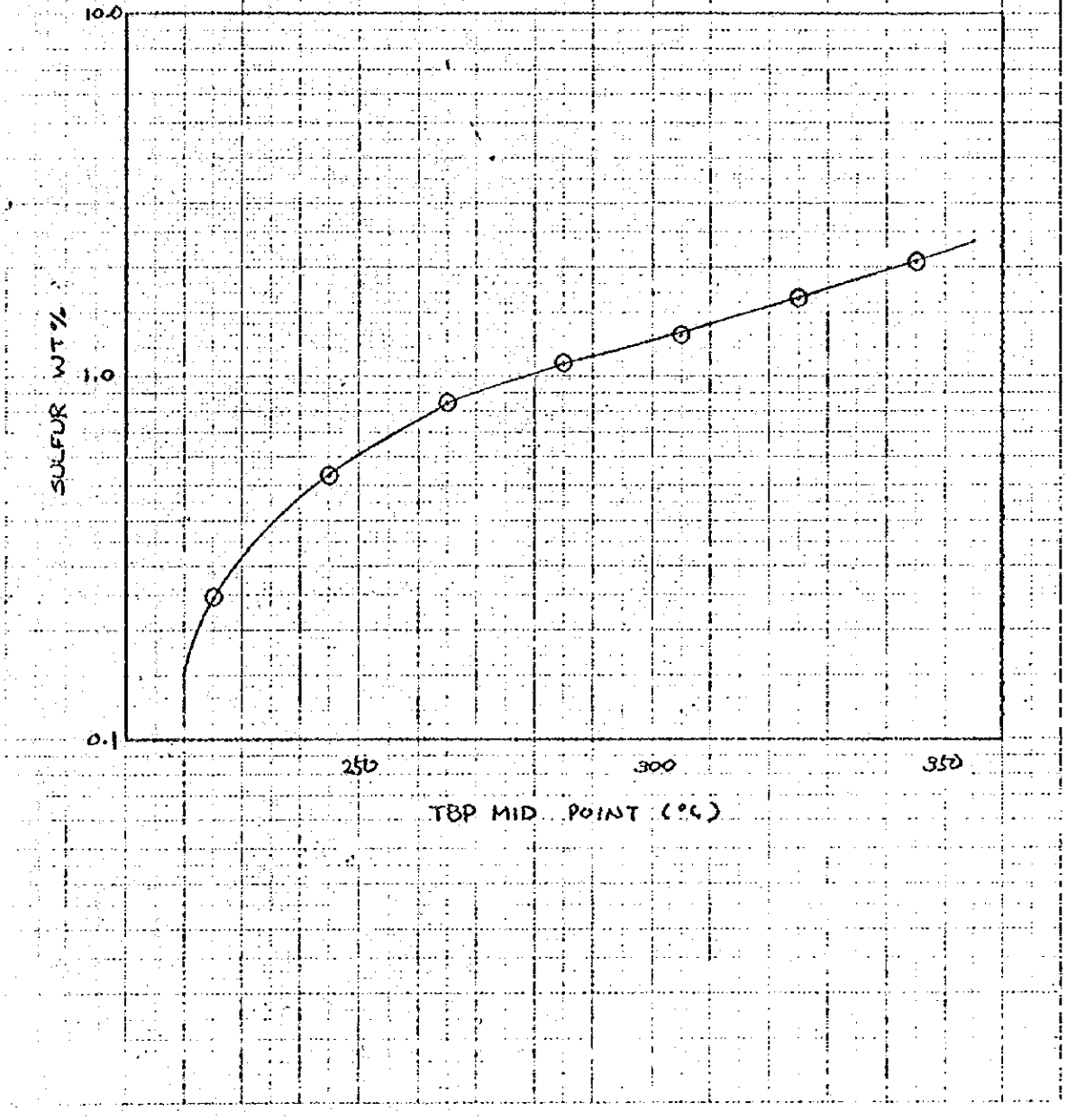


FIG. - 14

Sp. Gr.
SULFUR CONTENT OF RESIDUE
CON. CARBON.

FROM PAGE 51

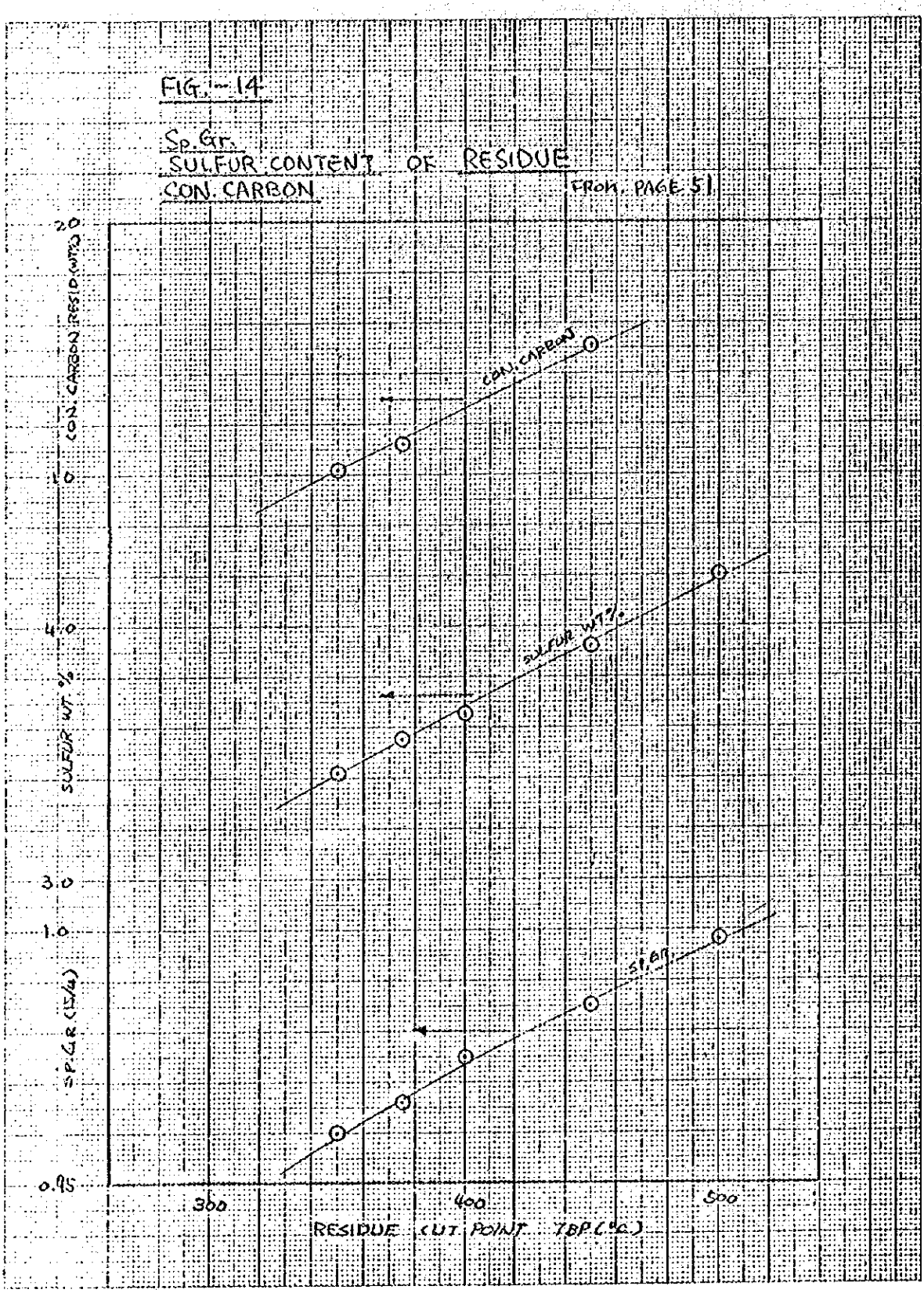
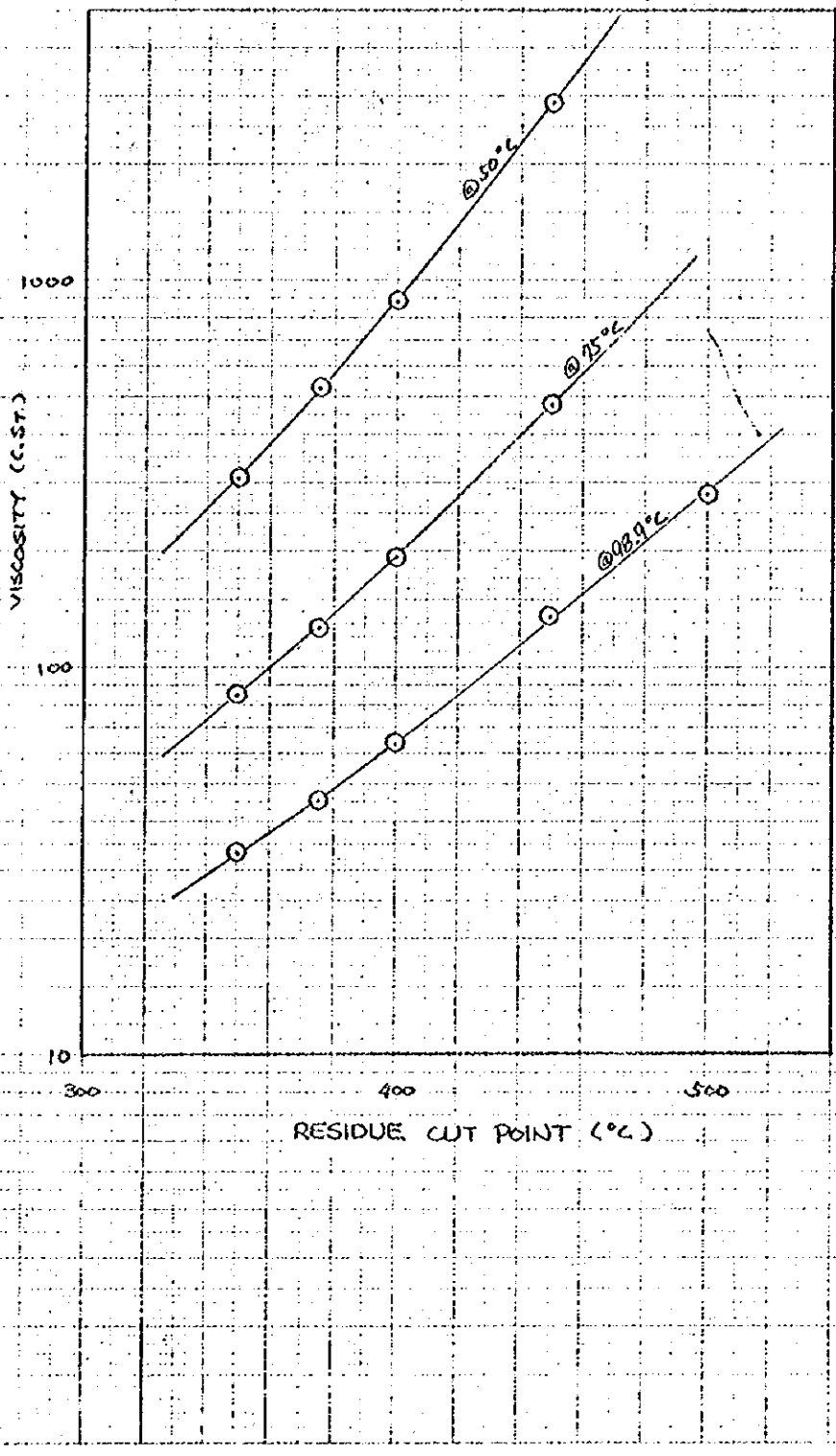


FIG. - 15

VISCOSITIES OF RESIDUE



MISCHRIF
CRUDE OIL ASSAY

VOL VI d

UOP
Universal Oil Products Company
World Headquarters
Ten UOP Plaza - Algonquin & Mt. Prospect Roads
Des Plaines, Illinois 60016
Telephone 312-391-2000

Iraq National Oil Company
Baghdad, Iraq

UOP Laboratory Order No. 6160

Inspection values obtained on the following sample are listed in the attached tables.

Description	UOP No.	Size
Mischrif Crude Oil	114-4138	5 gal.

F. W. Bruining
Analytical Laboratories
Corporate Research Center

FWB:bam

Hempel & Batch Vacuum Distillation and Inspection Analyses of [illegible] Crude Oil Received from the Iraq National Oil Company at [illegible], Iraq

UOP Sample No. [illegible]

UOP Laboratory Order No. [illegible]

Table No. 1

	Crude Oil	Depentanizer Overhead	Light Gasoline C5-75°C	<-- Naphtha --> 75-150°C	150-175°C	Kerosine 175-230°C	<-- Diesel Fuel --> 230-300°C	300-343°C	Gas Oil 343-360°C	<-- Residuum --> Above 343°C	Above 360°C	H2O
Yield Volume % of Crude as Received		6.5	3.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.1
Position in Crude Oil, L.V.%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]-100.0	[illegible]-100.0	[illegible]
Analyses of Fractions												
Gravity, °API at 60°F	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Specific Gravity at 60°F	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Total Sulfur, Wt.%	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Mercaptan Sulfur, Wt.%	[illegible]		[illegible]	[illegible]	[illegible]	None Detected						
Hydrogen Sulfide, Wt.%	None Detected		None Detected	[illegible]	[illegible]	[illegible]						
Octane Number, Micro												
Research Clear			[illegible]	[illegible]								
Research + 0.5 cc TEL			[illegible]	[illegible]								
Research + 3.0 cc TEL			[illegible]	[illegible]								
Motor Clear			[illegible]									
P.O.N.A. Composition, L.V.%												
Paraffins, %			[illegible]	[illegible]	[illegible]							
Naphthenes, %			[illegible]	[illegible]	[illegible]							
Aromatics, %			[illegible]	2	[illegible]							
F.I.A. Analysis, L.V.%												
Paraffins + Naphthenes						[illegible]						
Aromatics						[illegible]						
Nitrogen Content, Total, ppm			[illegible]	[illegible]								
Nitrogen Content, Total, Wt.%									[illegible]	[illegible]	[illegible]	
Color												
ASTM - D1500							[illegible]	[illegible]				
ASTM - D-156						[illegible]	[illegible]					
Aniline Point, °F						[illegible]	[illegible]	[illegible]	[illegible]			
Diesel Index						[illegible]	[illegible]	[illegible]				
Calculated Cetane Index (C.C.I.)						[illegible]	[illegible]	[illegible]				
Heptane Insolubles, Wt.%										[illegible]	[illegible]	
Sulfur in Heptane Insolubles, Wt.%										[illegible]	[illegible]	
Smoke Point					[illegible]	[illegible]						
Pour Point, °F						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Freezing Point, °F					Below -50	[illegible]						
B. S. &W., Vol.%	[illegible]											
Cloud Point, °F						[illegible]	Zero	[illegible]				
Sediment by Hot Toluene Extn. (Filter), %										[illegible]	[illegible]	
Ash Content Wt.%										[illegible]	[illegible]	
Conradson Carbon Residue, Wt.%									[illegible]	[illegible]	[illegible]	
Viscosities -												
Kinematic at 100°F., cSt.						[illegible]	[illegible]	[illegible]				
Kinematic at 122°F., cSt.							[illegible]	[illegible]	[illegible]	[illegible]		
Kinematic at 210°F., cSt.									[illegible]			
Universal at 100°F., secs.						[illegible]	[illegible]	[illegible]				
Universal at 122°F., secs.							[illegible]	[illegible]	[illegible]			
Universal at 210°F., secs.									[illegible]	[illegible]		
Furol at 122°F., secs.										[illegible]		
Furol at 210°F., secs.											[illegible]	
Flash, Tag Closed-Cup, °F					[illegible]							
Penetration @ 77°F. 100 g./5 secs.											[illegible]	
Softening Point, R. & B., °F												
Distillation, Type	D1160		D86	D86	D86	D86	[illegible]	[illegible]	D1160			
I.B.P., °F	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
5%	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
10	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
20	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
30	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
40	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
50	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
60	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
70	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
80	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
90			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
95			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
E.P., °F			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
% Recovered	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
% Residue	[illegible]		[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]			
Emission Spectrographic Analysis of Wet Ash — Elements Reported as ppm metal in the oil:												
Fe									[illegible]	[illegible]	[illegible]	
Ni									[illegible]	[illegible]	[illegible]	
V									[illegible]	[illegible]	[illegible]	
Zn									[illegible]	[illegible]	[illegible]	
Cu									[illegible]	[illegible]	[illegible]	
Na									[illegible]	[illegible]	[illegible]	

Fractionation and Component Analysis Composition Liquid Volume %

Component	L.V.%
Ethane	0.3
Propane	1.5
Isobutane	0.6
n-Butane	1.5
Iso-Pentane	[illegible]
n-Pentane	[illegible]
Hexanes +	[illegible]
Total	100.0

a. [illegible]
b. Dry point

uop

Iraq National Oil Company
Baghdad, Iraq

Table No. 2

Sample Identification		Mischrif Crude Oil	
UOP Number		114-4138	
		Light Gasoline	Naphtha
Fraction Analyzed		C_6-75°C	75-150°C
Liquid Volume % of Crude Oil		3.5	11.8
SUMMARY OF HYDROCARBON TYPES ANALYSES, L.V.% by GC			
Paraffins	C_5	0.3	0.2
	C_6	83.2	3.6
	C_7	6.3	21.1
	C_8	0.1	21.1
	C_9		19.0
	C_{10}		5.5
Cyclopentane		1.2	
Total C_6 Naphthenes		6.5	1.4
Total C_7 Naphthenes		1.0	5.4
Total C_8 Naphthenes		Trace	6.3
Total C_9 Naphthenes			5.8
Total C_{10} Naphthenes			1.3
Benzene		1.3	0.2
Toluene		0.1	2.2
Total C_8 Aromatics			4.9
Total C_9+ Aromatics			2.0

Iraq National Oil Company
Baghdad, Iraq

Table No. 3

Sample Identification: Mischrif Crude Oil
UOP Number: 114-4138

TBP Distillation, L.V.%

% Over	Temp. °F	% Over	Temp. °F
IBP	-	57.2	812
3.4	75	59.4	831
5.7	90	61.7	845
8.0	151	63.9	863
10.3	194	66.2	882
12.6	210	68.4	904
14.9	244	70.7	934
17.1	273	72.9	965
19.4	300	75.2	998
21.7	334	77.5	1030
23.5	343	79.3	1042
25.8	378	20.7% Bottoms	
28.1	401		
30.4	444		
32.9	464		
35.0	489		
37.3	509		
39.5	529		
41.8	558		
44.1	588		
46.4	617		
48.7	637		
51.0	667		
53.3	696		
54.9	768		

ADDENDUM TO UOP
RUMAILA MISHRIF ASSAY

The following tests were carried out on another Mishrif sample

Test	Crude Oil	Gas Oil 343-540°C	Residue 343 C	Residue 540 C
Pour Point F	- 35			
Nickel PPM			17	30
Vanadium PPM			112	182
Acidity , Mg.koH/Gram	0.219	0.152		
Salt Content (Lb Nacl /1000 BBL) + 4				
Viscosity Cs at 50 C	9.027			
RVP PSI	8.5			