Chapter 5.

Refinery Utility Design

Chapter 5. Refinery Utility Design

5.1 General

The refinery utility consists of such facilities as water system, steam system, instrument and air systems, fuel system, inert gas system and effluent water treatment system, etc.

The design basis for these facilities has been in accordance with TENDER DOCUMENT Vol. II Sect. 11, Page 32 through 46 of 60.

The design philosophies for the each system mentioned above are described respectively in the following paragraphs.
In addition, the flow sheet and the main equipment list of the each system are appended hereto.

5.2 Water system

(1) Water treatment

Capacity of raw water shall be given by all consumption of the water for drinking water, cooling tower make-up, miscellaneous process users, supply to demineralization plant, irrigation and fire system, etc.

Water treatment plant shall be schemed two stages of treatment such as clarification and filtration for raw water, and demineralization for filtered water.

Since the water treatment plant areas indicated on the Dwg. No. 40. E2 included in the TENDER DOCUMENTS are not enough to plan the above two-stage treatment the areas shall be made the expansion. Clarification and filtration plant is plotted with the effluent treatment plant

on the east edge area of refinery, and then demineralization plant is plotted on the utility plant area on the west side of process area.

The analysis value of Shatt-Al-Arab river water is given on Table 5 attached to TENDER DOCUMENT Vol. II Sect. 14, 14.3.1 Concerning the Figures given on Table 5, we have not taken into account any large variation through some variation has been into account.
Difinitive figures are given in Chapter 9, Design Engineering Article 9.1.2, (3) Water system herein.

(2) Cooling water

Cooling water maximum demand is considered as that under the design conditions.
Meanwhile, no additional cooling water demand under conditions severer than the design climatic conditions is considered.

In accordance with the requirement "Maximum economic use of air cooling is required" given in TENDER DOCUMENT Vol. II Sect. 10, 10.13.1.6 "Air Cooling", we have established the design criteria as follows:

(a) Break point between air and water is 60°C (140°F) in principle.

(b) Surface condencer for the steam turbine exhaust is the water cooled type.

5.3 Steam system

(1) Steam level

Regarding steam levels, as no specific requirements are indicated in the TENDER DOCUMENTS and as no steam power generation is planned in this project, the steam levels

have been decided so as to be convenient for the operation of the PROCESS UNITS.

Also, the steam balance has been provided based on the decided steam levels.

Details of these are as shown below.

(a) High pressure steam : 32 kg/cm^{2}G, 350°C

This has been decided with consideration given to the design of the waste heat boiler in the HYDROGEN PLANT and the economics of the distribution system.

(b) Middle pressure steam: 15 kg/cm^{2}G, 300°C and saturated

To meet the temperature required in the process reboiler, the pressure has been decided on, and this middle pressure steam will be superheated for general sue in the process, general pump turbine drive, fuel oil steam atomizing, steam supply to hose stations, etc.

(c) Low pressure steam : 3.5 kg/cm^{2}G saturated

This steam is intended for heating in process reboilers, tank heating and other protective heating.
The steam pressure (3.5 kg/cm^{2}G) has been decided with consideration given to the jacket heating of liquid sulfur.

(2) Steam balance

The steam balance has been maintained based on the above-mentioned steam levels, so that steam generation in the boiler and low pressure steam release to the atmosphere will be minimum in normal operation.

In this case, turbine driver selection has been made on the basis of the TENDER DOCUMENTS and steam generation in the waste heat boilers has been taken into account.

Turbine drive has been used only for the pumps required to shut down the PROCESS UNITS safely at an emergency (power failure, etc.) and the boiler capacity has been decided so as to cover the steam consumption at power failure.

Meanwhile, motor drive has been considered even for furnace feed pumps in cases where turbine drive has been used for the compressors on the gas sides of combined feed design.

(3) Condensate recovery

(a) Clean condensate

Condensate from the surface condensers and the reboilers in which the process fluid pressure is lower than the steam pressure, will be recovered as clean condensate and will be used in the waste heat boilers in the process area together with boiler feed water from the utility facilities.

(b) Oil contaminated condensate

Condensate from the reboilers in which the process fluid pressure is higher than the steam pressure will be returned as oil contaminated condensate to the condensate recovery system in the utility area since it is possible that the condensate will be contaminated with process fluid.

(c) Process condensate

Process condensate will be treated in respective PROCESS UNITS and will be reused in the PROCESS UNITS, depending on the quality of the treated condensate.

(d) Condensate from steam traps for steam tracers, steam jackets and header drains will not be recovered.

5.4 Instrument and plant air system

Air shall be generated at 7.7 kg/cm^{2}G by two parallel sets of equipment each set consisting of a compressor, inter and after coolers and a receiver.
The driver of one of the compressors shall be designed a steam turbine to provide security of supply during power failure.

After the air receivers the air shall be separated into two streams, i.e., instrument air and plant air.

5.5 Fuel system

Fuel system consists of fuel gas and fuel oil system.
Fuel gas and fuel oil shall be stored in tanks plotted on the tank yard.
Specification of storage tank shall be referred to tank list herein.

(1) Fuel gas

The generating system shall consist of 3 vessels.
The first of these shall be an LPG storage drum into which shall be fed the liquid streams. It shall be maintained at a pressure above that of the fuel gas system by means of a pressure controller. Any flashed-off vapour from the surge drum shall pass to the second vessel - the fuel gas mix drum. The surge drum shall be level controlled and fitted with a small heating coil to provide the necessary operating pressure by vaporisation.

Liquid LPG from the surge drum shall be passed via a pressure reset level control valve to an evaporator, together with the gas from the surge drum, natural gas and all gaseous streams from the refinery shall pass to the fuel gas mix drum to equalise the differing calorific valves of the H_2 rich gas, refinery gas and Natural Gas.

Fuel gas shall be distributed to the process furnaces and off-site boiler and for burners at the flare stack, etc.

(2) Fuel oil

Fuel oil for firing the steam generators and refinery furnaces shall be blended and stored in fixed roof tanks and situated close to the main process, and utility users.

The oil in the distribution pipework shall be maintained at a constant pressure by a pressure control system which will have its sensing element at the furthest point of the fuel oil pipework and the control valve located immediately after the most distant user. Any fuel oil surplus to demand shall be returned to the pump suction via the control valve.

5.6 Inert gas system

N_2 gas shall be produced as 7.7 kg/cm^{2}G by N_2 gas generator. A part of produced N_2 gas shall be compressed to 28.0 kg/cm^{2}G move for use in process plant 28.0 kg/cm^{2}G compressed N_2 gas shall be stored in sphere storage tank planned on utility plant area.

5.7 Miscellaneous utilities

(1) Flare and blow-down system

The main flare header and the flare stack have been sized on the basis that relief valves on all the units should not open simultaneously.

(2) Electric power consumptions

It is understood that the limitations on power consumptions need not be considered and that insufficiency will not be met by supply from any power generator.

Refer: Minutes of meeting on Export Refinery between SCOP and CONTRACTOR at Baghdad held on April 29, 1976 Item 5.10.

(3) Refinery effluent system

The elevation of each area has been decided based on Topographic Site Survey Dwg. No. 508-C-01 included in the TENDER DOCUMENT (Vol. VI a-soil information and topographic; map), and the refinery layout has been planned on the basis that refinery liquid effluent should be passed from west to east.

MAIN EQUIPMENT LIST

1. WATER SYSTEM

Main Equipment	Q'ty	Description (Per One)	Remarks
Raw water pond	1	$32^{M} \times 30^{M} \times 3.6^{H}$	
Hi-rate mixing tank	2	$3^{M} \times 28^{M} \times 3.6^{H}$	with Flash mixer chemical dosing equipments
Coagulator	4	$30^{M\phi} \times 4.8^{H}$	
Thickner	1	$20^{M\phi} \times 3.1^{H}$	
Sand filter	5	$11.3^{M} \times 9.4^{M} \times 2.8^{H}$	
Filtered water storage tank	1	$72.7^{M\phi} \times 19.3^{M}$ ($80{,}000M^{3}$)	
Drinking water tank	1	$4.75^{M\phi}$ ($50M^{3}$)	elevated sphere tank
Demineralizer unit	3	840 T/H (MAX.)	with measuring hopper and regeneration tower
Demineralized water storage tank	1	$43^{M\phi} \times 15.2^{H}$ ($22{,}000M^{3}$)	
Cooling tower	2	25,000 T/H	

2. STEAM SYSTEM

Main Equipment	Q'ty	Description (Per One)	Remarks
Boiler	4	135 T/H	
Dearator	2		with condensate cooler and condensate tank

3. INSTRUMENT AND PLANT AIR SYSTEM

Main Equipment	Q'ty	Description (Per One)	Remarks
Air compressor	2	13,000 Nm^{3}/h	with air receiver and air dryer

4. FUEL SYSTEM

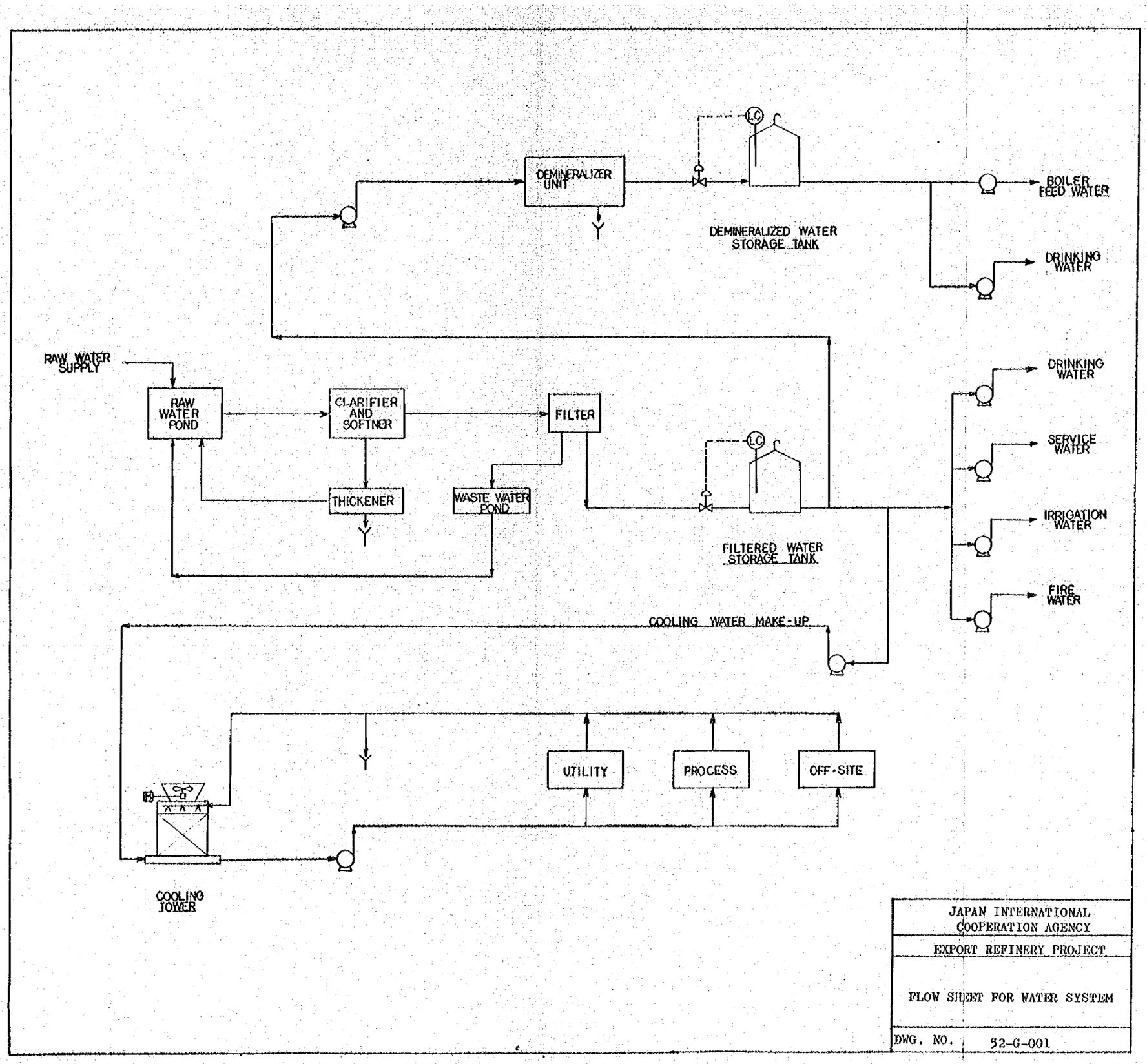
Main Equipment	Q'ty	Description (Per One)	Remarks
LPG storage tank	1	$12.7^{M\phi}$ (sphere) ($1{,}082M^{3}$)	with LPG drum, balance drum and vaporizer
Fuel oil tank	2	$27.5^{M\phi} \times 16^{H}$ ($9503M^{3}$)	with heat exchanger

5. INERT GAS SYSTEM

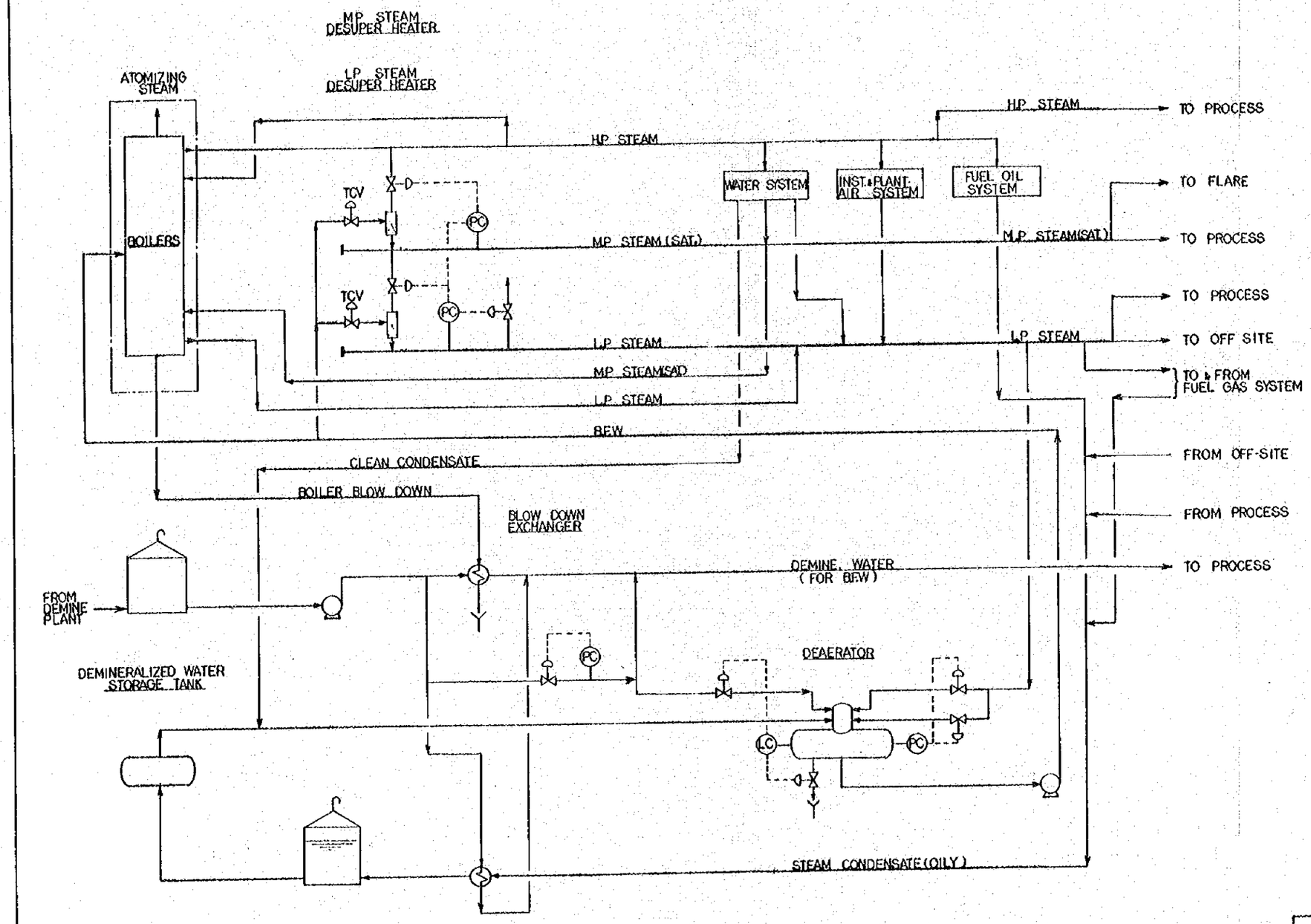
Main Equipment	Q'ty	Description (Per One)	Remarks
N_2 generator	3	400 Nm^3/h	
N_2 holder	1	500m^3, 28 kg/cm^2G	sphere tank

6. EFFLUENT SYSTEM

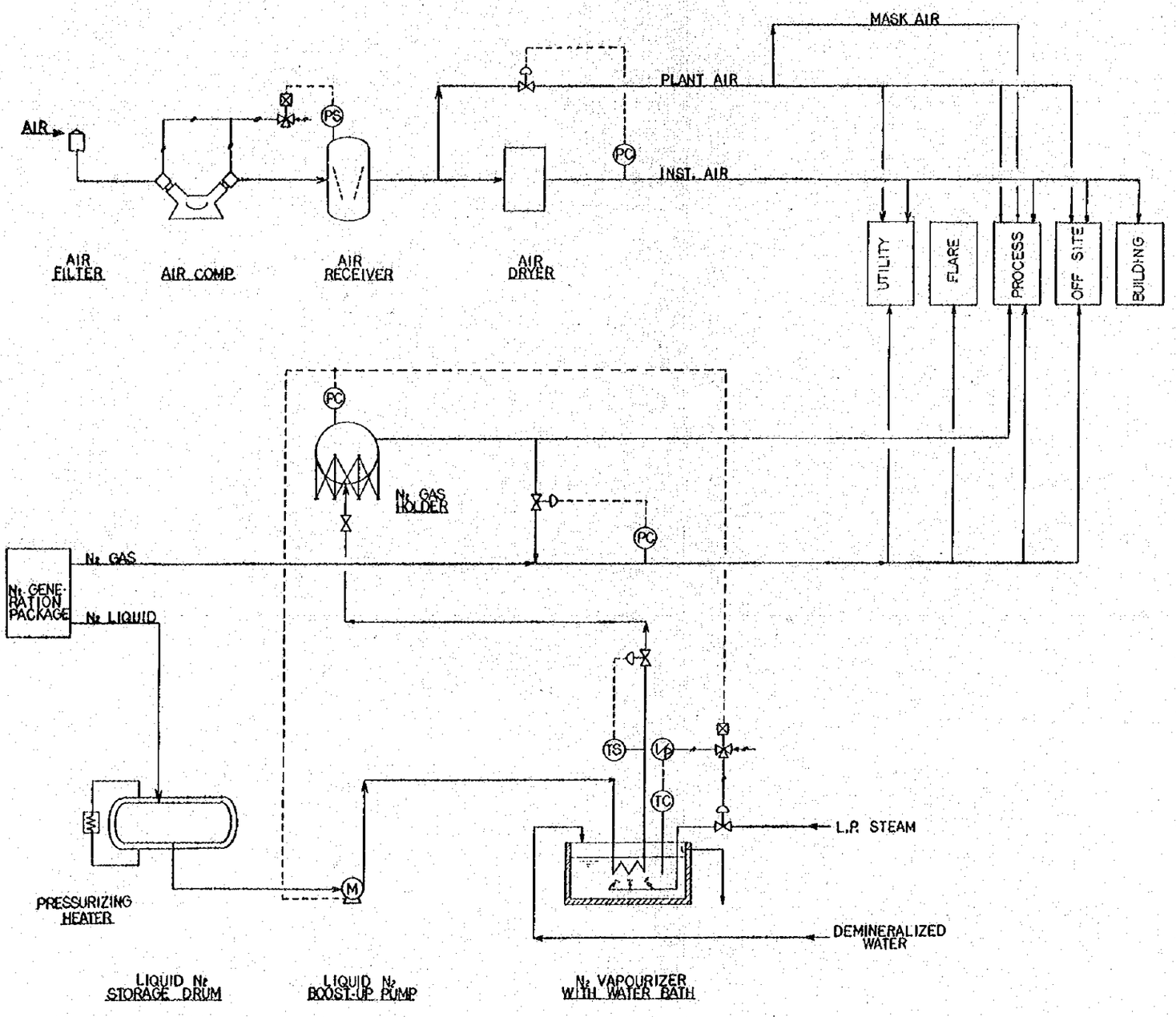
Main Equipment	Q'ty	Description (Per One)	Remarks
API oil separator	7		
Holding basin	2	60^M x 60^M x 1.5^H	



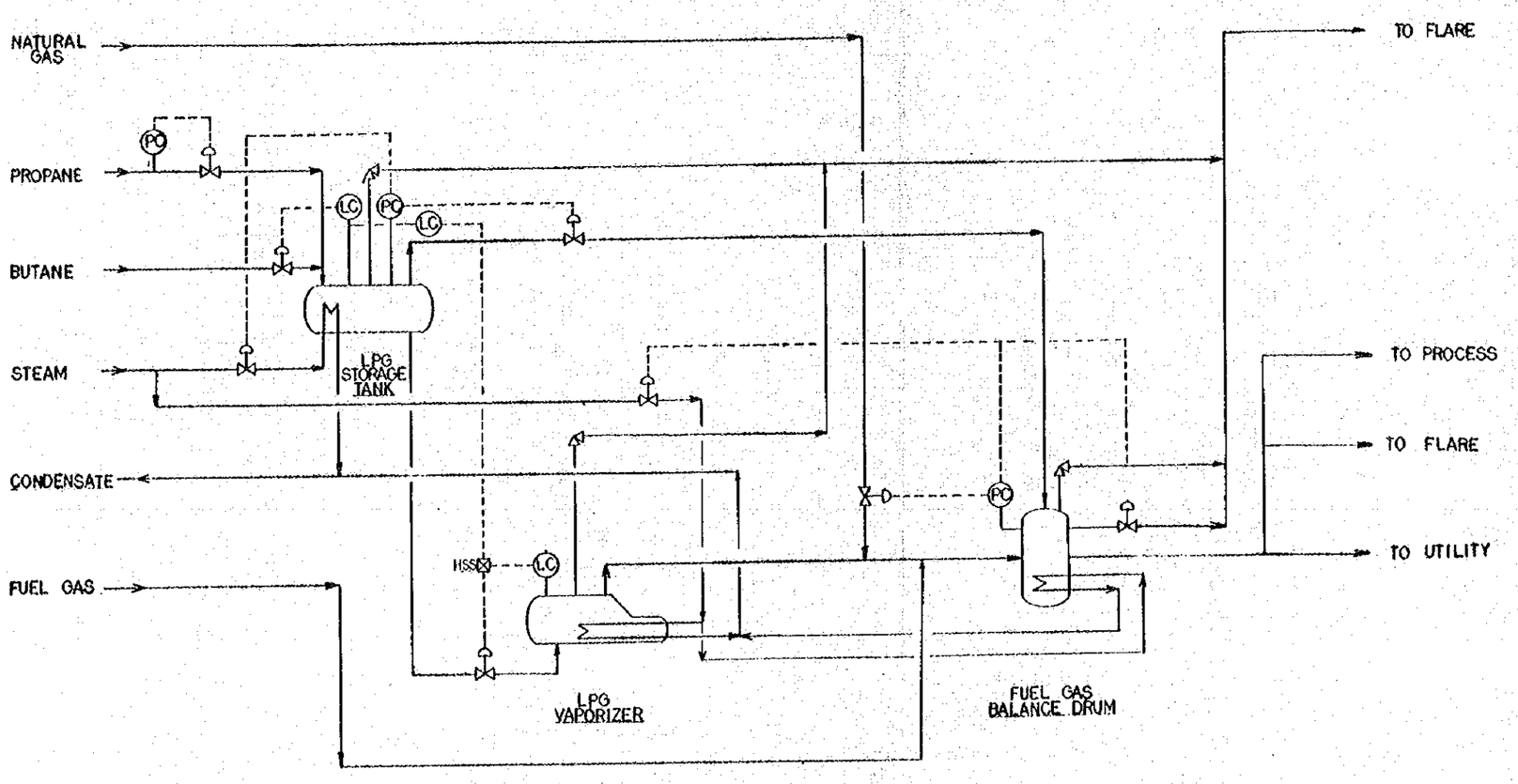
JAPAN INTERNATIONAL COOPERATION AGENCY	
EXPORT REFINERY PROJECT	
PLOW SHEET FOR WATER SYSTEM	
DWG. NO.	52-G-001



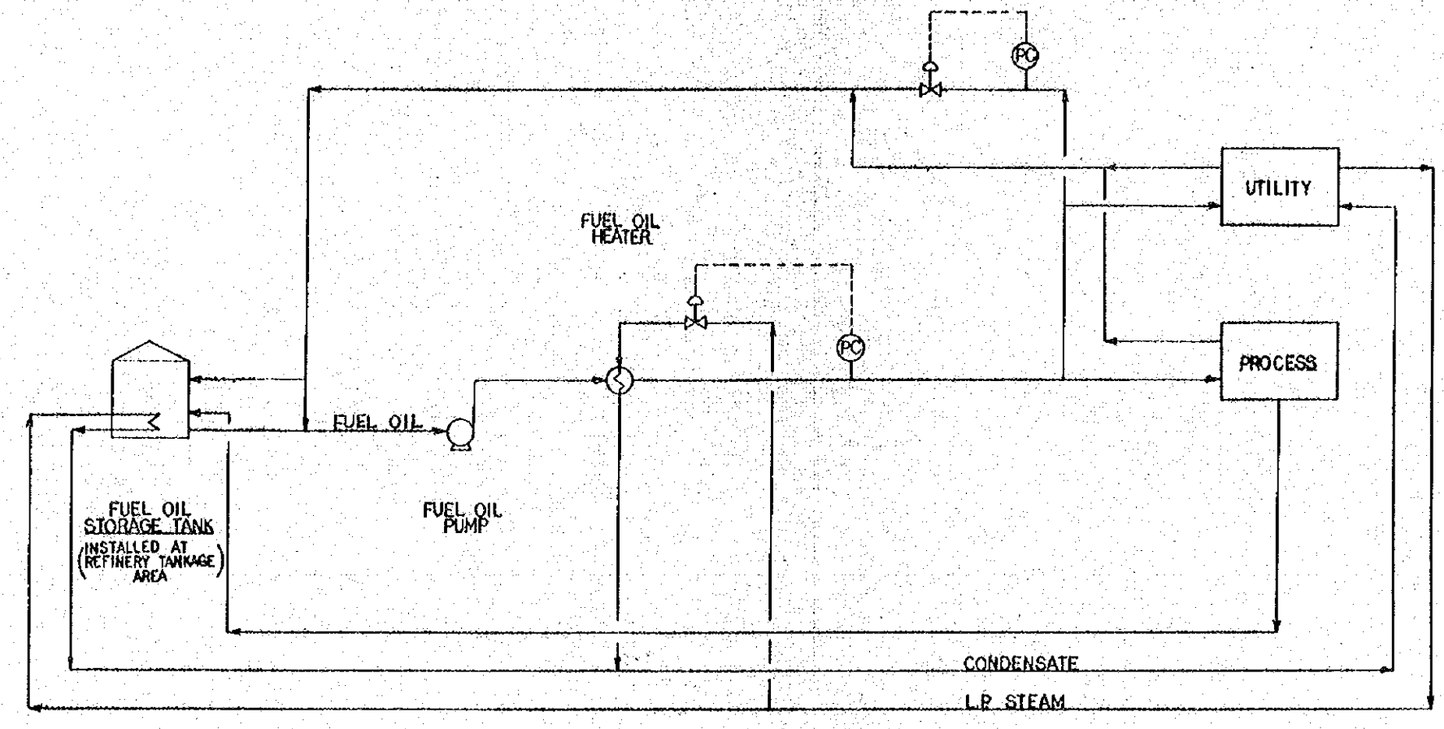
JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
FLOW SHEET FOR STEAM, BFW & CONDENSATE
DWG. NO. 52-G-002



JAPAN INTERNATIONAL COOPERATION AGENCY	
EXPORT REFINERY PROJECT	
FLOW SHEET FOR INSTRUMENT & PLANT AIR & N_2 SYSTEM	
DWG. NO.	52-G-003



JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
FLOW SHEET FOR FUEL GAS SYSTEM
DWG. NO. 52-G-004



JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
FLOW SHEET FOR HOME FUEL OIL SYSTEM
DWG. NO. 52-G-005

Chapter 6.

Refinery Off-site Tankage Design

Chapter 6. Refinery Off-site Tankage Design

6.1 General

Refinery off-site tankage facilities shall be prepared to store and to blend the miscellaneous oil products and the design basis for these tankage facilities is to be in accordance with TENDER DOCUMENTS Vol. II Sect. 11, Page 2 through 31 of 60.

The schemes of oil systems have been intended based on refinery scheme which was planned from modified crude assay in Sect. 1 & 2 herein. The schemes have not taken into account any large variation though some variation has been into account on the TENDER DOCUMENT.
The tankage capacity, blending and shipping plan have been designed in accordance with the TENDER DOCUMENT as far as possible.

Deviations made in connection with the deviations in the PROCESS UNITS are as shown in the subsequent paragraphs.

The individual specifications of the storage tank are given in the tank list herein.

(1) Adjusted items of tankage equipment and facilities

(a) The capacities of the intermediate oil tanks have been checked with refirence to the changes in the capacities of the PROCESS UNITS.

Though some tanks underrun or overrun the ten-day or five-day storage capacity called for in the TENDER DOCUMENTS, as almost all the tanks satisfy the requirements, it has been decided that the tank capacities should not be altered.

(b) Since un-desulfurized naphtha from the CRUDE UNITS will be fed directly to the N-HDS UNITS, the vapor pressure of the naphtha will be too high for the un-desulfurized naphtha tanks.
However, the tank will not be eliminated since it can be used to receive un-desulfurized naphtha run down through the N-HDS UNIT and stabilizers at start-up when the naphtha bypasses the N-HDS UNIT reactor section.

(c) For the atmospheric bottoms tanks, the cone roof type is indicated at TENDER DOCUMENTS, but it has been changed to the floating roof type in connection with the process requirements of the GULF-HDS UNITS.

The booster pumps on the streams from these tanks have been eliminated and the lines to the pumps in the GULF-HDS UNITS are regarded as suction lines.

(d) Component oil tanks have been provided in accordance with the TENDER DOCUMENTS. Since desulfurized heavy naphtha will not be produced by PROCESS UNIT, desulfurized heavy naphtha tanks can be eliminated, but as they can be used for other purposes, their elimination has not been considered.

(2) Tankage layout

The tankage layout shown on the plot plan included in the TENDER DOCUMENTS has been used after adjustment to the expanded PROCESS UNITS and utility facility areas.

6.2 Crude oil system

Two crude oils will be delivered to the refinery by one pipeline, the N-Rumaila crude oil and Mischerif crude oil. The N-Rumaila and Mischerief crude will each be

stored in three floating roof tanks. The two crude oils shall be routed to six respective storage tanks through the pipeline. Automatic operating pigging equipment shall be provided on the pipeline to avoid the mix of two crude oils.

The sizing of the crude oil tankage is based on providing storage for five days normal feed to the crude oil distillation units.

The crude storage tanks shall be fitted with high level alarms whose signals will be used for the automatic cut-out of the crude pumps.

The crude oils will be transferred from their storage tanks to their respective CRUDE DISTILLATION UNITS.

6.3 Intermediate oil system

Intermediate storage facilities shall be provided for the outputs from the N-Rumaila and Mischerief CRUDE DISTILLATION UNITS to allow the plant to continue operating for a limited number of days in the event of a shutdown of either or both of the CRUDE UNITS.

The sizing of the intermediate oil tankage is, in general, based on providing storage for ten days normal output from the PROCESS UNIT.

6.4 Component oil system

Component storage facilities shall be provided for all input streams to the blenders to allow production of the final products to continue in the event of shutdown of the process plant.

The sizing of the component oil tankage is, in general, dependent upon the product oil tankage in that the size of each component tank is based on the total quantity of that particular component used in blending one storage tank of each and every product, and the number of each component's tank allows discharge and rundown to occur simultaneously using separate tanks.

6.5 Product oil system

The component oils shall be blended in predetermined quantities in three blenders and the resulting black and white product oils shall be stored prior to despatch from the refinery to export terminal.
Blending of the component oils into the black and white product oils shall be accomplished in three in-line digital type blenders.
Automatic operating changing-over valve for control of product shall be attached to this blender.

The blend rates are based on the daily refinery output being blended in 8 hours.

Blender	Blend Rate	Product Oil
Gasoline (blend header No. 1)	1,135 m^3/hr	Petrochemical naphtha Regular gasoline Premium gasoline Aviation turbine fuel
Kerosine/gas oil (blend header No. 2)	1,039 m^3/hr	Kerosine Automotive diesel fuel Heating oil
Fuel oil (blend header No. 3)	2,993 m^3/hr	0.3%S fuel oil 1.0%S fuel oil

Blending will be carried out on a percentage volume basis using turbine or positive displacement meters having automatic temperature compensation to 15.6°C.

All meters shall be provided with twin heads for actual and compensated readings.

The meters with their associated control valve sets shall be located in the discharge lines of the component oil pumps, any ancillary electronic equipment being located in the off-sites control room.

The pumps realted to each blender shall be located in a common area with the exception of the butane pumps.

Pump controls and indications shall be located on the blender control panel in the off-sites control room.

Each blender controller shall comprise a master panel and separate component panels.

6.6 Ancillary systems

(1) Additive

In this export refinery, an anti-oxidant additive will be used for the batch blending of aviation turbine fuel, premium gasoline and regular gasoline in their respective storage tanks and in the petrochemical naphtha swing tank.

Other additive will be charged in the above oils in the export terminal.

(2) Slop oil

Slop oil collected on the refinery shall be disposed of into either a single unleaded slop tank for re-use or into the refinery fuel oil tanks for burning.

The slop oil tank shall have heaters and mixers.
The size of the tank is based on providing storage for 10% of the feed to one CRUDE DISTILLATION UNIT.

The slop oil shall be discharged to either the N-Rumaila or Mischerief crude oil storage tanks or CRUDE DISTILLATION UNIT.

TANK LIST

1. CRUDE OIL TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
NORTH RUMAILA CRUDE OIL TANK	3	45,931	57m DIA x 18m ST	FLOATING	CONE DOWN	MIXERS FITTED
BUZURGAN/ABU GRAB CRUDE OIL TANK	3	45,931	57m DIA x 18m ST	FLOATING	CONE DOWN	MIXERS FITTED

2. INTERMEDIATE OIL TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
ATMOSPHERIC BOTTOMS (BUZURGAN) TANK	1	73,286	72m DIA x 18m ST	FLOATING CONE	CONE DOWN	HEATERS FITTED
ATMOSPHERIC BOTTOMS (RUMAILA) TANK	1	73,286	72m DIA x 18m ST	FLOATING CONE	CONE DOWN	HEATERS FITTED
UNDESULPHURIZED MIXED GAS OIL TANK	1	38,933	54m DIA x 17m ST	CONE	CONE DOWN	MIXERS FITTED
UNDESULPHURIZED KEROSINE (BUZURGAN) TANK	1	36,643	54m DIA x 16m ST	FLOATING	CONE DOWN	MIXERS FITTED ALSO USED AS COMPONENT TANK
UNDESULPHURIZED KEROSINE (RUMAILA) TANK	2	14,540	33m DIA x 17m ST	FLOATING	CONE DOWN	FITTED ALSO USED AS COMPONENT TANK
UNDESULPHURIZED NAPHTHA TANK	1	58,160	66m DIA x 17m ST	FLOATING	CONE DOWN	
DESULPHURIZED NAPHTHA REFORMER FEED TANK	1	38,933	54m DIA x 17m ST	FLOATING	C CONE DOWN	
REFORMATE TANK	2	28,627	45m DIA x 18m ST	CONE	CONE DOWN	BLANKET PURGE ALSO USED AS COMPONENT TANK
MIXED XYLENE FEED TANK	1	10,691	27m DIA x 18m ST	FLOATING	CONE DOWN	
BUTANE TANK	1	1,082	12.7m DIA	-	-	PRESSURIZED SPHERE

3. COMPONENT OIL TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
1.0%S BOTTOMS TANK	2	50,893	60m DIA x 18m ST	CONE	CONE DOWN	HEATERS & MIXERS FITTED
0.3%S BOTTOMS TANK	2	73,286	72m DIA x 18m ST	CONE	CONE DOWN	HEATERS & MIXERS FITTED
UNDESULPHRIZED HEAVY GAS OIL TANK	2	4,329	17.5m DIA x 18m ST	CONE	CONE DOWN	MIXERS FITTED
UNDESULPHRIZED MEDIUM GAS OIL TANK	2	11,309	30m DIA x 16m ST	CONE	CONE DOWN	MIXERS FITTED
DESULPHURIZED HEAVY GAS OIL TANK	2	12,016	30m DIA x 17m ST	CONE	CONE DOWN	MIXERS FITTED
DESULPHURIZED MEDIUM GAS OIL TANK	2	8,835	25m DIA x 18m ST	CONE	CONE DOWN	MIXERS FITTED
DESULPHURIZED KEROSINE TANK	2	12,016	30m DIA x 17m ST	FLOATING	CONE DOWN	MIXERS FITTED
DESULPHURIZED HEAVY KEROSINE TANK	2	4,329	17.5m DIA x 18m ST	FLOATING	CONE DOWN	MIXERS FITTED
DESULPHURIZED HEAVY NAPHTHA TANK	2	4,088	17.5m DIA x 17m ST	FLOATING	CONE DOWN	MIXERS FITTED
HEAVY AROMATICS TANK	2	4,088	17.5m DIA x 17m ST	CONE	CONE DOWN	MIXERS FITTED
DEHEPTANISER OVERHEAD TANK	2	8,835	25 m DIA x 18m ST	FLOATING	CONE DOWN	MIXERS FITTED
REFFINATE TANK	2	9,503	27.5m DIA x 16m ST	FLOATING	CONE DOWN	
LIGHT STRAIGHT RUN GASOLINE TANK	2	24,937	42m DIA x 18m ST	FLOATING	CONE DOWN	MIXERS FITTED
BUTANE TANK	2	2,081	15.8m DIA	-	-	PRESSURIZED SPHERES
BENSENE	1	17,303	36.0m DIA x 17m ST	WEATHER MASTER	CONE UP	HEATERS FITTED ALSO USED AS PRODUCT TANK

4. PRODUCT OIL TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
1.0%S FUEL OIL TANK	3	61,581	66m DIA x 18m ST	CONE	CONE UP	HEATERS & MIXERS FITTED
0.3%S FUEL OIL TANK	3	61,581	66m DIA x 18m ST	CONE	CONE UP	HEATERS & MIXERS FITTED
HEATING OIL TANK	2	15,395	33m DIA x 18m ST	CONE	CONE UP	MIXERS FITTED
AUTOMOTIVE DIESEL FUEL TANK	2	15,395	33m DIA x 18m ST	CONE	CONE UP	MIXERS FITTED
KEROSINE TANK	2	15,395	33m DIA x 18m ST	FLOATING	CONE UP	MIXERS FITTED
ADIATION TURBINE FUEL TANK	2	3,004	15m DIA x 17m ST	FLOATING	CONE UP	MIXERS FITTED
PREMIUM GASOLINE TANK	2	5,340	20m DIA x 17m ST	FLOATING	CONE UP	MIXERS FITTED
REGULAR GASOLINE TANK	2	30,624	51m DIA x 15m ST	FLOATING	CONE UP	MIXERS FITTED
PETROCHEMICAL NAPHTHA TANK	2	8,344	25m DIA x 17m ST	FLOATING	CONE UP	MIXERS FITTED
PARA-XYLENE TANK	1	15,395	33m DIA x 18m ST	WEATHER MASTER	CONE UP	HEATERS FITTED

5. ANCILLARY TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
REFINERY FUEL OIL TANK	2	9,503	27.5m DIA x 16m ST	CONE	CONE DOWN	HEATERS & MIXERS FITTED
SLOP OIL TANK	1	2,650	15m DIA x 15m ST	CONE	CONE DOWN	HEATERS & MIXERS FITTED
ADDITIVE TANK	2			FLAT	FLAT	

6. LIQUID SULPHUR TANKS

SERVICE	QTY	CAPACITY (m^3)	SIZE	ROOF TYPE	BOTTOM TYPE	REMARKS
LIQUID SULPHUR HEAD TANK	2	100				HEATERS FITTED CYLINDRICAL TANKS

Chapter 7.

Refinery Layout

Chapter 7. Refinery Layout

7.1 Refinery plot plan

(1) We made a study of Dwg. No. 40.E2 Refinery Plot Plan included in the TENDER DOCUMENTS, resulting particularly in the enlargement of PROCESS UNITS (A), PROCESS UNITS (B) and the Utility areas indicated in the attached drawing.
Based on this study, we prepared the Refinery Plot Plan as shown in Dwg. No. 00-G-003.

(2) Coordination procedure of refinery plot plan

All locations relative to the refinery plot plan are based on the Bench Mark "A" (South +0, East +0) indicated on Topographic Site Survey Dwg. No. 508-C-01 contained in TENDER DOCUMENT Vol. VI Para. a.
According to the above, the straight road from the main gate which passes on the north side of PROCESS UNITS (B) and goes to the tankage is to be S +920,000 whereas the road between the utility areas located on the west side of PROCESS UNITS (A) and (B) is to be E +440,000. As indicated on Dwg. No. 00-G-021-B "Process General Plot Plan", intersection of the above two roads is indicated as E +440,000, S +920,000.

7.2 General process plot plan

(1) After carefully studying PROCESS UNITS (A), PROCESS UNITS (B) and the pipe tracks to be installed in the area between them, we prepared the General Process Plot Plan shown in Dwg. No. 00-G-021-B.

(2) Configuration of process units

On the refinery plot plan shown on Dwg. No. 40-E2 included in the TENDER DOCUMENTS (Vol. V), the Process Units are grouped into two and located in two separate areas.

This plot plan has been reviewed carefully and the PROCESS UNITS have been grouped into PROCESS UNITS (A) and PROCESS UNITS (B); namely, the HDS COMPLEX have been located together based on the view that they should be covered by the same control room.

(3) Battery limits of process areas

The battery limits of the process areas are as shown by using two-dot chain lines on the process general plot plan Dwg. No. 00-G-021-B.

As seen from the drawing, the substation and the common stack are located outside the process area. The facilities outside the areas will be provided in accordance with the off-site design specification

(4) Enlargement of process plant area

(a) As the result of detailed studies on the areas for both PROCESS UNITS (A) and (B), the plot plan will be a little larger in area than can be estimated from Dwg. No. 40-E2 attached to the TENDER DOCUMENT Vol. V, namely east-west dimension (center line of road) is 500 m and north-south dimension is 270 m for both PROCESS UNITS (A) and (B).

Center spacing between the ab ove two process units (pipe truck area) is laid to be 76 m from the above drawing and thus remains unchanged.

(b) Both spacing between PROCESS UNITS (A) north side battery limit and road, and between PROCESS UNITS (B) south side battery limit and road are enlarged where the substation and common stack are planned to be located.

(5) Plot plan of process control rooms

(a) After an overall study on operation and maintenance, it has been decided not to use the north-west and south-west ends plotted in Dwg. No. 40-E2 but to locate the control rooms at the pipe truck area side of each process unit.

(b) In the PROCESS UNITS (A) area, the control room has been divided into three; one for the N-RUMAILA train, another for the MISCHRIF train and a third for the Common Units. For control in one control room considerably long panels must be provided, and excessively long panels are inadequate for monitoring.
Meanwhile, even if the control room is divided into three, no demerits are expected.

7.3 Refinery utility plot plan

Utility plant shall be plotted on the west of on-site, and, water treatment and effluent treatment plant shall be plotted on the east edge of refinery indicated on TENDOR DOCUMENT Dwg. No. 40-E2.

It was described in the above section 7.2 that area of these facilities are planned as expanded area than the above indicated area since the area on TENDER DOCUMENT is not enough to these facilities.

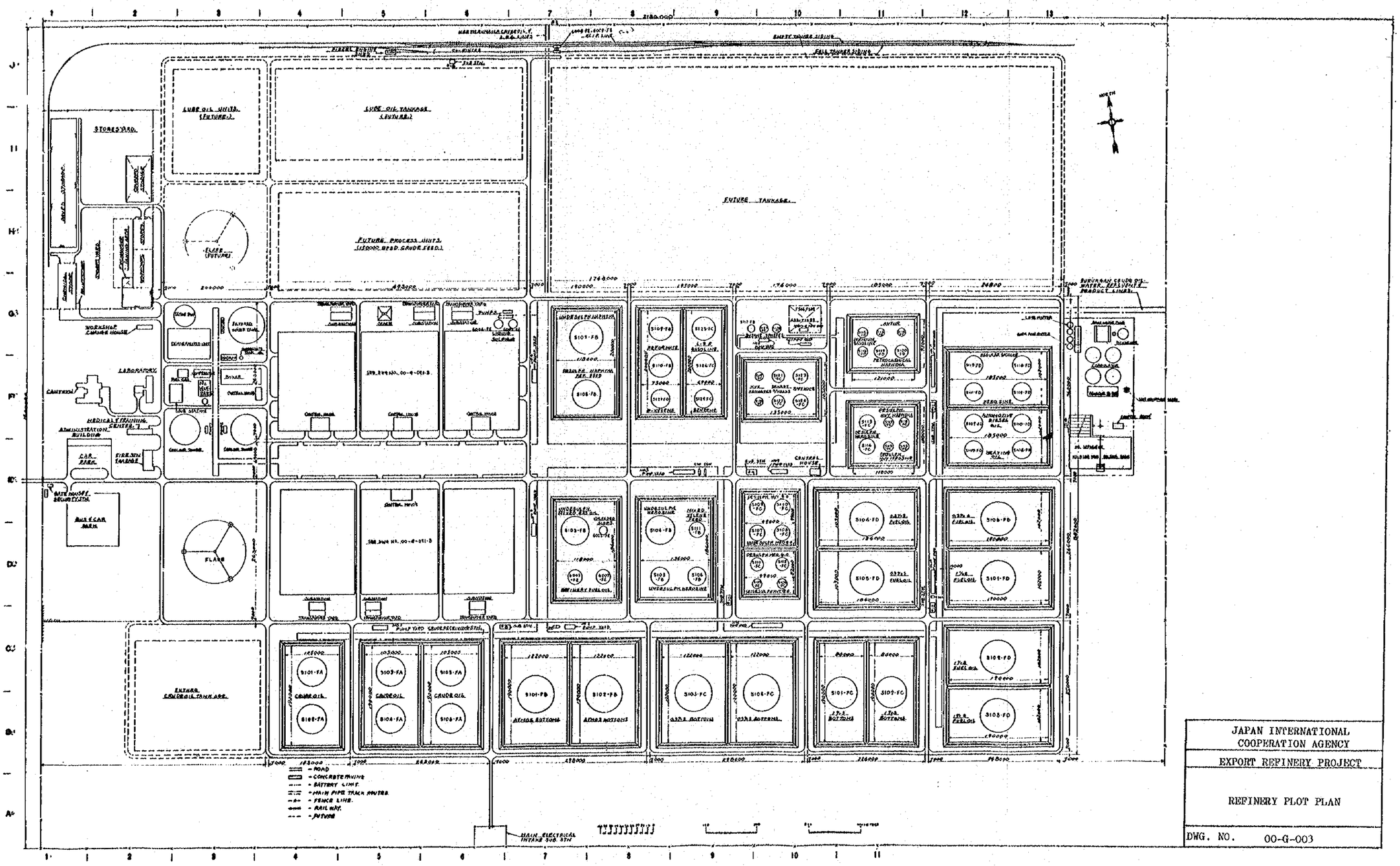
In utility plant area, water treatment facilities such as filtrated water storage tank, deminerelizer units and demineralized water storage tank shall be planned with utility facilities such as cooling tower, inert gas generator, etc.

Facilities of filtration and effluent treatment facilities basin shall be plotted on water treatment plant on the east side of refinery.
Fuel oil tank and fuel gas tank shall be plotted on the tank yard. Plot plan of these facilities shall be given on Dwg. No. 50-G-001 herein.

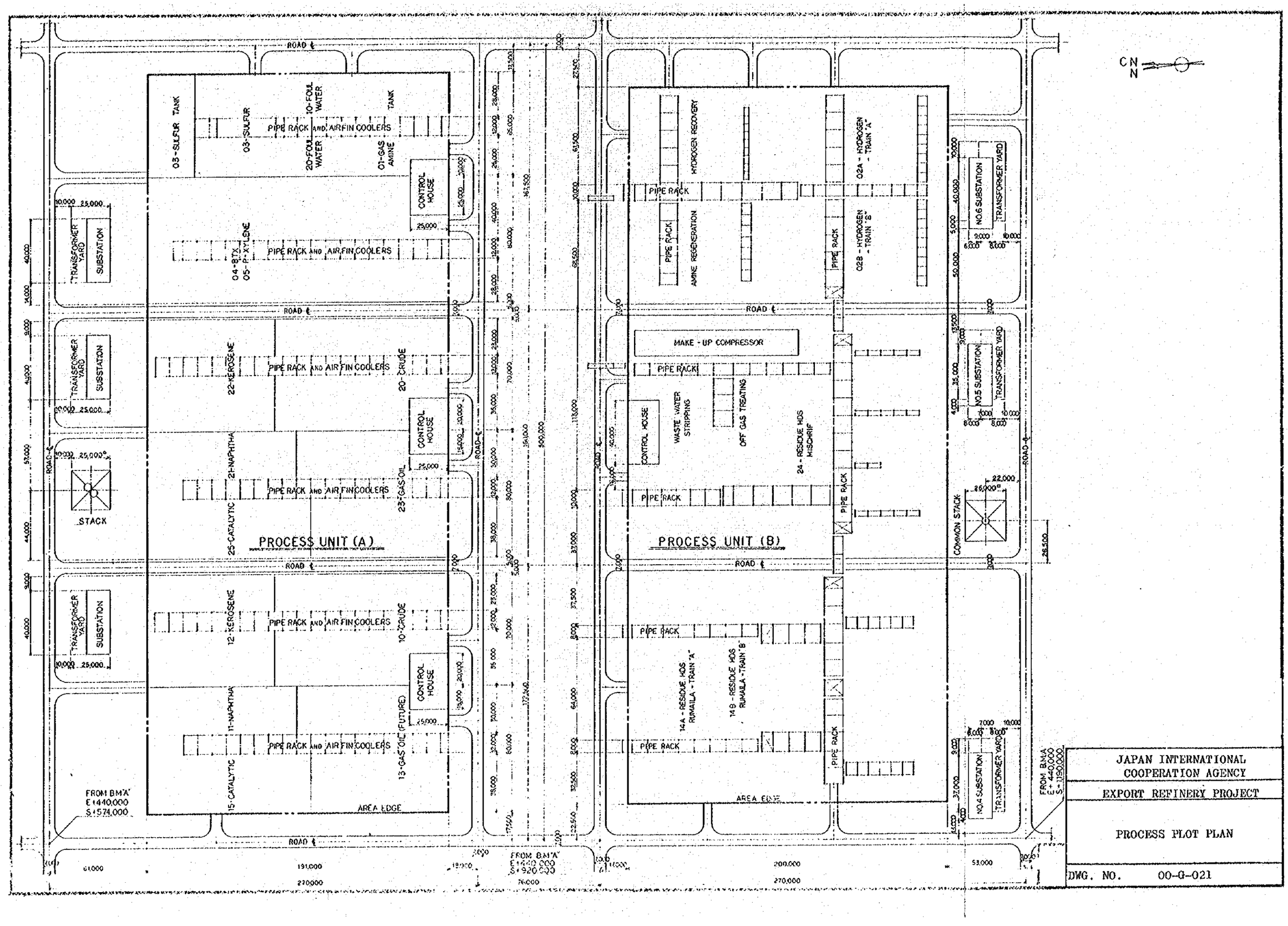
7.4 Refinery elevation

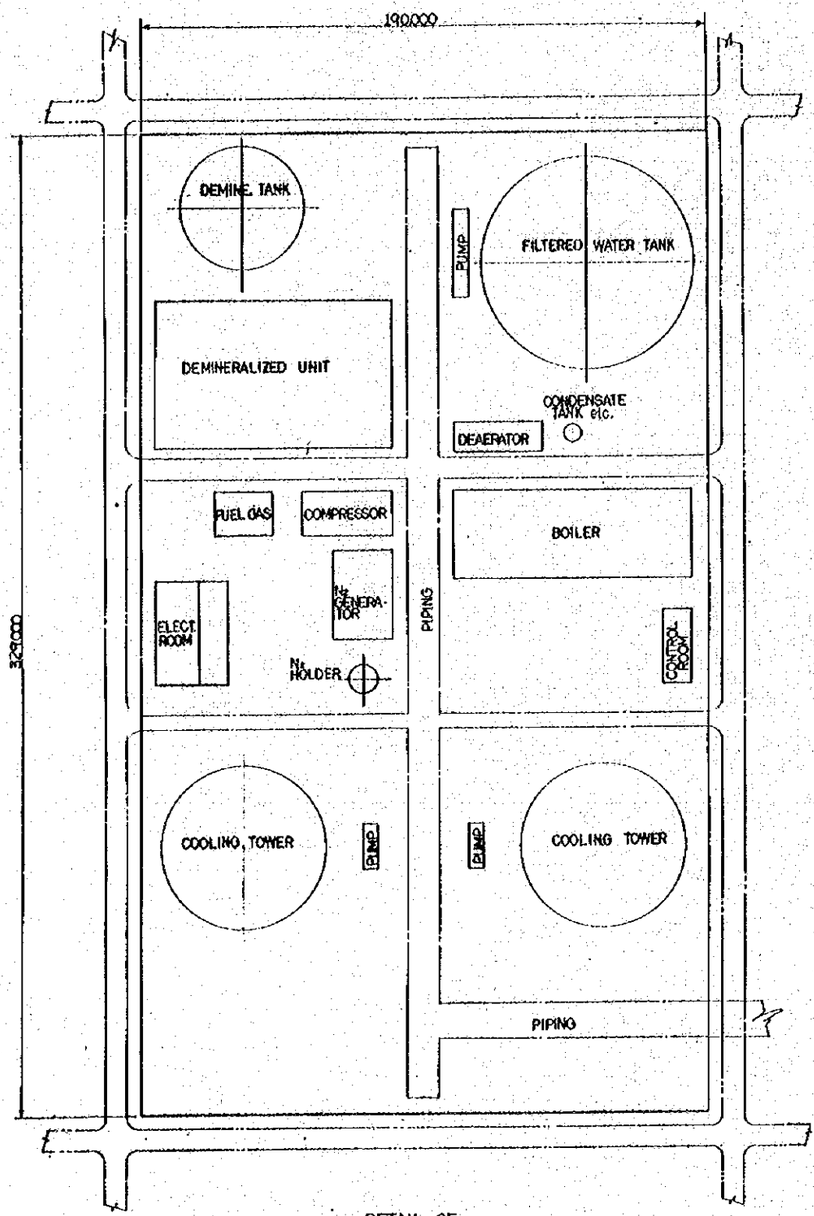
On the basis of the contour lines specified in the drawing captioned as Topographic Site Survey (Dwg. No. 508-C-01) which is included in the TENDER DOCUMENTS, the level was decided so that the soil movement may be carried out economically.

The level decided in this manner is specified in this report Section 8.1 Basic Engineering Design Data, Article 8.1.3 Site Conditions, Item 6) and a drawing (Dwg. No. 00-G-002) is attached thereto for reference.

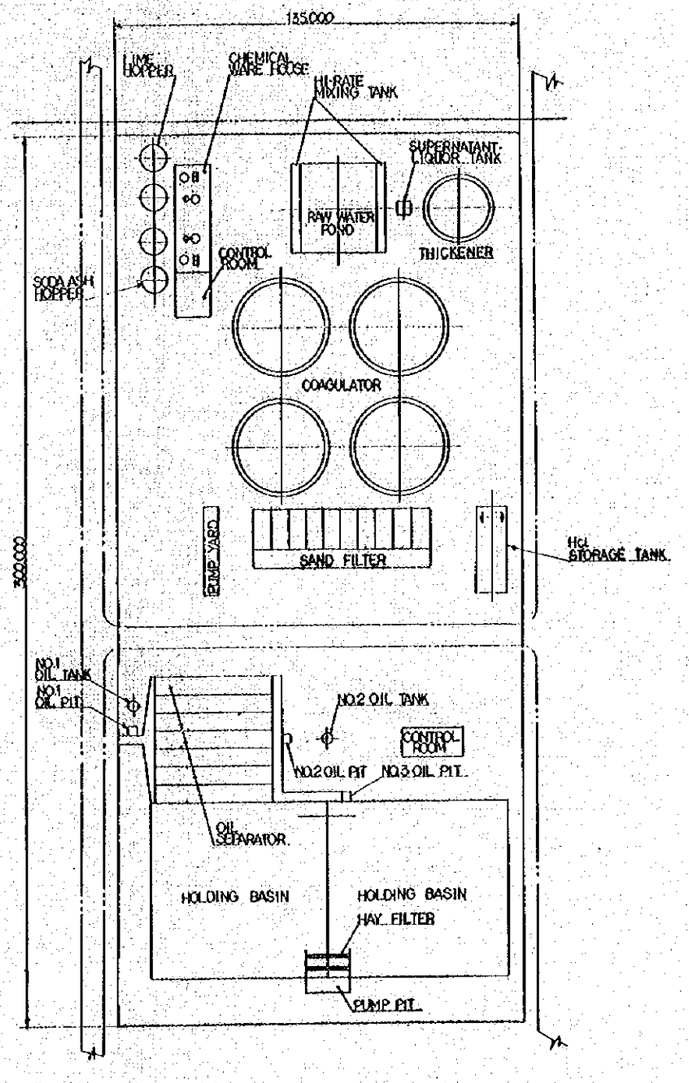


JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
REFINERY PLOT PLAN
DWG. NO. 00-G-003

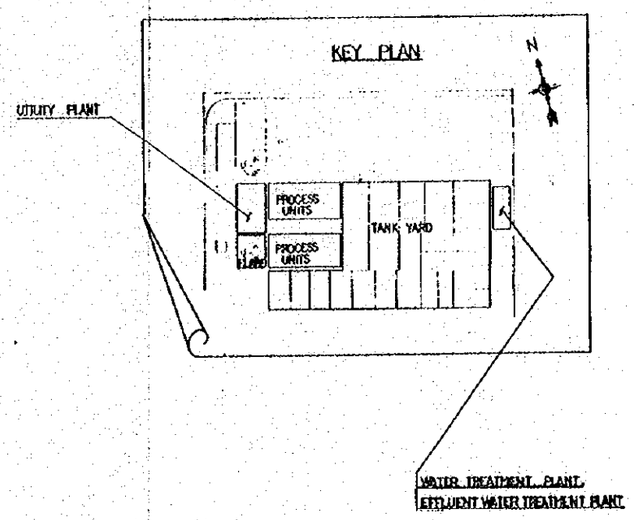

ROAD
03-SULFUR TANK
03-SULFUR
20-FOUL WATER
PIPE RACK AND AIR FIN COOLERS
01-GAS AMINE TANK
CONTROL HOUSE
TRANSFORMER YARD
SUBSTATION
04-BTX
05-P-XYLENE
22-KEROSENE
20-CRUDE
21-NAPHTHA
23-GAS OIL
STACK
PROCESS UNIT (A)
12-KEROSENE
10-CRUDE
11-NAPHTHA
13-GAS OIL (FUTURE)
15-CATALYTIC
AREA EDGE
FROM B.M.'A'
E+440,000
S+574,000
FROM B.M.'A'
E+440,000
S+920,000
HYDROGEN RECOVERY
AMINE REGENERATION
PIPE RACK
02A - HYDROGEN - TRAIN 'A'
02B - HYDROGEN - TRAIN 'B'
NO.6 SUBSTATION
MAKE - UP COMPRESSOR
WASTE WATER STRIPPING
OFF GAS TREATING
24 - RESIDUE HDS MISCHRIF
PROCESS UNIT (B)
14A - RESIDUE HDS RUMAILA - TRAIN 'A'
14B - RESIDUE HDS RUMAILA - TRAIN 'B'
NO.5 SUBSTATION
COMMON STACK
NO.4 SUBSTATION
FROM B.M.'A'
E+440,000
S+1190,000
N
JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
PROCESS PLOT PLAN
DWG. NO. 00-G-021



DETAIL OF
UTILITY PLANT



DETAIL OF
WATER TREATMENT PLANT
EFFLUENT WATER TREATMENT PLANT



JAPAN INTERNATIONAL COOPERATION AGENCY	
EXPORT REFINERY PROJECT	
REFINERY UTILITY PLOT PLAN	
DWG. NO.	50-G-001

ELEVATION
14.5 M

ELEVATION
12.5M

ELEVATION
16.0M

ELEVATION
14.5M

ELEVATION
18.0M

STORES YARD

LUBE OIL UNITS (FUTURE)

LUBE OIL TANKAGE (FUTURE)

FUTURE PROCESS UNITS (150000 BPSD CRUDE FEED)

FLARE (FUTURE)

FUTURE TANKAGE

WORKSHOP CHARGE HOUSE

LABORATORY

CANTEEN

MEDICAL & TRAINING CENTER

ADMINISTRATION BUILDING

CAR PARK

RUBBISH TRENCH

BATTERY ROOM & RECTIFYING STN.

BUS & CAR PARK

FLARE

FUTURE CRUDE OIL TANK AREA

PUMP YARD

MAIN ELECTRICAL INTAKE SUB STN

NORTH

2000

- ROAD
- CONCRETE PAVING
- BATTERY LIMIT
- MAIN PIPE TRACK ROUTES
- FENCE LINE
- RAILWAY
- FUTURE

JAPAN INTERNATIONAL COOPERATION AGENCY

EXPORT REFINERY PROJECT

REFINERY ELEVATION

DWG. NO. 00-G-002

Chapter 8.

Pipeline Design

Chapter 8. Pipeline Design

8.1 General

For supplying crude oil and raw water to the refinery, and for loading products from the refinery, the following pipelines (including despatching and/or loading stations) have been studied.

	Service	From	To	Length (km)
(i)	Crude oil	N-Rumaila Pumping station	Refinery	50
(ii)	Products			
	o Benzen	Refinery	Muftieh jetty	40
	o Para-xylen	Refinery	Muftieh jetty	40
(iii)	Raw water	Shat Al Arab	Refinery	40
(iv)	Effluent	Refinery	Khor Al Zubair	9
(v)	Others			
	o Butane	Refinery	LPG plant	1
	o Pure butane	LPG plant	Refinery	1
	o Natural gas	LPG plant	Refinery	1

The other pipelines such as White product lines, Black product lines and Ballast water lines, etc. called for in TENDER DOCUMENT will be studied after deciding the location of the Storage Terminal.

(1) Proposed pipeline routes

The pipeline routes for each pipeline were roughly examined in accordance with "Key Plant Pipeline Routes" provided by the ENGINEER during site survey performed on July, 1976.

On the basis of the examination, the pipeline routes as shown in Dwg. No. 00-M-001, "Proposed Pipeline Routes" are recommended.

The difference between original routes and proposed routes is the water pipeline route. The difference comes from no availability of land space for water intake station in Muftieh site.

(2) Basic engineering design data

In addition to the basic engineering design data stipulated in Sect. 9.1, the following site conditions are considered in the design of the pipelines.

Temperature

(i) Air temperature

Minimum	Winter	0°C
Maximum	Summer	46°C

(ii) Soil temperature

Minimum	Winter	4°C
Maximum	Summer	38°C

(iii) Sun exposure temperature

Maximum	82°C

(3) Pipeline design

(a) Code and standards

Following code and standards are applied to the design of the pipelines.

(i) ANSI (American National Standard Institute)

(ii) ASTM (American Society for Testing and Material)

(iii) ASME (American Society of Mechanical Engineering)

(iv) API (American Petroleum Institute)

(v) JIS (Japanese Industrial Standard)

(vi) ACI (American Concrete Institute)

(vii) AISC (American Institute of Steel Construction)

(b) The pipelines except Effluent pipeline are planned to be protected against pressure surge hummering due to the starting and stopping of pumps by pressure relief valves.

(c) The pipelines are buried with suitable soil coverages and the cathodic protections are provided by means of the impressed current system.

(d) Where each pipeline crosses roads and railways, the pipeline is protected with steel casing pipe.

8.2 Crude oil pipeline

The pipeline is designed to transport two (2) kinds of crude, i.e., N-Rumaila and Mischrif, from N-Rumaila pumping station to the refinery.

The despatching pump station will be constructed in the area of the existing pumping station, and existing crude tanks and booster pumps will be used for this pump system.

(1) Design flow rate

The design flow rate of the pipeline is 2,700 m^3/hr. The flow rate was decided in considering the capacity of existing booster pumps at the pumping station which is operating at the flow rate from 2,700 m^3/hr to 6,400 m^3/hr.

(2) Transfer pump system

The pump station has been planned to have the flexibility for operation of two (2) kinds of crude oil and in considering the existing facilities.

The schematic main pump system is shown in Dwg. No. 90-M-001 "Mechanical Flow Sheet". This system consists of four (4) horizontal centrifugal pumps which shall be operated in series and driven by gas turbines.

This system is designed by taking account of the following conditions.

(a) Pressure variation

The pressure loss in the pipeline will vary widely (approximate from 15 kg/cm^2 to 25 kg/cm^2) due to the change of crude oil to be transported and it's temperature.

(b) Capacity of existing electricity

The capacity of the existing electricity is already used for the existing facilities and no surplus for new equipments. (It is estimated to be necessary approximate 6,000 KW, if new pumps are driven by electric motors.)

(3) Pipiline sizing

From the calculation of friction loss, the 30 inches of pipe diameter is derived expecting pressure drop as 24.5 kg/cm^2 in the maximum for Mischrif.

Flow sheet of the pipeline is shown in Dwg. No. 90-M-001 "Mechanical Flow Sheet".

8.3 Products pipelines

Two (2) pipelines are designed to transport products from the refinery to Muftieh jetty, one is for benzen and the other is for para-xylen.

(1) Design flow rate

The design flow rate of each pipeline is 800 m^3/hr.

(2) Transfer pump system

The transfer pump system for each pipeline consists of two (2) horozontal centrifugal pumps driven by electric motors, one is for normal operation and the other is standby.

(3) Pipeline sizing

For bezen pipeline, from the calculation of friction loss, the 16 inches of pipe diameter is derived, expecting the pressure drop as approximate 31.0 kg/cm^2 and for para-xylen, the 16 inches is derived, expecting as 31.0 kg/cm^2.

(4) Heating up system

Notwithstanding heating up of benzene and para-xylen to approximate 90°C at the refinery, our calculation for heat loss indicates that benzene and para-xylen will be solidified during transportation through the insulated pipelines in winter.

So, it is recommended to apply electrical heat tracing system with insulation such skin electric current tracing system on the pipelines so as to avoide the solidification.

(5) Muftieh terminal

For loading the products to tankers from Muftieh jetty, receiving facilities such as pig receivers, slop pumps and separators, etc. and loading facilities such as loading arms and metering devices shall be installed at Muftieh jetty.
But we found that the spaces needed for both receiving and loading facilities are no avairable there at present. So we would like to recommend that remolding and cleaning the old refinery having stopped operation to get the space for receiving facilities, and remolding the existing wooden jetty located next to the existing concrete jetty and reconstructing new concrete jetty for new loading facilities. (It is estimated to need 10 m in length for installation of two 12" loading arms for two products and one 8" loading arm for deballast water.)

Flow sheets of the pipelines are shown in Dwg. No. 92-M-001, 92-M-002, "Mechanical Flow Sheet".

8.4 Raw water pipeline

The pipeline is designed to transport river water from Shat Al Arab river to the refinery. This pipeline consists of water intake station and pipeline itself.

(1) Design flow rate

Considering the future expansion of refinery, the design capacity of each facility is determinded as follows.

For pipeline	:	4,500 m^3/hr
For raw water transfer pump system	:	Max. 2,900 m^3/hr Nor. 2,100 m^3/hr
For water intake system	:	4,500 m^3/hr

(2) Water intake system

The location of the water intake station is recommended to shift to the point approximate 10 km down stream from Muftieh site which is indicated in TENDER DOCUMENT, because of no availability of space for constructing new water intake to be estimated as approximate 3,000 m^2 (60 m x 50 m).

The river water is carried into the sedimentation basin by gravity through intake pipes. The sedimentation basin is equipped with bar screens, scraper and rotating screens (traveling screens) and divided into two parts by partition wall for inspection and maintenance.

The system is shown in "Water Intake System Block Flow Diagram" (Dwg. No. 94-M-010).

(3) Transfer pump system

The transfer system consists of three vertical pump which are operated in parallel and driven by electric motors, two of them are for normal operation and one is standby.

Considering the future expansion, the space for one additional pump in the pump system is provided.

(4) Pipeline

As the location of water intake system is changed, accodingly the route of the pipeline is also changed. Recommended route is shown in "Proposed Routs Drawing", and the length of the route is approximate 40 km.

(5) Pipeline sizing

From the calculation of friction loss, the 38 inches of pipe diameter is derived, expecting the pressure drop as approximate 20.0 kg/cm^2 at flow rate 4,500 m^3/hr, and approximate 10.6 kg/cm^2 at flow rate 2,900 m^3/hr.

Flow sheet of the pipeline is shown in Dwg. No. 94-M-001 "Mechanical Flow Sheet".

8.5 Effluent pipeline

(1) Design flow rate

The design capacity of each facility is determined as follows.

For pipeline	:	2,100 m^3/hr
For transfer pump system:	Max.	2,100 m^3/hr
	Nor.	1,150 m^3/hr

(2) Transfer pump system

The transfer pump system consists of two (2) horizontal centrifugal pumps driven by electric motors, one is for normal operation.

(3) Pipeline

On the route of the pipeline, it is anticipated that the pipeline will pass through flooded area near Khor Al Zubair. At this area, the pipeline shall be installed on pipe sleepers having enough height not to expose the pipeline to flooded water.

(4) Pipeline sizing

From the calculation of friction loss, the 20 inches of pipe diameter is derived, expecting the pressure drop as approximate 20.7 kg/cm^2 at flow rate 2,100 m^3/hr.

Flow sheet of the pipeline is shown in Dwg. No. 54-M-001 "Mechanical Flow Sheet".

8.6 Other pipelines

Three (3) pipelines are designed to transport butan and natural gas between the LPG plant and the refinery.

(1) Design flow rate

The design of the pipelines is based on the following flow rates.

For butan pipeline (Refinery → LPG plant)	:	28,400 kg/hr
For butan pipeline (LPG plant → Refinery)	:	9,200 kg/hr
For natural gas pipeline: (LPG plant → Refinery)		82,000 Nm^3/hr

(2) Pipeline sizing

From the calculation of friction loss, the 3 inches of pipe diameter is derived for the butan pipeline (from the refinery to the LPG plant), the 2 inches is derived for the butan pipeline (from the LPG Plant to the refinery), and the 10 inches is derived for the natural gas pipeline (from the LPG plant to the refinery).

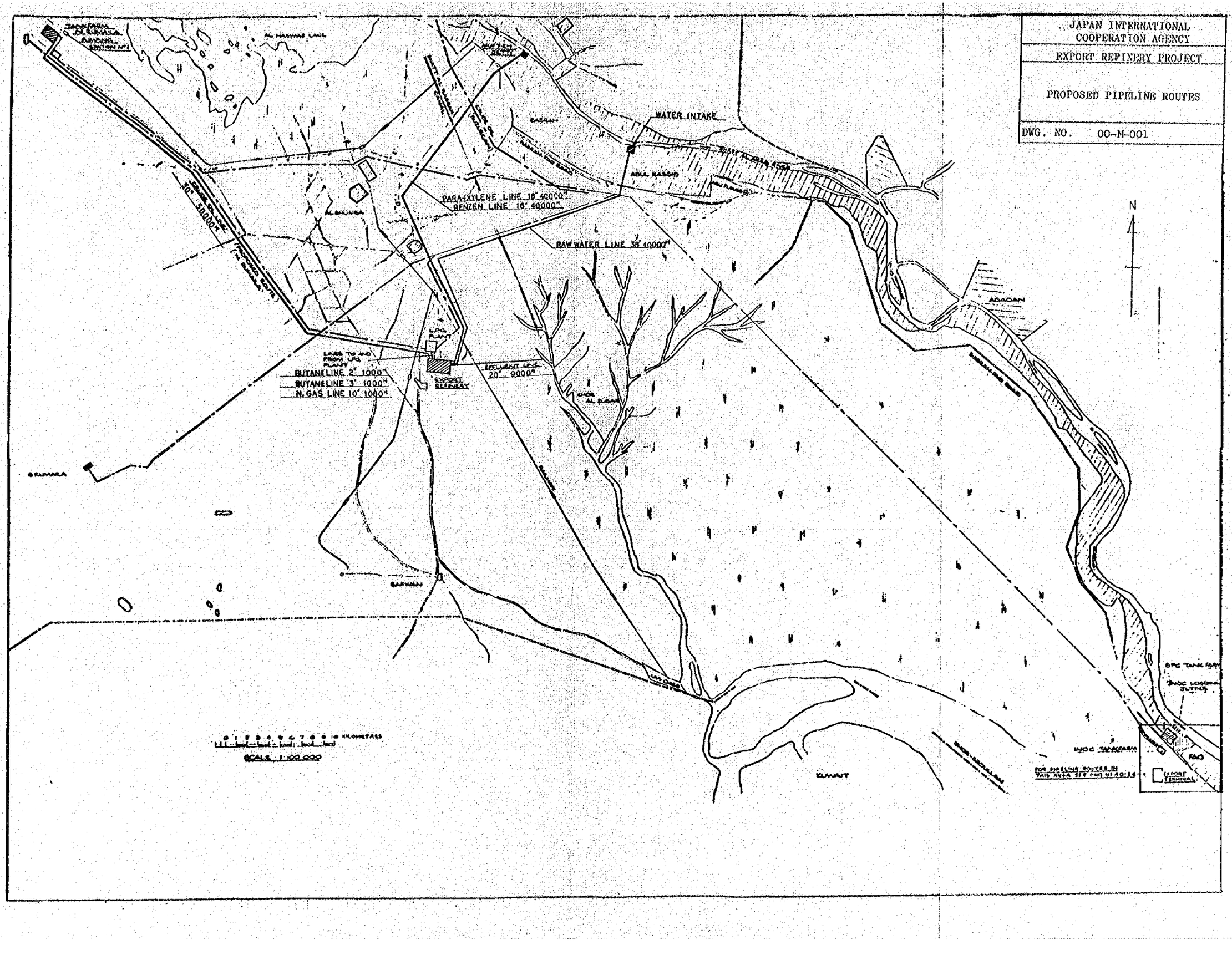
Flow sheets of the pipelines are shown in Dwg. No. 98-M-001, 98-M-002 and 98-M-003, "Mechanical Flow Sheet".

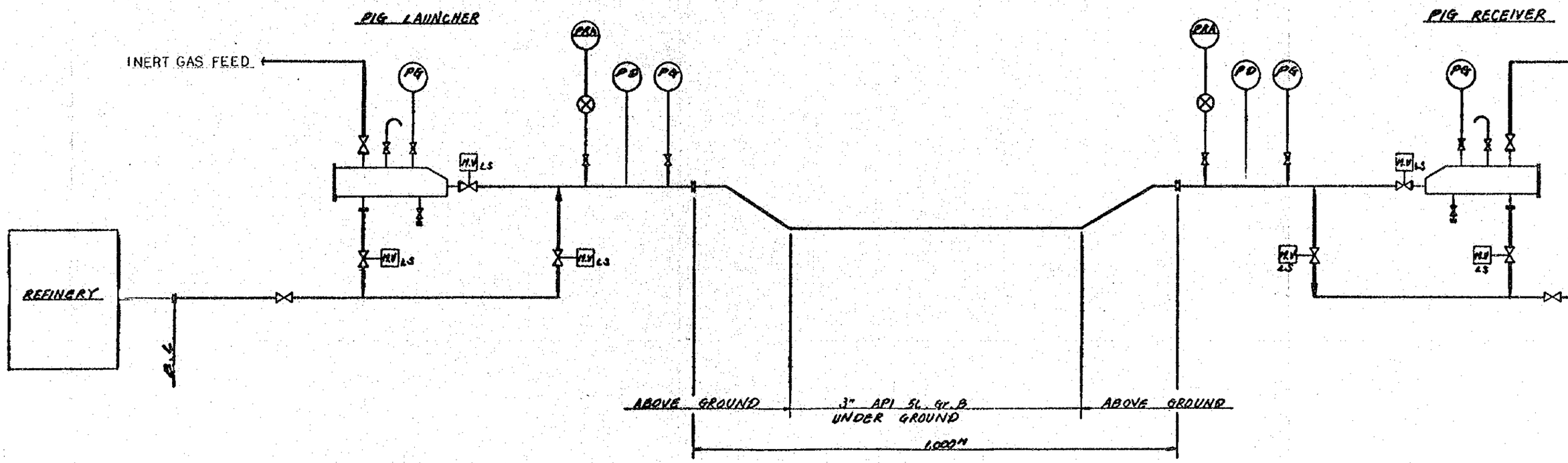
JAPAN INTERNATIONAL COOPERATION AGENCY

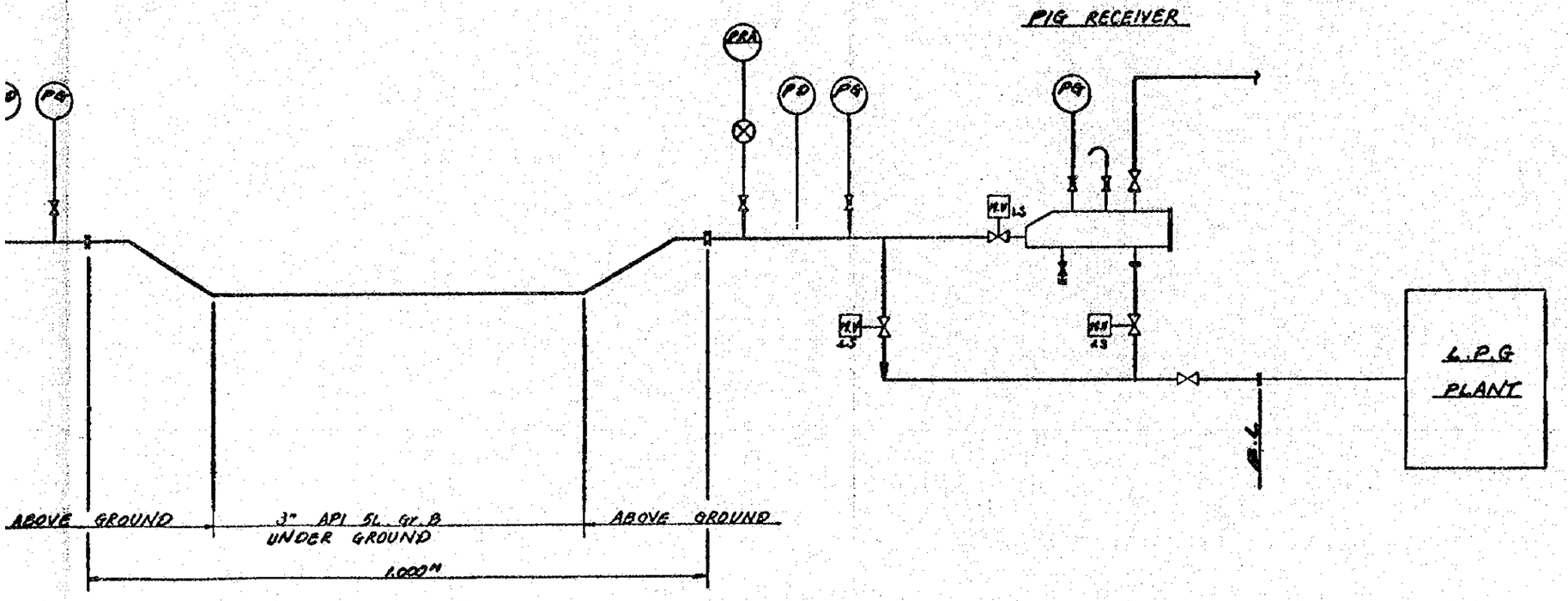
EXPORT REFINERY PROJECT

PROPOSED PIPELINE ROUTES

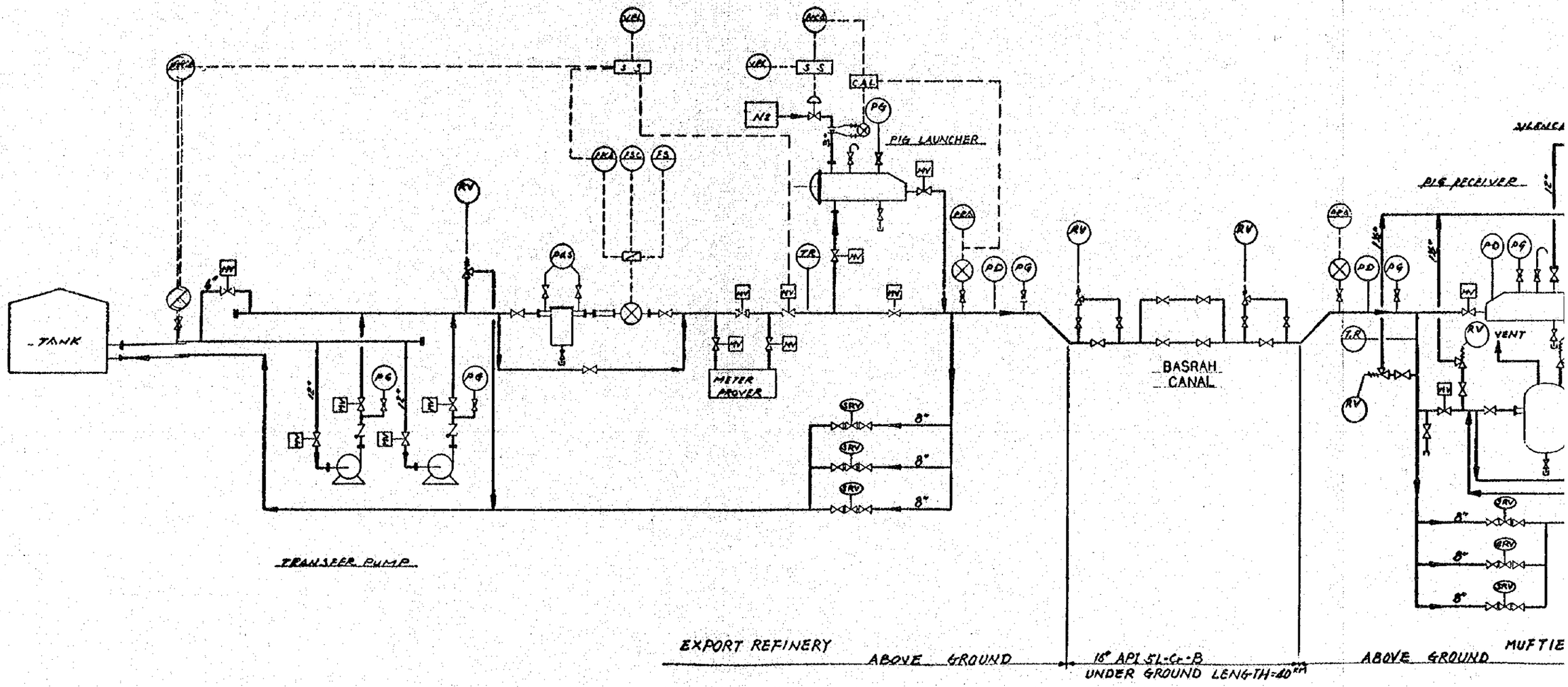
DWG. NO. 00-M-001

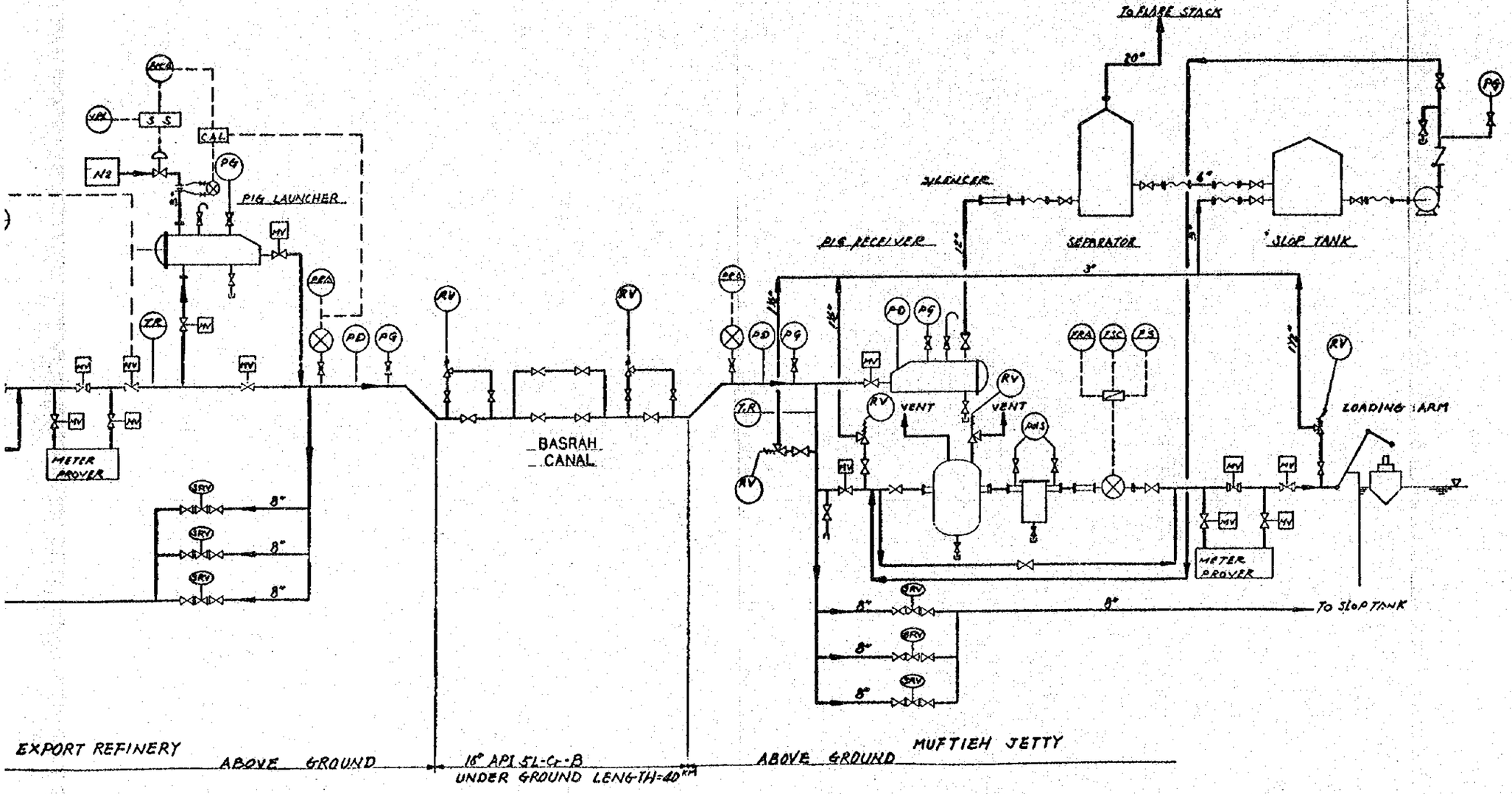



PIG LAUNCHER
PIG RECEIVER
INERT GAS FEED
PG
PDA
PD
PG
H.V LS
REFINERY
B.V.
ABOVE GROUND
3" API 5L Gr. B
UNDER GROUND
ABOVE GROUND
1,000'

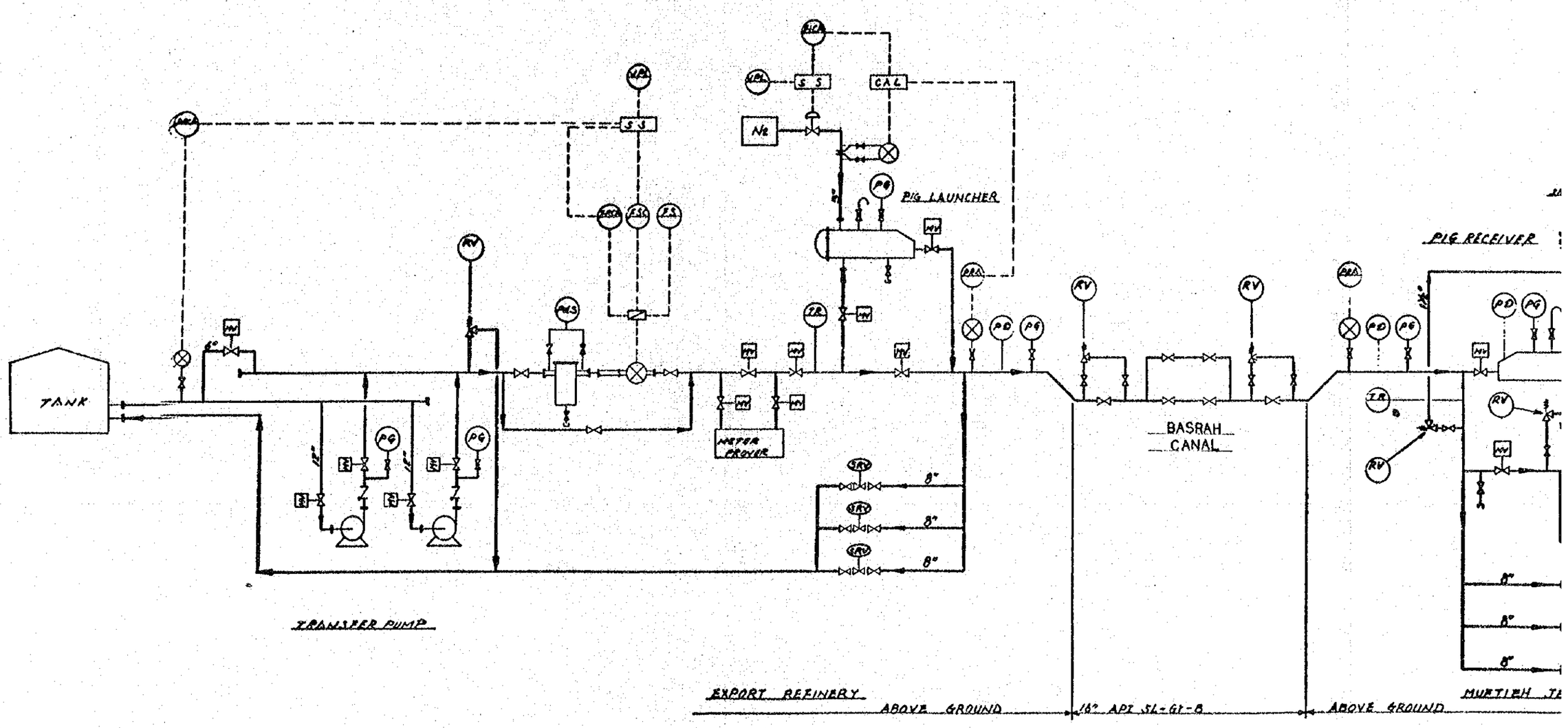


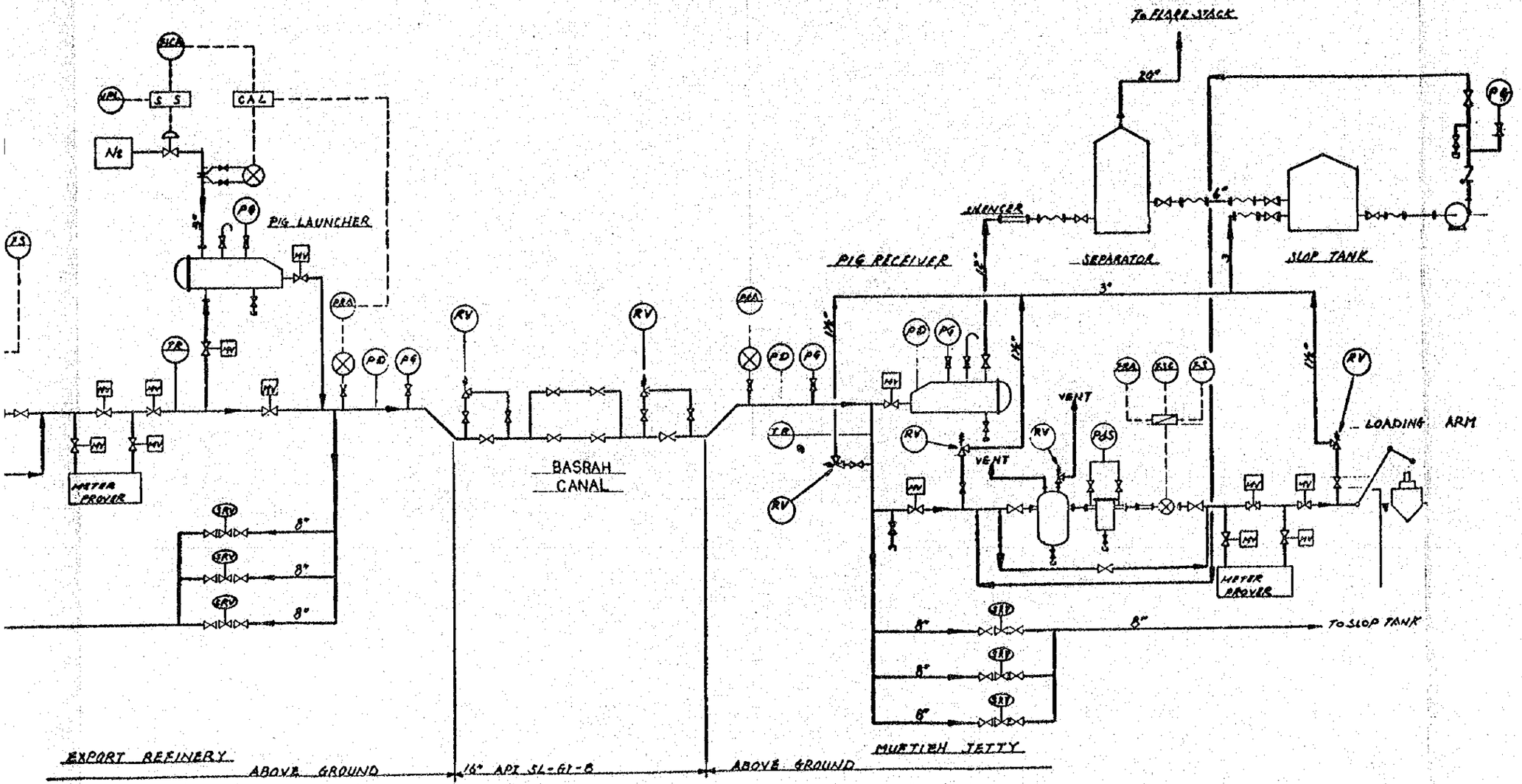
JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
CRUD OIL FLOW SHEET
DWG. NO. 90-M-001


TANK
TRANSFER PUMP
METER PROVER
PIG LAUNCHER
PIG RECEIVER
SILENCER
VENT
BASRAH CANAL
EXPORT REFINERY
ABOVE GROUND
16" API 5L-Gr-B
UNDER GROUND LENGTH=40KM
ABOVE GROUND
MUFTIE
N2
CAL
12"
16"
8"

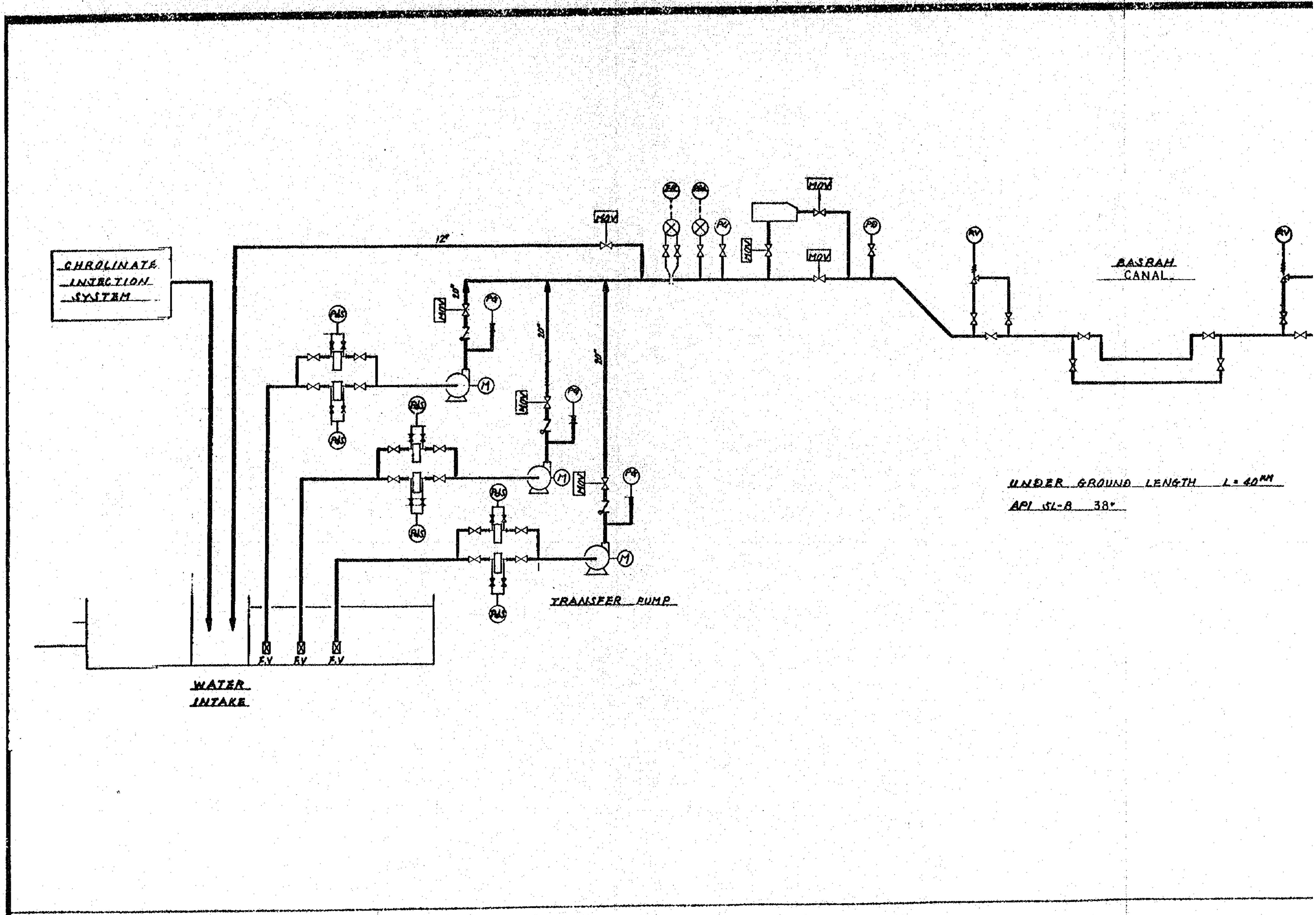


JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
BENZEN FLOW SHEET
DWG. NO. 92-M-001

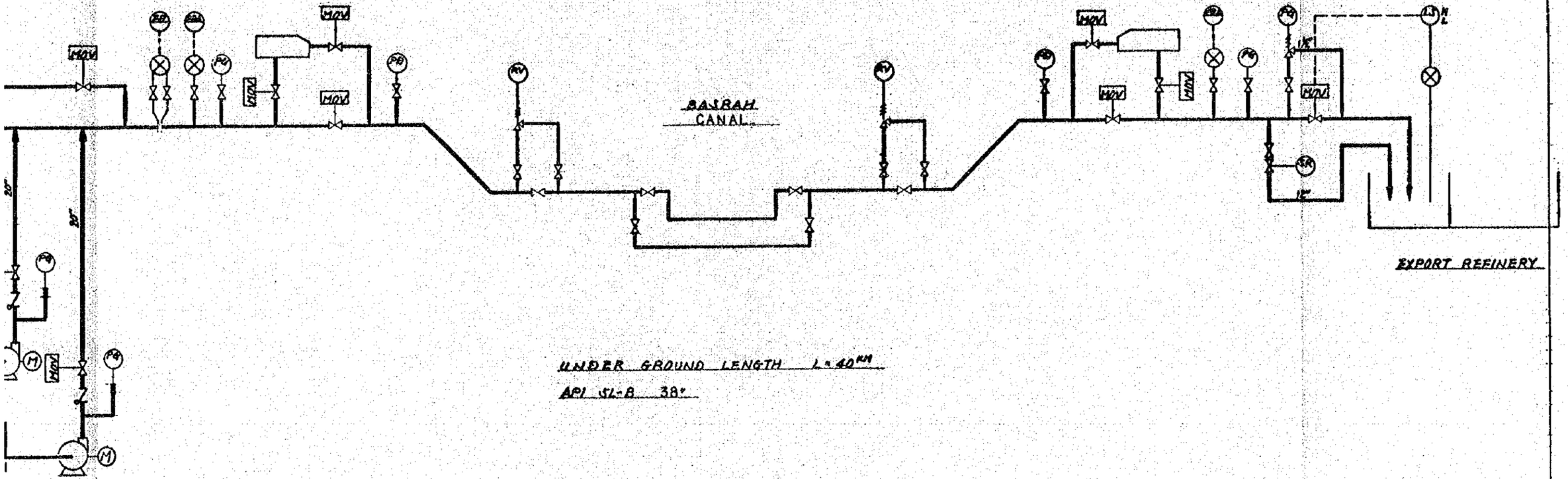

TANK
PIG LAUNCHER
PIG RECEIVER
METER PROVER
BASRAH
CANAL
TRANSFER PUMP
EXPORT REFINERY
ABOVE GROUND
16" API 5L-Gr-B
ABOVE GROUND
MUFTIAH TE



JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
PARA-XYLENE FLOW SHEET
DWG. NO. 92-M-002



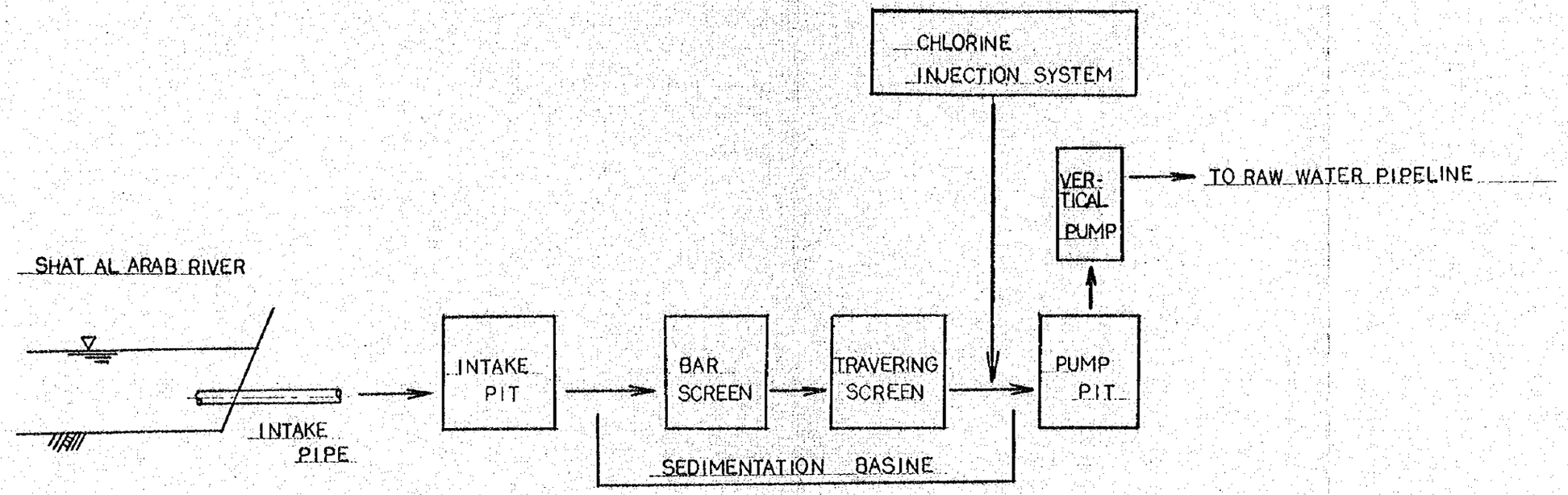
CHROLINATE
INJECTION
SYSTEM
12"
MOV
20"
TRANSFER PUMP
WATER
INTAKE
F.V
BASRAH
CANAL
UNDER GROUND LENGTH L = 40 KM
API 5L-B 38"



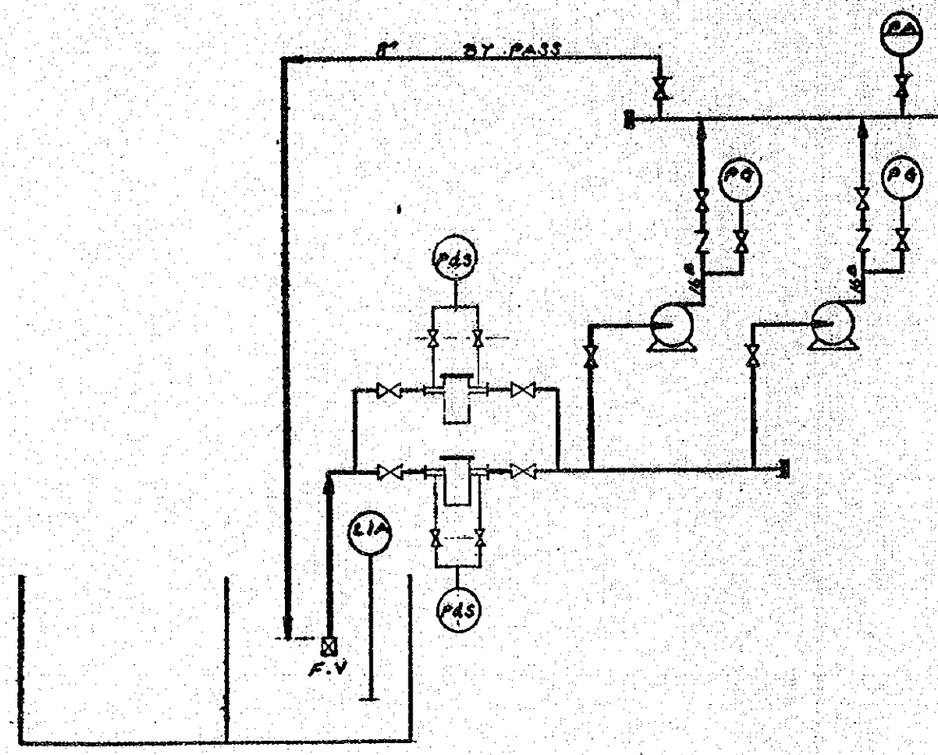
UNDER GROUND LENGTH L = 40 KM

API 5L-B 38"

JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
WATER INTAKE SYSTEM BLOCK FLOW DIAGRAM
DWG. NO. 94-M-010

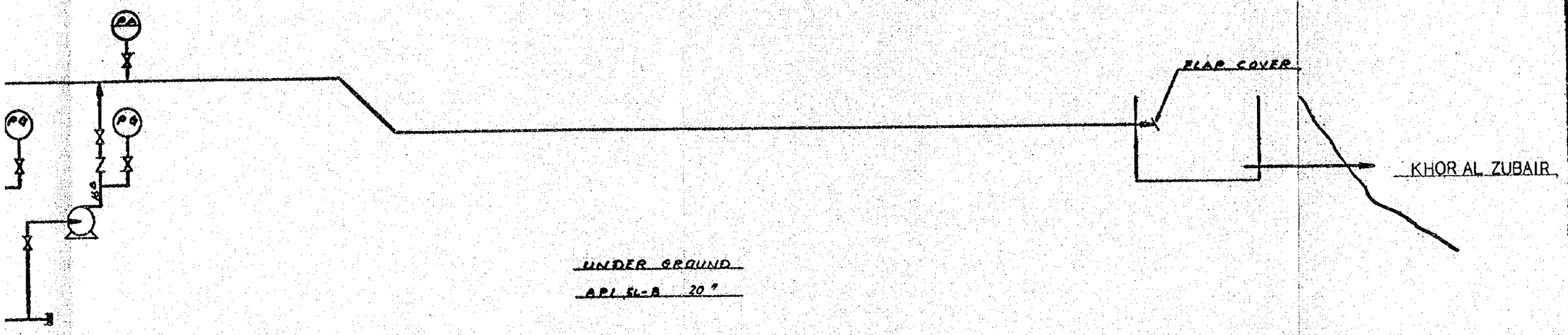


JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
RAW WATER FLOW SHEET
DWG. NO. 94-M-001



WASTE WATER
POND

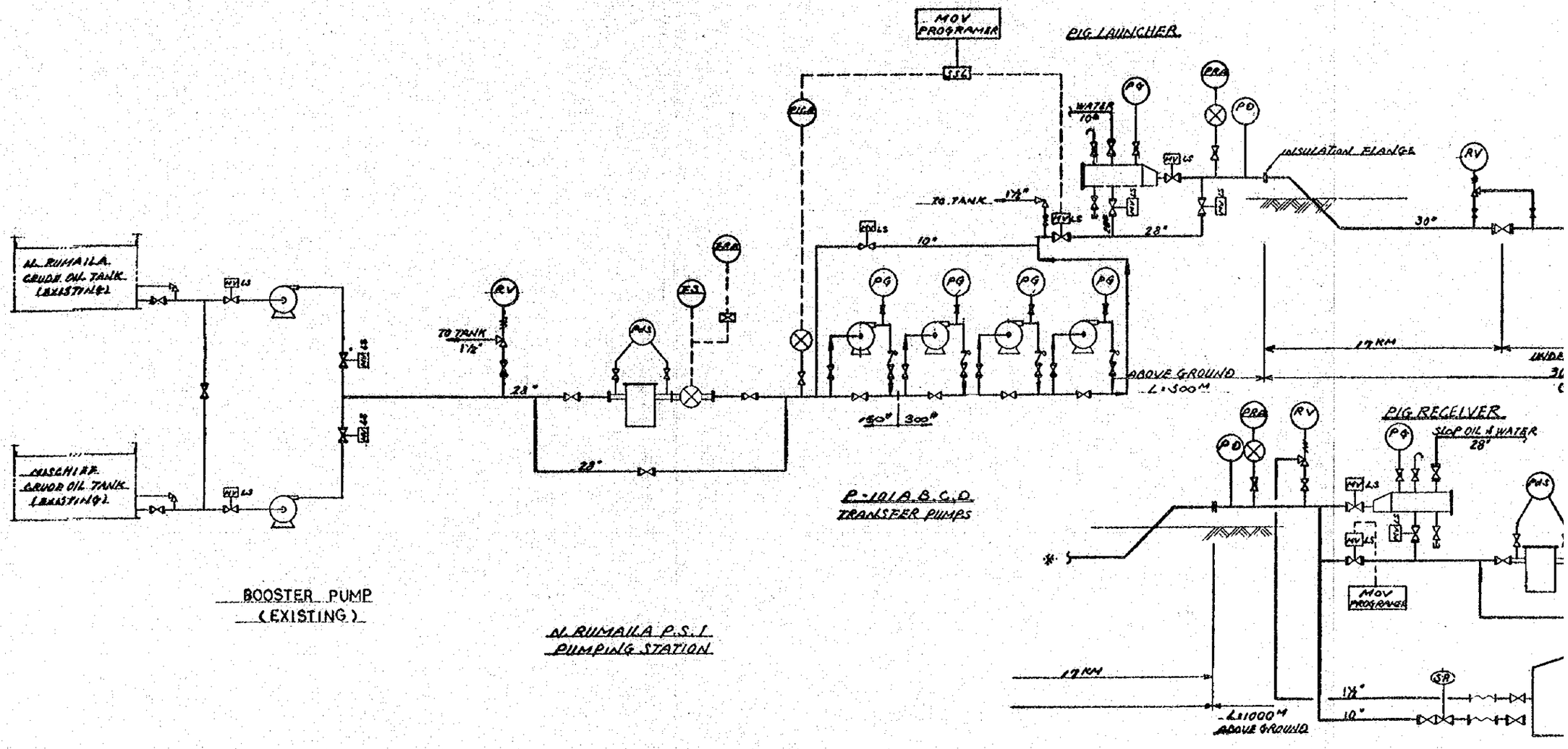
UNDER GROUND
API 5L-B 20"

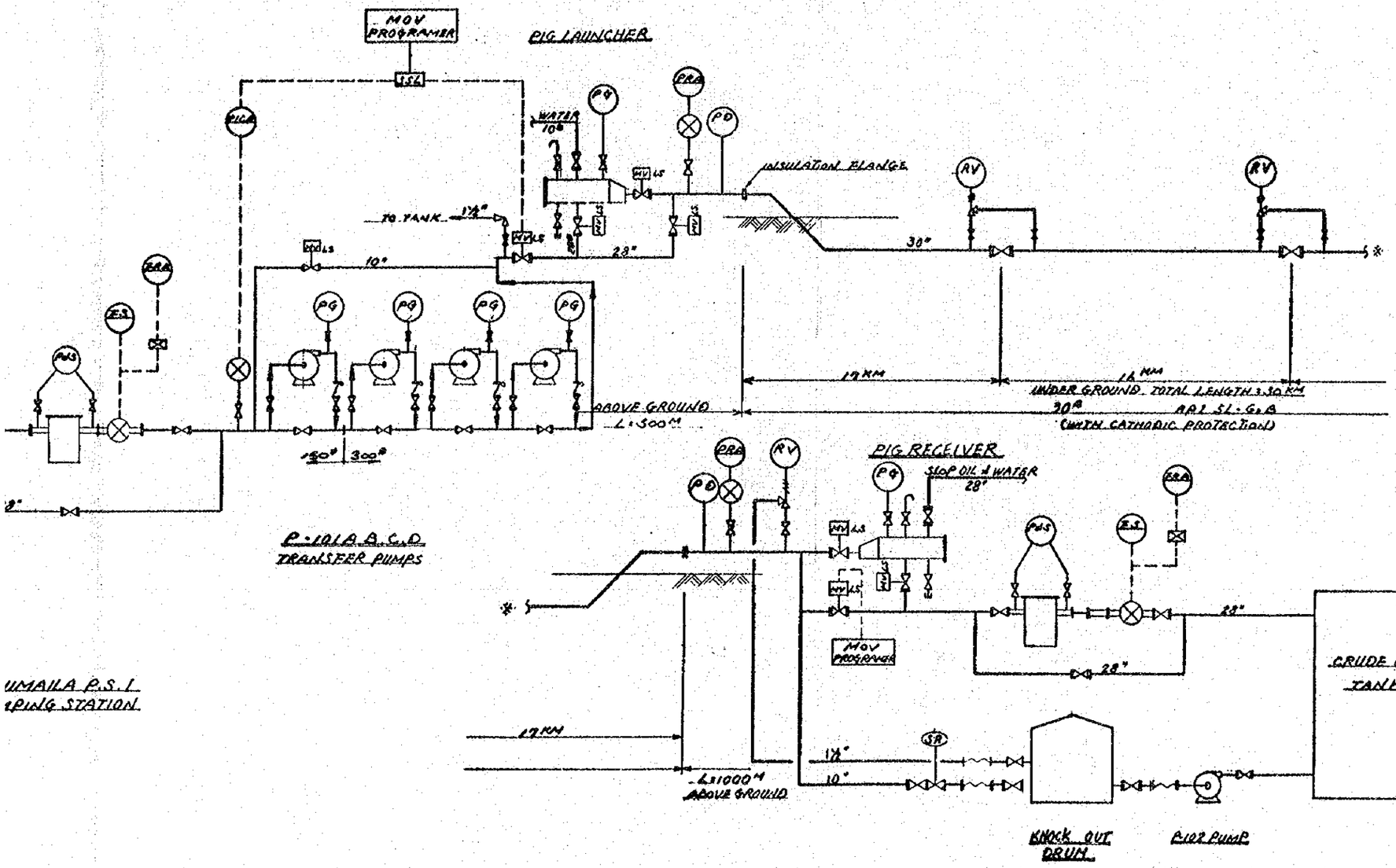


UNDER GROUND

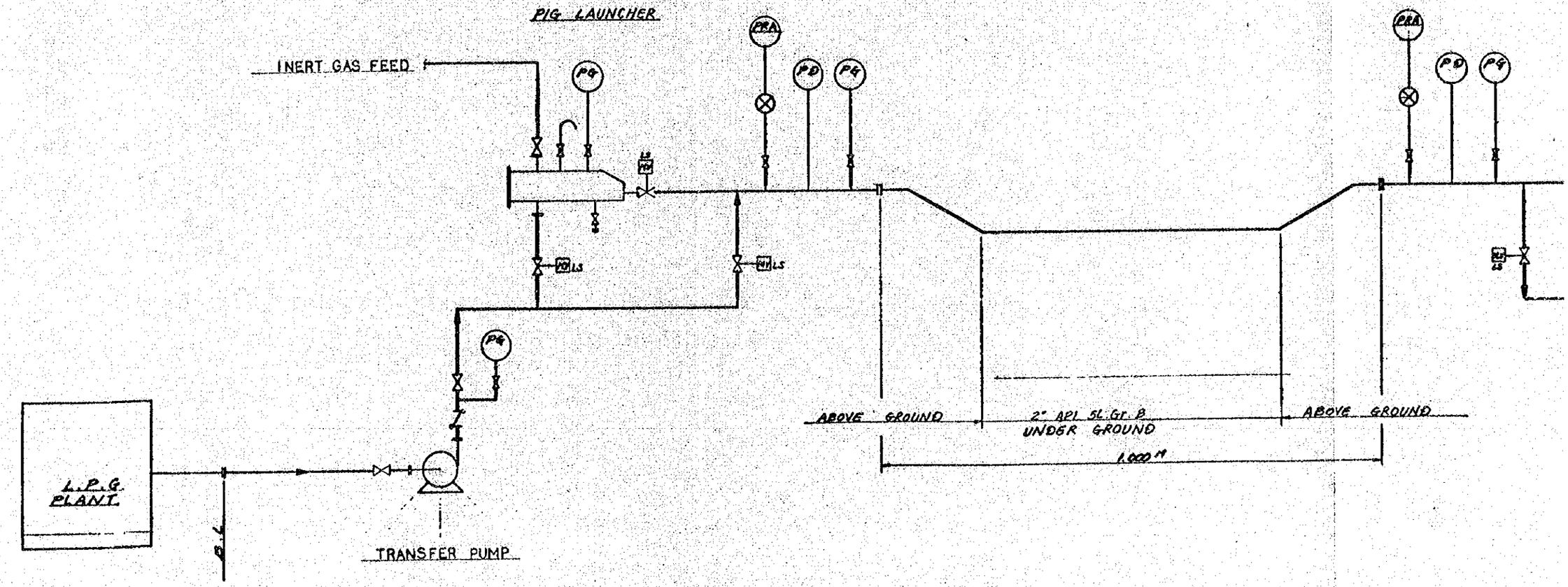
API 5L-B 20"

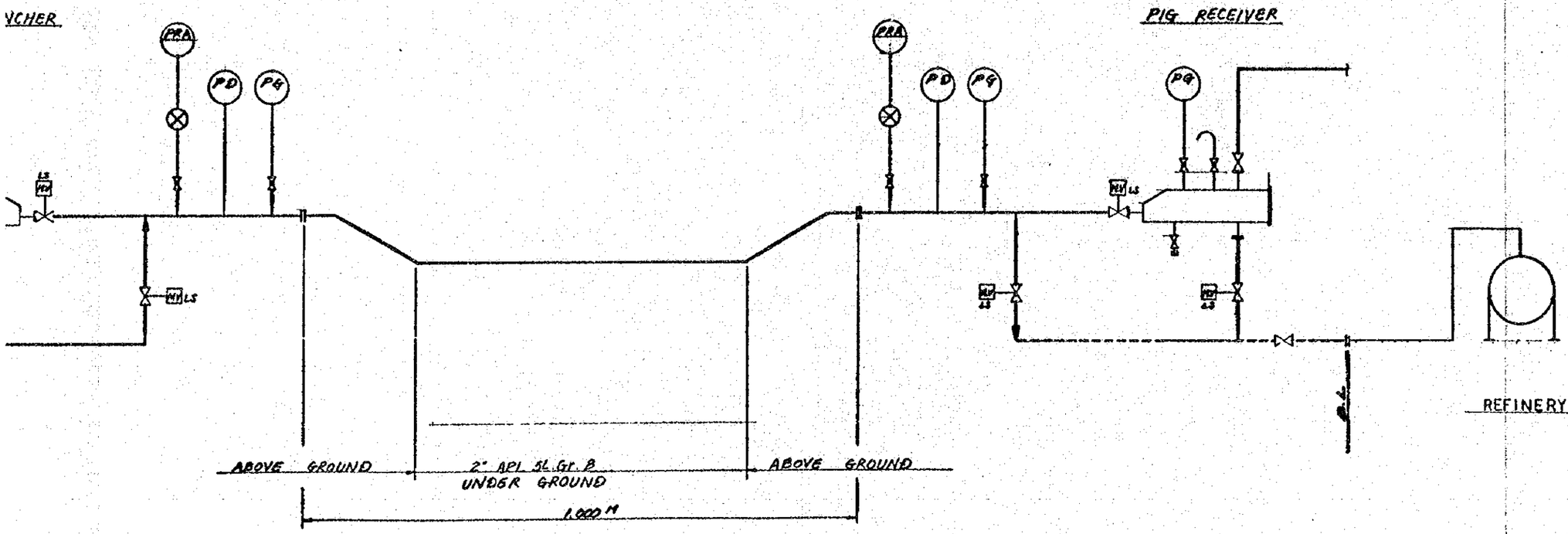
JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
EFFLUENT FLOW SHEET
DWG. NO. 54-M-001


MOV PROGRAMER
PIG LAUNCHER
WATER 10"
INSULATION FLANGE
TO TANK 1½"
10"
28"
30"
17 KM
ABOVE GROUND
L=500M
AL RUMAILA CRUDE OIL TANK (EXISTING)
TO TANK 1½"
28"
50"
300"
MUSHIAB CRUDE OIL TANK (EXISTING)
28"
P-101 A.B.C.D
TRANSFER PUMPS
PIG RECEIVER
SLOP OIL & WATER
28"
MOV PROGRAMER
17 KM
L=1000 M
ABOVE GROUND
1½"
10"
BOOSTER PUMP
(EXISTING)
AL RUMAILA P.S.I
PUMPING STATION

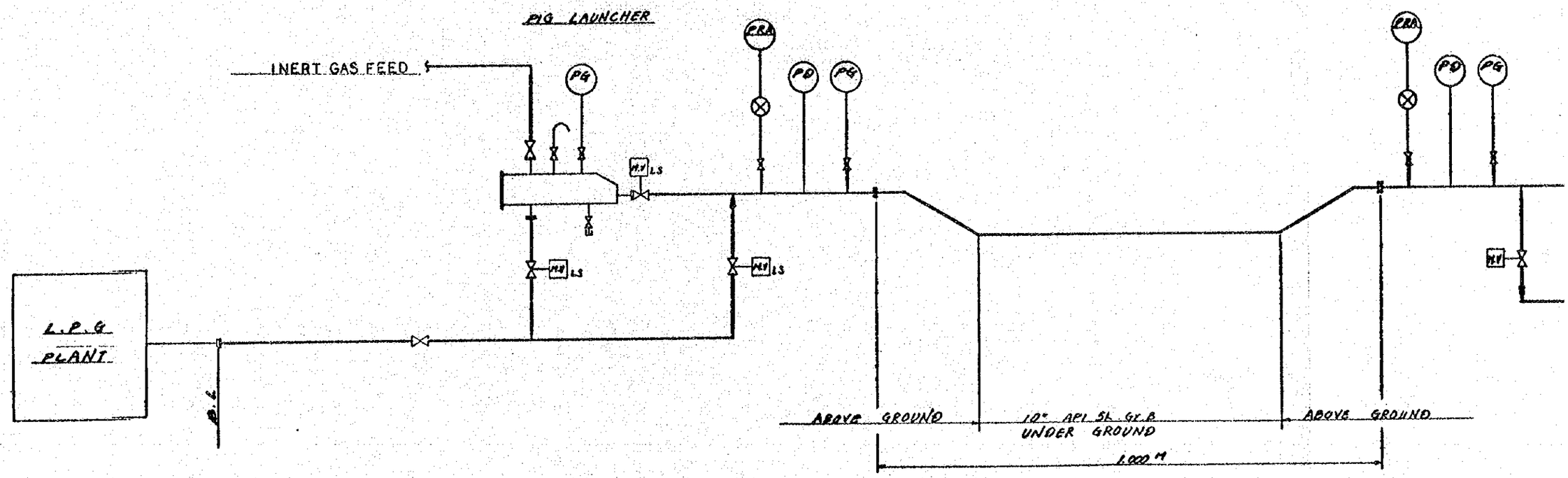


JAPAN INTERNATIONAL COOPERATION AGENCY	
EXPORT REFINERY PROJECT	
BUTANE FLOW SHEET	
DWG. NO.	98-M-001


PIG LAUNCHER
INERT GAS FEED
PG
PRA
PD
PG
LS
LS
PG
L.P.G. PLANT
TRANSFER PUMP
PRA
PD
PG
ABOVE GROUND
2" API 5L Gr. B
UNDER GROUND
ABOVE GROUND
1.000 M



JAPAN INTERNATIONAL COOPERATION AGENCY
EXPORT REFINERY PROJECT
BUTANE GAS FLOW SHEET
DWG. NO. 98-M-002


PIG LAUNCHER
INERT GAS FEED
PG
PRA
PD
PG
HV
LS
L.P.G
PLANT
8"
ABOVE GROUND
10" API 5L Gr.B
UNDER GROUND
ABOVE GROUND
1.000 M

PIG LAUNCHER

PIG RECEIVER

PRA

PD

PG

HV LS

HV

LS

FIDEL GAS K.O DRUM

REFINERY

ABOVE GROUND

10" API 5L Gr.B UNDER GROUND

ABOVE GROUND

1000 M

JAPAN INTERNATIONAL COOPERATION AGENCY	
EXPORT REFINERY PROJECT	
NATURAL GAS FLOW SHEET	
DWG. NO.	98-M-003