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CATHODIC PROTECTION OF ALL BURIED PIPELINES ON THE 600 MW GUDDU COMBINED CYCLE PROJECT

REQUISITION No. 391-0473-90036

REPORT ON

IMPROVEMENT AND RECTIFICATION
OF 20" MARI-GUDDU GAS PIPELINE

BEST AVAILABLE DOCUMENT

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LIST OF ABBREVIATIONS

1)	ROW	Right of Way
2)	Psi	Pounds per Square Inch
3)	L	Length
4)	Kg	Kilogram
5)	N	Newton
6)	MB	Mili Bells
7)	mm	Millimeter
8)	M	Meter
9)	KM	Kilometer
10)	Nm	Newton meter
11)	g	gram
12)	Cm	Centimeter
13)	lbs	Pounds
14)	MG	Mari Guddu
15)	%	Percent
16)	PT	Peel Test
17)	BC	Backfilling
18)	RC	Re-Coating
19)	TP	Test Post
20)	TW	Trench Weight
21)	CRC	Culvert for Road Crossing
22)	RCC	Reinforced Concrete Cement
23)	CP	Cathodic Protection
24)	XING	Crossing

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25)	IF	Insulating Flange
26)	BP	By Pass
27)	VA	Valve Assembly
28)	SD	Schematic Diagram
29)	SC	Shorted Casing
30)	CTP	Casing Test Post
31)	TS	Test Station
32)	EP	Exposed Pipe
33)	PP	Pillar Post
34)	P,PES	Pakistan Engineering Services
35)	WAPDA	Water & Power Development Authority
36)	G&H	Gibbs & Hill
37)	USAid	United States Agency for International Development.
38)	PE	Polyethylene
39)	USD	United States Dollars
	Rs	Rupees
[illegible]	VP	Valve Pit
42)	V	Volt
43)	Kv	Kilovolt
44)	Deg.C	Degree Centigrade
45)	Deg.F	Degree Fahrenheit
46)	CNF	Cost & Freight
47)	FOB	Freight on Board
48)	Qty.	Quantity
49)	RP	Repair

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50)	h	Hour
51)	max.	Maximum
52)	min.	Minimum
53)	Spec.	Specification
54)	O.D	Outer Diameter
55)	I.D	Inner Diameter
56)	dia	Diameter
57)	GR	Grade
58)	Sch.	Schedule
59)	Co.	Company
60)	LOR	Lock-o-Ring
61)	Hz	Hertz
62)	BASCO	Bosford Anode Supply Company
63)	AWG	American Wire Gauge
64)	NACE	National Association for Corrosion Engineers
65)	DIN	German Specification
66)	ASTM	American Society for Testing Materials
67)	ANSI	American National Standard Institution
68)	ASI	American Standard Institution
69)	API	American Petroleum Institute
70)	Ch.	Chainage
71)	PSP	Pipe to Soil Potential
72)	GA	Gauge
73)	Cft.	Cubic Feet
74)	approx.	Approximately

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75)	D/S	Down Stream
76)	U/S	Up Stream
77)	CL	Centre Line
78)	LS	Lumpsum
79)	Zn	Zinc
80)	$	Dollar
81)	CCPS	Combined Cycle Power Station
82)	CCP	Combined Cycle Project
83)	MW	Mega Watt
84)	amps	Amperes
85)	GL	Ground Level.
86)	Sq.ft.	Square Feet

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RECTIFICATION OF MARI-GUDDU GAS PIPELINE DEFICIENCIES

EXECUTIVE SUMMARY

Assignment

Scope of work required field investigation to assess the deficiencies in the Mari-Guddu Gas Pipeline and the changes required in the existing design. Based on field investigation to prepare technical specifications, bill of quantities and cost estimates for material, equipment and labour for remedying the pipeline deficiencies.

The field investigation was done with followings results:

1. The pipeline coating is below standard for 3000 meters divided over 25 sections along the pipeline route.

2. The pipeline cover is insufficient over 4500 meters length over 13 sections which is to be rectified by earth filling over the pipe.

3. Six pipeline casings are shorted which are proposed to be rectified.

4. In one section proper culvert has to be provided to protect the exposed line.

5. Proper alignment, depth and route survey has to be done to prepare as "land laid" drawing with correlation on Survey of Pakistan coordinates.

6. Pipeline marker post are to be installed at each 250 meters all along the pipeline.

7. Three bypasses are proposed across each of the three automatic shut-off valves.

8. Two alternatives for rectification have been evaluated, one by shut-down of gas supply and the other without shut-down.

   The total cost of material and labour for without shut down of gas supply is USD 1.59 million vs USD 1.13 million where gas supply is shut-down.

   It is a highly specialized work and must only be done by specialist contractors and under supervision of pipeline engineers with knowledge and credibility.

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SECTION NO.1

1.0 FIELD INVESTIGATION

The 20" dia Mari-Guddu pipeline construction was started on 14th April,1985 pipeline was and commissioned on 21st Feb.1986. It is supplying 100 million cubic feet of gas per day to the Guddu power generation complex. The length as per construction drawing is 59 Kilometers. One of the most important aspect of high pressure gas transmission pipeline is availability of exact, as built, record of the pipeline and its components. Consequently even though it is not covered in the scope of work it is necessary to review this important area of control.

1.01 Drawing Review

Following drawings were received from Gibbs & Hill:

A. Route Plan drawings (21 sheets). These drawings are dated 27th June,1985 and show "proposed gas line". The route plan drawing do not show the ground elevation and therefore the pipeline proposed elevation profile is also not available. "As built" drawings of Route Plan are not available. The "as built drawings" should have shown the exact final location of the "as laid" pipeline, the "as built" route plan should also give crossectional details and 'L' section at frequent intervals to show ground crossectional profile. A crossectional profile and 'L' section at 100 meter interval and at locations where there are changes in ground profile and condition would be appropriate. The width of this profile should cover 100 feet wide strip or 50 feet either side of the pipeline.

B. The "as built" drawing No.MG/001 Route Map of 20" is "not to scale' and cover the whole 59 kilometers length in one sheet of 18"x32" which is obviously just a line diagram.

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C. The "as built" drawings of valve assemblies, roads, canals, tube wells, crossings etc., are given with dimensions but without any ground profile details, without which the drawings are incomplete.

D. It is essential to mark the pipeline route by permanent marking pillar post. Pillar posts at say, each 250 meters must be installed with a 5 feet offset and recorded on the "as built" drawing. Presently no such posts exist. In order to fix the 'exact' location of the post the exact location of the pipeline would need to be fixed using an electronic pipe locator. The dimensions given from centreline of the canal to pipeline locations is of no value..

E. In view of the above there is a need to carryout a detail pipeline route survey to fix the pipeline right of way and all the contours, levels of ground and to check if pipeline is in right of way of irrigation department or private ownership etc. This right of way (ROW) would then need to be maintained as an essential part of securing the safety of the pipeline as well as the safety of life and property along the pipeline route. The maintenance of ROW would require. cutting of grass and bushes, filling of washed out earth cover, securing the canal embarkments, and any other action needed to secure the safety of the pipeline. Presently the ROW is not in a satisfactory condition.

1.02 <u>Identification of Pipeline Sections to be Re-coated and/or provided with extra soil cover.</u>

In absence of proper "as built" pipeline route drawings a visual survey has been used to assess these requirements:

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A. Re-coating

The only sections that require re-coating are the ones where pipeline has been shallow and the farmers have ploughed over the pipeline damaging the coating and where C-Scan survey show abnormal readings. These sections are not many and are marked on drawing No.P/U/CP(MG/001)RC/01 and in Table No.3.

Other than the above sections re-coating of pipeline is not recommended. This is further discussed under design consideration.

B. Lowering

The pipeline has shallow cover where there was subsoil water problem. That problem still exists. To lower an operating pipeline which is operating at pressure of 900 PSIG and hoop stress of over 60% is not advisable. It is therefore recommended that the sections where cover is below 30 inches earth filling be done on a width of minimum of 10 feet, that is, 5 feet either side of the centre line. The filling to be done so that cover is brought up to 30 inches. The filling should then be secured where necessary by stone pitching.

It maybe mentioned that ROW can only be maintained and controlled if the private property is purchased and for public property a proper contract is made for safety of the gas pipeline ROW.

The sections where the pipeline cover is not sufficient are given in drawing No.P/U/CP/MG/001)BF/01 and in Table No.4

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1.03 Determination of Coating Condition.

Pipeline coating plays a very important part in providing primary protection against corrosion. The secondary protection is provided by cathodic protection. The design of pipeline coating has a good margin of safety. The two inner layer provide the basic protection and the two outer layer provide the mechanical protection against soil stresses and external damage during construction. So even if one outer layer is damaged there is still the second layer to provide mechanical protection to the two 3 ply inner layers that provide the real separation of soil and water from the pipe.

The Third aspect of coating protection is the consistent quality of coating material. The coating material comprises of primer, butyl rubber inner layer and polyethylene backing. The balance between the bond of primer with bare steel and with butyl is a critical factor. If the mechanical aspect of the coating is sound and if the butyl and polyethylene materials are OK then the final test of a good coating is its bond with the pipe. If this bond is poor then there is a possibility of seeping in of moisture at damaged locations. If the bond is good then even if the coating is damaged the damage is restricted to the location/area of the damage only and moisture will not travel along the non-bonded coating by capillary action. The peel test is a good method of checking the bond strength of the tape with the steel pipe.

The peel test location were chosen in the areas where the C-Scan survey had indicated poor coating. Results of the peel tests are described below. The locations of the peel tests are marked in drawing No. P/U/CP(MG/001) PT/01 and Table No.2.

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Peel Test No.1

Pipe depth was 3'-6". Soil was dry. There was no bond between tape and pipe. Priming application not sufficient. Pipe surface therefore slightly rusty . Since the pipe has been in ground for over three years it is likely that original insufficient cleaning and priming is showing and further rusting/corrosion has not taken place. Though the coating bond is poor the four layers of coating has effectively sealed the pipe from surrounding soil. The wall thickness measured at point of peel test was 7.1 mm which is within pipe specification tolerance.

Peel Test No.2

Pipe depth was only one foot. The coating had no bonding strength. The land was dry but it is cultivated so the soil cover is exposed to wet and dry cycle. The pipe surface showed rusting. The wall thickness was however 7.1 mm which is within tolerance.

Peel Test No.3

Pipe depth was only one foot. The bonding strength of coating was 0.4 Kg/10 mm or 3.92N/10 mm which is within acceptable limit. The mode of failure was adhesive, whereas cohesive failure is the preferred mode. The surface of pipe looked slightly rusty. In view of satisfactory bond it appears that rusty surface is due to insufficient cleaning and priming. The wall thickness was 7.2 mm which is within tolerance. The land was dry but cultivated so the pipe soil will be exposed to wet and dry cycle.

Peel Test No.4

Pipe depth was only one foot. The bond strength was 0.4 Kg/10 mm or 3.92N/10 mm. The bond strength is satisfactory. The failure mode was adhesive whereas preferred failure mode is cohesive. The pipe surface was slightly rusty which is likely due to

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original poor cleaning and priming. The land is under cultivation and wet. The wall thickness was measured at 7.2 mm which is within tolerance.

Peel Test No.5

Pipe depth was 2'-6" from groundlevel. The bond strength was 0.4 Kg/10 mm or 3.92N/10 mm which is a satisfactory value. The failure mode was adhesive whereas a cohesive failure is preferred. Pipe surface was slightly rusty. In view of the acceptable bond strength the surface rust is from original insufficient cleaning and priming of pipe. The land was cultivated and wet. Wall thickness was measured at 7.1 mm which is within tolerance.

Peel Test No.6

Pipe surface was exposed without any ground cover. The bond strength was 1.4 Kg/10 mm or 13.72 N/10 mm which is very high bond strength. Inspite of this high bond strength the pipe surface was found slightly rusty which indicates insufficient cleaning of pipe surface. Land was cultivated but dry. This means that pipe coating will be exposed to dry/wet cycle. The wall thickness of pipe was measured at 7.2 mm which is within tolerance.

Peel Test No.7

Pipe depth was 2'-9" from ground level. Bond strength was 1.6 Kg/10 mm or 15.68 N/10 mm which is very high bond strength. Inspite of this high bond strength the failure was adhesive whereas preferred failure mode is cohesive. However at places the butyl rubber which has in previous case separated from pipe surface has in this case separated from polyethylene backing. Here too pipe surface was found rusty. In view of very high bond strength and no damage to coating the rusty surface appears to be from original

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insufficient cleaning of pipe. The land was cultivated but dry. The wall thickness was measured at 7.2 mm which is within tolerance.

Peel Test No.8

Pipe depth 1'-11" from top of ground to top of pipe. The bonding strength of tape to pipe was 1.2 Kg/10 mm or 11.76 N/10 mm which is very high. The butyl rubber had separated from polyethylene and kept sticking to the pipe which is better than adhesive failure where butyl rubber separates from the pipe and remain on polyethylene backing. However the preferred failure is cohesive where the butyl rubber remains in a uniform pattern both on the polyethylene and on pipe. The pipe surface was slightly rusty which indicate insufficient cleaning of pipe. The land was dry. The wall thickness was measured at 7.1 mm which is within tolerance.

Peel Test No.9

Pipe depth was 2'-4" from ground level. Bond strength was 2.8 Kg/10 mm or 27.44 N/10 mm which is abnormally high bond strength. The butyl rubber was totally left on pipe surface. The land was dry. Pipe had no rusting at all which indicate good cleaning and proper application of primer. The wall thickness of pipe was measured at 7.2 mm which is within tolerance.

Peel Test No.10

Pipe depth was 2'-0" from ground level. The soil was dry. Bond strength was 0.4 Kg/10 mm or 3.92 N/10 mm which is acceptable level. Pipe was slightly rusty. The failure mode was adhesive. Wall thickness was measured at 7.2 mm which is within tolerance.

Peel Test No.11

Pipe depth was 2'-4". Soil was dry. The bonding strength was 0.4 Kg/10 mm or

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3.92 N/10 mm. Pipe was slightly rusty. Failure mode was adhesive. Wall thickness was measured at 7.2 mm which is within tolerance.

Pell Test No.12

Pipe depth was 2'-4" from ground level. The land was cultivated but dry. The bonding strength was 0.2 Kg/10 mm or 1.96 N/10 mm which is 50% below acceptable standard. There was no rust on pipe surface. The failure mode was adhesive. The wall thickness was measured at 7.2 mm which is within tolerance.

Peel Test No.13

Pipe depth was 3'-6". The soil was dry and sandy. There was no bond between tape and pipe. The pipe was slightly rusty. The wall thickness was measured at 7.2 mm.

Peel Test No.14

Pipe depth was 3'-2". The bond strength was 0.6 Kg/10 mm or 5.88 N/10 mm which is satisfactory. The soil was dry. The failure mode was adhesive with part of butyl layer remaining on pipe and part on polyethylene backing. The pipe surface was slightly rusty which appears to be due to insufficient cleaning of pipe. The wall thickness was measured at 7.2 mm which is within tolerance.

Peel Test No.15

Pipe depth was 3'-6". The soil was dry. The bond strength of tape to pipe was 1.4 Kg/10 mm or 13.72 N/10 mm, this is a high bond strength much above the acceptable level of 4.0 N/10 mm. The pipe was slightly rusty which is likely due to insufficient cleaning of pipe. The high bond strength indicates proper quality of primer was applied for the type of surface. The wall thickness was measured at 7.2 mm which is within tolerance.

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Following conclusion can be made from above results:

(a) The level of cleaning of pipe has been insufficient.

(b) The bond strength of tape to pipe is very erratic even for similar level of cleaning. This indicates that quality of primer is not consistent.

(c) The wall thickness has variation within 7.1 to 7.2 which is 2.8% all along the 60 Km pipeline. This indicates that this pipe has not been subject to accelerated corrosion. By and large the 3 ply/2 ply, 4 layer coating system is holding intact and providing the needed primary protection. The secondary corrosion protection by cathodic protection is also effective as no pitting or electrolytic corrosion was observed at peel test points.

(d) At three locations the low bond strength and high C-Scan MB readings had a correlations. This is a good. In other cases this correlation did not exist. However since peel test is done on a very small section of the pipe it is not necessary that the entire section which is indicated by C-Scan as having poor coating will have poor bond. Specially keeping in mind the erratic values of bond strength. By and large it appears that the section of pipe showing high MB reading of C-Scan is most likely to have poor bond. The sections of very high MB reading are therefore being recommended for re-coating. The total length of these sections only 3000 meters and is marked on drawing NO. P/U/CP/(MG/001)KC/01 and in Table No.3

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1.04 Checking of Trench Weight/Packing.

The trench weights are generally placed over the pipeline in areas where the water level is low. The trench weights counters the buoyancy force of water. In absence of trench weights, if the earth around the pipeline becomes soft, there is a likely hood that the pipeline will be pushed up toward the surface. In case of washout of earth, due to flooding, the pipeline would float on water and can fracture due to the excessive stress that would be put on the pipeline.

The trench weight location must be marked on "as built" drawings. However there are no drawings available where the trench weights have been marked, nor there is any data available indicating the number of trench weignts that have been installed.

The visual survey has however shown that there are 58 trench weights which are exposed due to the low cover of soil over the pipeline which are marked on drawings No. P/U/CP(MG/001)TW/01. It was therefore decided to expose five of these trench weights in one section near the Mari-Gas field and another five near the Guddu Barrage side for inspection by lifting the trench weights of the pipe.

The basic purpose was to check if the coating under the trench weights is in satisfactory conditions and if proper packing has been provided.

Investigation showed that on the side of the Guddu Barrage there was extra layers of coating provided under the trench weights and the coating was not damaged. This situation is considered satisfactory, as far as packing is concerned.

In the second section near Mari-Gas field no additional layers of coating was provided. The tape coating was however found in good condition below the trench weights. However as WAPDA had supplied good polyethylene tape,

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additional layers were provided under the trench weights that were lifted for observation.

1.05 Investigation of Pipeline Casing Faults for Rectification.

The pipeline casings that are shorted are given in Table 5.

All these casings are in close proximity of the irrigation canals. It is therefore expected that the casing is exposed to water during the summer seasons and are dry during the winter season. If the end seals are not of proper quality or damaged or not installed properly then water will seep into the annulus between carrier pipe and casing, resulting in short circuit and current drainage to the uncoated casing.

The cathodic potentials were again taken to check the shift in the potential after WAPDA had optimized the potential levels on the entire pipeline.

a) National Highway Crossing
MG-008 -1.25 to -1.0V

b) Khanju Dharki Road Crossing
MG-003 -1.25 to -1.1V

c) Reti Road Crossing
MG-007 -0.94 to -0.70V

d) Machka Road Crossing
MG-011 -0.54 TO -0.6V

e) Railway Crossing
MG-004 -0.54 to 0.60V

f) Dharki/Sankhe Road Crossing
MG-002 -0.70 to 0.65V

The field investigation shows that the casing crossing are such that will require considerable excavation and dewatering if work is carried out in summer. It would be appropriate if the rectification is carried

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out in months of December to March so that focus is on rectification rather on dewatering and excavation problems.

The above refers to properly designed and installed casing. During the investigation of route, casing was found which have not been designed properly. This refers to the Drawing NO. MG/MISC/003/6 (sheet NO.6 of 21) where the pipeline is crossing Nehal Wah and Dahar Wah. Although the crossings of the canals are standard above ground crossings the portions inbetween has been put in a casing without any end seals or separators. The casing and pipe ends are exposed. There is pedestrian traffic over these two sections. To give a better understanding photograph No. 1,2,3,4 and 5 show this section alongwith the growth of grass into the tape coating. This is extremely undesirable. Continued growth would result in disbonding the coating and root penetration to the pipe surface. The next phase would be severe crossing due to chemical action of the roots and effect due to exposure to atmospheric elements.

At other locations exposed pipeline is crossing minor water channel in exposed position shown in Photograph No.6. There is no casing protection nor there is any special barrier. A high pressure carrier pipe should not be easily accessible to general public. Besides all exposed pipe needs to be inspected regularly for checking the condition of coating. Presently the coating in these sections appears undamaged.

Casing at Machka Road, Machka Minor was found to have only one vent pipe at the road side end. No vent pipe is seen on the other side of Machka Minor as shown in the drawing NO. MG/XING/011. This needs to be checked by excavation and installation of pipe vent as per standard practice.

1.06 <u>Investigation of Bond Box at Guddu end.</u>

The bond box was investigated. It appears that this bond box was installed to connect to a nearby water drainage pipeline. However

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this pipeline is totally above ground and therefore the question of interference with the gas pipeline does not arise.

The voltage potential of the wires in the bond box was checked and voltage value was zero. Similarly the water drainage line voltage potential with respect to ground was checked and no interference was observed with the gas pipeline.

The bond box is therefore superfluous and can be dispensed with.

1.07 Investigate Requirements for Installation of Bypass and Shutoff Valves Around Each Automatic Shutoff Valves.

The three locations were visited and investigated. The two auto - shut - off valves at either side of the Guddu Barrage can be provided bypass by hot tapping or by gas shut-off. Similarly the by-pass across the shut - off valve at Mari-Gas field can be provided by hot tapping or by shut - off. The detail is covered under design and technical specification.

1.08 Rectification of Exposed Carrier Pipe and Casing.

The pipe crossing Dahar Wah and Nehal Wah crosses a portion inbetween Nehal Wah and Dahar Wah which is unsafe. In this case a portion of the pipe going under the dirt road has been encased but the casing is without end Seals or vent pipes. Besides the carrier pie is lying exposed in pedestrian pathway. This is an extremely unsafe and dangerous situation. The pictures of this portion are shown at the end of this report.

Similarly at one location the carrier pipe without any protection is passing through a culvert which is easily accessible to public. This needs to be protected also.

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SECTION NO.2

2.0 DESIGN CONSIDERATION

The technical specifications for inclusion in the tender documents are based on certain design criteria. The design criteria of each aspect is discussed in this section.

2.01 Lowering of Pipeline

The detail investigation, C-Scan survey, peel tests, visual route survey have been taken into consideration in determining the action to be taken to correct the fault of insufficient soil cover.

In the absence of ground elevation profile and as-laid elevation profile of pipeline the exact position is uncertain. However the data of C-Scan survey, visual route survey has been used to determine the location with insufficient cover. A minimum cover of 30 inches from ground level is an acceptable cover. Additional cover has to be provided where the cover is less than 30 inches.

This cover can be provided either by lowering of pipeline or by adding additional cover of earth. The lowering of pipeline is not recommended as it is a high pressure gasline with hoop stress of over 60 percent. The lowering can add additional stresses which can pass the yield limit of the steel. To lower the pipeline would require a shut down of gas supply and cutting the sections to eliminate any accumulated stress of lowering. It is not a practical solution. Consequently the next best solution is to add additional cover to the pipeline to increase the cover to minimum of 30 inches. The width of this additional earth filling to be a minimum of five feet either side of the centre line of the pipeline.

As advised earlier it is necessary that proper survey of the pipeline route should be done to establish the ground profile along the pipeline on a 30 meter wide strip. All

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salient features like culverts, trees, bunds, roads, railways, embankments, huts, canals, etc. must be marked. The exact location of pipeline with reference to these structures

must also be marked. The pipeline depth survey can then be done using electronic depth measuring instrument.

The sections of pipeline which require backfilling has been given in Table 4 on the basis of limited information available. After the above survey more accurate picture will emerge.

2.02 Re-coating decision criteria.

Our investigation shows a clear positive correlation between low bond strength of coating with pipe and high C-Scan attenuation reading in three location. In other cases this correlation is not there. However this could be because of nonuniform behaviour of tape bond strength which has a abnormally high variation of bonding strength. Furthermore the peel test is done on only a 10 mm section and basically represents only that point. The analysis shows that section of high attenuation above 5 MB are very likely to have low bond strength between the tape and steel surface. These sections are marked on the drawing NO.P/U/CP(MG/001)PT/01 as well as in Table 3.

The section of low bond have not shown pitting or accelerated corrosion but only slight rust. The rusty surface is likely to be from original poor cleaning of the pipe.

However since the total length of these sections is small and a project is being started to rectify the faults it is recommended that these sections be re-coated.

It is however very strongly emphasized that unless materials of proven high quality are used under very tight quality control of cleaning, priming and coating, it would be better to leave the existing coating. This is because to re-coat the 20 inch pipeline in

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trench is much more difficult then above ground. It is quite possible that the re-coating job may end up to be of lower quality in material and workmanship.

The section where the coating is totally removed or damaged ofcourse has to be re-coated immediately. This refers to section 200 meters after T-P 25 towards Guddu which is also shown in photograph No.7 at end of this report. Length is approximately 150 meters.

The coating material specifications and application procedure is covered under Technical Specifications.

2.03 Trench Weight Packing Rectification.

A total of 58 trench weights have been located as these are exposed to the surface. In view of the investigation all these trench weights must be lifted and additional packing material put under the weights. Although additional packing in form of more layers of polyethylene tape has been provided it would be even better if more suitable material is used as provided for in the specifications.

2.04 Need of Metal Loss Survey

Although the peel test survey and wall thickness survey has given a good indication of the condition of the pipe but it is limited to the locations at which these tests were done. The C-Scan survey gives the condition of the coating only and not of the pipe. The cathodic protection survey gives the condition of Cathodic Protection effectiveness but not the pipe. All these survey are a reference to the condition of the pipe. The wall thickness tests are real measurements but only a point measurement. This aspect has been recognized by pipeline companies. Over the years substantial developments have been done to measure the real condition of pipeline both inside and outside. The most realistic method is to

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check the metal loss (wall thickness) all along the pipeline and for the full circumference. British Gas Corporation of United Kingdom has developed what they called the "On-Line Inspection" for metal loss. This inspection can be done while the gasline is in operation. The system has been tested and proven over many years and is now considered to be the quickest and most accurate system. The On-Line Inspection for metal loss will locate corrosion at any point in the pipeline. It will give exact location of this corroded area the extent of corrosion and if the corrosion is internal or external. The "pig" that is put in the pipeline is called "intelligent pig" as it has an inbuilt computer package to measure and record the metal loss data. This data is then put through a major computer program for printing out. A metal loss survey thought somewhat expensive is a very powerful tool to assess the exact position of the pipeline condition in a very accurate way. Once this data becomes available, it can be used to predict the future problem areas as well as advice on existing areas for repair/replacement decision.

It is recommended that this survey should be done on Main-Gas Line. Since the cost of mobilization is rather high as the equipment has to be imported and exported it would be economical if the inspection of other lines like Khandkot-Guddu and Sui-Guddu lines are also considered at the same time. The approximate cost of this Survey would be in the region of about US$ 450,000. This does not include any taxes, duties or other import that would need to be paid by British Gas Plc in Pakistan. If the two or more pipelines are inspected at the same time then there will be a saving of 10 to 15% depending on the conditions.

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2.05 By-pass Installation at Automatic Shut-off Valves.

Two alternatives are being specified in the documents for the installation of the by-pass.

Alternative 1

This alternative is for installation of bypass and insulating flanges by shut down of the gas supply and purging of all gas from the pipeline. This can be done. All the fittings would need to be prefabricated and ready. From the time of shut down and immediately after purging of all gas from the pipeline the cutting and welding operation would start at all five locations simultaneously. It is estimated that the shut would be required for about 18 hours to be on safe side. If it can be done earlier so much the better. Only contractors with required experience of pipeline operations should be used to avoid complications.

Alternate 2

In this alternate the pipeline will continue to be in operation. Hot tap and stopple fitting and appropriate tapping and Stopple Machines would need to be used for performing this important function. In order to limit number of tapping and drilling operations 3-way tees have been proposed. Thus for each station only two tees have to be used. Since all existing fittings on this line are ANSI Class 400 rated. The valves and fitting proposed are of ANSI 400 Class.

For the mainline full bore ball valve have been proposed. However for by-pass plug valves are specified which are more suitable for by-pass application.

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2.06 Insulating Flanges

Where ever by-pass is being installed it is most appropriate time to install an insulating flange. Consequently insulating flanges are [illegible] proposed with each by-pass. In case of Alternative 1 when the pipeline will be shut [illegible] then additional one flange is being [illegible] these will simply be welded in after [illegible] the pipeline.

The location [illegible] the by-pass and of the insulating [illegible] are shown in drawing Nos.
P/U/CP(GD-M-[illegible] 01/4,
P/U/CP(MG/MI[illegible] 02/4,
P/U/CP(MG/MI[illegible] 03/4 and
P/U/CP(MG/MI[illegible] 04/44

The arrangement [illegible] the fittings, tees, and valves are shown [illegible] drawing NO.
P/U/CP(GD-M-[illegible] 01/3,
P/U/CP(MG/VA[illegible] 02/3 and
P/U/CP(MG/VA[illegible] 03/3

2.07 Exposed Pipe [illegible] ends at Dahar Wah

The pipe section [illegible] Dahar Wah and Nehal Wah as [illegible] in drawing No. P/U/CP(MG/MI[illegible] EP 02/3 and in photograph No. 1,2,3,4 [illegible] at end of this reports needs to be [illegible] to make the pipe safe and provide [illegible] protection to it. The casing must be [illegible] and removed. A proper RCC culvert for full length of this section must be constructed. The area below the culvert to be filled with [illegible]. This is necessary and essential for [illegible] pressure transmission line. In this way the pipeline will be physically [illegible]. Besides the Cathodic protection will [illegible] be fully effective.

The detail of the required culvert is given in drawing No. [illegible] CRC 01/3 to 03/3.

The exposed [illegible] crossing the concrete water channel is also not safe. This should be protected by installation of concrete RCC slab of five feet width.

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2.08 Special Note

Since there is not enough space to install a tapping tee and a 10 inch valve at the Mari Field By-pass, the by-pass arrangement has been proposed from the 12 inch by-pass already provided.

The specification of the 12 inch, 16 inch and 20 inch pipe were not available on drawings or records. The information was provided by WAPDA during [illegible] of PES engineer to Guddu. For the [illegible] pipe it is ASTM, 106 GR.B.Sch.40 ([illegible] wall thickness) and for 12 inch pipe the specifications are same but pipe is Sch.[illegible] ([illegible]" wall thickness). These specifications are therefore being used for design purposes and specifications of fittings to be installed.

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SECTION NO.3

3.0 TECHNICAL SPECIFICATIONS

3.01 Scope of work

The work for fault rectification and improvement of the Mari-Guddu gas line can be divided into four sections.

A. Detail pipeline right of way survey to cover following:

- The right of way of 50 feet either side of pipeline to be surveyed for topographic details, elevation profile, and all above ground features such as culverts, huts, trees, canals, road, rail, bunds, etc. The alignment of pipeline to be fixed on survey of Pakistan map grid. The survey to be plotted on 1:2000 Horizontal Scale and 1:200 Vertical Scale. The centre line of the pipeline to be located by use of electronic locator. Depth of pipeline to ground level to be fixed using electronic depth gauging instrument. The alignment of the pipeline is marked using suitable cement pillars at every 250 meter interval. The height of the pillars to be four feet above ground and placed at a five feet offset from the pipeline.

B. Re-coating of the sections with poor bond strength as identified in Table No.3 as well as where coating has been damaged. Provision of extra soil cover over the pipeline where the cover is less than 30 inches, given in Table No.4, providing of proper packing material under the trench weights.

C. Rectification of casing faults as per list given in Table No.5.

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D. Installation of By-pass around the three automatic shut-off valves. Installation of insulating flanges at these by-pass locations. In case of shut-down of pipeline additional insulating flange to be installed in one locations as shown in drawing Nos. P/U/CP(MG/MIP[illegible]12)IF 02/4.

3.02 Material Specifications [illegible] Quantities

Introduction: The scope of materials, their specifications and quantities are detailed in this section. As far as possible comprehensive details of the requirements have been provided. However for small items like test posts, Thermite Welds, etc. standard terminologies and even trade name of well-known products have been used due to specialized nature of the work.

3.02.1 Pipeline Coating Material

(A) Tapes - Innerwrap (DENSO S/20)

Three-ply polyethylene tape consisting of a stabilized L.-polyethylene backing with plastic [illegible] rubber on both sides. The innerwrap tape must be fully compatible [illegible] the properties of the primer and the properties of the outerwrap.

Application temperature: -40 Deg.C to +60 Deg.C
Operating temperature : -60 Deg.c to +65 Deg.C

Butyl	0.2 mm
PE	0.4 mm
Total thickness	0.6 mm

Roll Size: 100M/150mm for manual machine application.

Quantity: 1051 Rolls.

Tensile strength at +23 Deg.C	50 N/10mm
Elongation at break at +23 Deg.C	400%

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Dielectric strength	40 Kv/mm
Water vapour transmission	2.10^{-1} g/m^2.24h

The tape must comply with DIN 30 672, DIN 53 481, DIN 53 455, DIN 53 122. The Tape must fully amalgamate at the overlap and between the layers. Peel Test should show a cohesive failure mode. Bond strength should exceed 4.0N/10mm.

(B) Tapes - Outerwrap (DENSO R/20)

Two-ply polyethylene tape consisting of a stabilized LD-polyethylene backing with plastic butyl rubber on one side. The outerwrap tape must be fully compatible with the properties of the inner wrap.

Application temperature: -40 Deg.C to +60 Deg.C
Operating temperature : -60 Deg.C to +65 Deg.C

PE backing	0.[illegible] mm
butyl	0.2 mm
Total	0.[illegible] mm

Roll Size: 125M/150mm for machine application by manual machine in the ditch application by Densomat IV.

Quantity: 840 Rolls.

Technical values identical as with innerwrap tapes. The tape must comply with DIN 30 672, DIN 53 481, DIN 53 455, DIN 53 122. Minimum overlap 50mm. The tape must fully bond with the innerwrap.

(C) Primer (DENSO MT/2[illegible])

Solution of butyl rubber and unsaponifiable resins in petroleum spirit.

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Application temperature:	-10 Deg.C to +75 Deg.C
Operating temperature:	max. +50 Deg.C
Flashpoint:	approx. +24 Deg.C
Packed:	in 10 Litre tins

The primers must comply with: DIN 51 757, DIN 51 758, DIN 53 211.

Quantity: 1200 Litres - to be supplied in 10 litre cans packed 4 cans to a carton for easy handling.

(D) Repair Tape (DENSOLEN RP)

Application temperature:	+5 Deg.C to +40 Deg.C
Operating temperature :	-20 Deg.C to +50 Deg.C
Total thickness:	approx. 1.5 mm
Thickness of PE-film	approx. 0.15 mm
Total thickness of Mastic coating:	approx. 1.35 mm
Tensile strength:	140 N/cm width
Test according to DIN	30672.
Adhesive strength on steel without primer:	40 N/cm width
Adhesive strength on polyethylene:	15 N/Cm width
Impact resistance	1 layer : 3 Nm 2 layers: 10 Nm 3 layers: 16 Nm
Roll Size:	10M/100mm
Quantity:	250 Rolls

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3.02.2 Casing Filler

Kendex 0261 Casing Filler, petroleum based compound containing corrosion inhibitors which is used to fill the annulus between the carrier pipe and casing.

Physical Properties:

Composition: Petroleum-based compound with additives and corrosion inhibitors.

Color: Brown

Consistency: Firm Gel @ temperatures below about 125 degrees F.

Viscosity: 6.25 CS @ 212 degrees F.

Weight Per Gallon: 7.075 lbs. @ 120 degrees F.

Specific Gravity: .8660 @ 120 degrees F.

API Gravity Dielectric: 33.8

Strength: 10,000 V/.100" ASTM D-149 @ 68 degrees

Congealing Point: 127 +/- 5 Degrees F.

Pour Point: 125 +/- 5 Degrees F. ASTM D97.

Melt Point: 131 +/- 5 Degrees F. ASTM D127.

Flash Point: 355 Degrees F.

Volume Weight Factor: 1 Gallon = 7.083 lb.

Ash Content: .1%

Qty. 60 Drums (3492 US Gallons)

3.02.3 Casing End Seals

a) Maloney Zipper end seals made of 1/8" Synthetic rubber with stainless steel zippers pressure moulded to the rubber with rubber protective seal attached to the seal under the zipper. Stainless

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steel band clips to be provided. Size 20"x24" Qty. 15 NOS.

b) Link type Model PL 400 Series NO. LS-400-C, Link-Seal NO.2024. For casing pipe size O.D. 24", I.D. 23.376". Complete Seals. Qty. 15 Nos.

3.02.4 Insulating Flanges

Monolithic isolating joints, BASCO equivalent. The details of size, material, pressure rating, fluid service is given below. Following performance characteristics are required.

- Test Pressure shall be 1.5 times working pressure.

- Operating Temperature -5 Deg.C to 70 Deg.C.

- Electrical resistance in dry air better than 5M Ohm (at 500 V.d.c.).

- Dielectric strength in dry air better than 2500 volts (at 50 Hz) with minimal of current leakage and no reduction of resistance.

- Joints shall be provided with surge diverters and provision for field testing. Lugs for connecting AWG No.6 cable for field testing required.

- For all steel joints bevel ends shall be provided as per ANSI B 16.25 specifications.

- Test certificates shall be provided for each flange to cover hydrostatic pressure tests, electrical resistance and dielectric test and the factory prior to shipment.

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3.02.5 Trench Weight Packing Material Densolen Rockshield DRM:

- Weight approx. 400g/m^2
- Tensile Strength (DIN 53857)
- Resistance to longtime thermal stress upto +100 Deg.Cen
- Specific electric resistance of wrapping approx. 0.5 Ohm.m^2
- Resistant to salt solutions, hydrocarbons, fungi and soil bacteria.

Roll Size: 1050mm width x 50M Long.

Quantity: 2 Rolls.

3.02.6 Stopple/Hot Tape Fitting

The by-pass operation can be done by use of three kinds of tapping and stopple tees. These are separate tees for stopple and tapping operations requiring four tappings for each bypass, the 3-way full encirclement tee requiring two tappings per by-pass but requiring sufficient earth cover over the pipe incase of buried pipes and the 3-way conduit barrel split tees which requires only two tapping per by-pass and does not require more space.

The material is based on use of 3-way conduit barrel split tees for the two bypasses on the automatic valves on two ends of the Guddu barrage. Since the Mari-Gas field automatic shut-off valve piping is above ground the 3-way full encirclement tee can be used there.

Bidders can quote alternatives with full details of materials that are proposed to be used.

(a) 20"x16"x20", 3-way conduit barrel split tees with LOR Flanges and LOR Plugs. By-pass outlet to be weld end and bevelled. Fitting class ANSI 400. The tee would be

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installed for hot tapping and stopple operation on 20 inch pipe of API 5LX56 of 0.250 inch wall thickness. Maximum operating pressure 950 Psi.

(b) 16"x12" Full encirclement 3-way tee for tapping and stopple operation with LOR Flange with LOR plug and 12 inch weld end outlet duly bevelled. Class ANSI 400. The tee would be installed on 16 inch pipe ASTM 106 GR B Sch.40. Maximum operating pressure 950 Psi.

(c) 12"x12" Full encirclement 3-way tee for tapping and stopple operation with LOR Flange with LOR Plug and 12 inch bevelled weld end outlet. Maximum operating pressure 950 Psi.

(d) 12 inch Sandwich Valve ANSI Class 400 for use with the 3-way tapping tee.

(e) 12 inch Class 400 tapping machine adaptor for Williamson 1200 Tapping machine.

(f) 20 inch Class 400 Tapping machine adaptor for Williamson 1200 Tapping machine.

(g) Sandwich valves for use with 3-way tapping tee. 16 inch ANSI Class 400.

(h) 12 inch Stopple housing with plugging heads with Class 400 flange.

(i) 20" Stopple cutter with holder for use with Williamson 1200 machine and in 3-way conduit barrel split tee.

(j) 12" Stopple cutter with holder for use with Williamson 1200 machine and in 3-way full encirclement tee.

(k) 16" Stopple cutter with holder for use with Williamson 1200 machine and 16"x12" (outlet) 3-way full encirclement tee.

(l) Rubber sealing cup for 12 inch Stopple head of Williamson machine.

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(m) Rubber sealing cup for 16 inch stopple head of Williamson machine.

(n) Rubber sealing cup for 20 inch stopple head of Williamson machine.

3.02.7 Blind Flanges

ANSI 400 conforming to ASTM A 181 GR I OR II and ASA B 16.5.

3.02.8 Weld Fittings

Forged steel weld end fittings conforming to ANSI B 16.9 for welding with API 5L X 56 pipe standard wall thickness. Maximum operating pressure 950 Psi.

3.02.9 Flanges Weld Neck

Faced and drilled Ring Type Joint. ANSI Class 400 rating. All dimensions and tolerances to ANSI B 16.5 Ring Dimension to ANSI 16.20. Nominal bore as given. Material ASTM A 105 GRII.

3.02.10 Plug Valves

Dynamic Balance Plug Valves Venturi Pattern flanged ends conforming to NACE MR-01-75. Body and cover of Carbon steel with HRC 22 max, non-threaded stem of alloy steel HRC 22 max, Gland malleable or ductile iron, Gland packing compound of Graphite and TFE. Plug preloaded with balancing spring to prevent taper lock. Bottom Balance Hole Plug coated with .003 electroless nickel. Sealant injection fitting. Weather seal at top and bottom. Valves to conform to API 6D, API 607/API 6F.

3.02.11 Ball Valves

Full bore ball valves ANSI Class 400. Gear operated (enclosed gearing). Ball ASTM A 48 Class 50 B-22 with 0.003 electroless nickel coating. Body ASTM A 216 GR WCB. Stem A 322

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GR 4140 LQT. Trunnion/stem/seat seals: Buna 'N' 'O' Rings. Seat insert: Nylon filled with MOS.

Triple seat sealing system (1) Soft seat (2) Wide metal to metal seat (3) Fully contained lubricant seat. Bubble tight sealing system with double block and bleed facility weld end. Conforming to API-6D, API 607/API 6F.

3.02.12 Pipe

ERW or Double submerged arc welded in accordance to API 5L latest edition. Pipelengths 40 feet. Ends bevelled to 30 Deg.C + 5 Deg.C- 0 Deg.C. Pipe to be supplied bare without any coating.

3.02.13 Studs and Bolts

To be provided for the above flanges and fittings. Following specification to apply.

For studs ASTM A 193 GR7M For Bolts A 194 GR 2HX Sizes and quantities as per Class 400 fittings.

3.02.14 Cables

One conductor, stranded, plain annealed copper, black high molecular weight polyethylene insulation and jacket. Conforming to ASTM spec. D-1248 Type 1, Class C, Grade 5.

3.02.15 Test Posts

Fink type test station or equivalent. Lexan body. Machine screws, hex-nut, cadmium or zinc plated.

Conduits ultraviolet stabilized polyethylene predrilled in 5 feet lengths with anchor and access holes for wires. Each station to have lockable cover, a terminal board with

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integral compression fit base, compression nut for clamping the base to the conduit and complete hardware.

- Single 5 lead

3.02.16 Reference Electrodes

1.4"x1.4"x9" Zinc reference cell bar with 1/4" dia mild steel core packed in backfill material in cloth bag. Lead wire of 5 meter length duly connected and sealed to be provided. For details see drawing No. P/U/CP TS 04/4

3.03 Installation Specifications

3.03.1 Cleaning, Priming and Coating.

The pipeline sections to be re-coated are marked in drawing NO.P/U/CP(MG/001)RC/01 and Table NO.3. The pipeline re-coating has to be done in the as laid position. No lifting of the pipeline by crane or chain pulley block will be allowed. The pipeline section's to be re-coated must first be marked on site and approval of Engineer obtained on appropriate drawing. The soil around the pipe to be excavated and removed and shored up to provide a non-dusty space. The existing coating must be removed. After removal of coating all the primer, loose rust, scale, etc. must be completely removed and clean bare steel surface obtained. Cleaning can be by use of wire brush, or sand blasting. The level of cleaning required is that obtained by sand blasting or close to it.

The cleaned surface to be primed using the compatible primer. The coating of pipe to be done using manual or power machine. The machine should be such that it can provide proper tension on the tape. Both the 3 ply inner layer and the 2 ply outer layer must be wrapped at the same time with the tape wrapping machine. Hand wrapping of tape without the machine will not be permitted.

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Manufacturers recommendation of primer drying time will be enforced. The primed pipe must be protected from dust of the excavated earth. In order to minimize contamination of primed pipe with dust short section to be primed and coated at a time.

The trench must be sufficiently wide and secured to allow the machine to be used.

The primer and tapes must be store as per manufacturers recommendation.

Detail actual procedure to be adopted must be approved by Employer prior to start of the cleaning and re-coating work.

3.03.2 Providing Proper Earth Cover.

The sections with low earth cover are marked on drawing NO.P/U/CP(MG/001)BF/07 and Table NO.4. The exact alignment and depth of the pipe to be fixed by survey using electronic instrument. The line should then be marked by use of RCC pillars. Subsequently topographic and profile survey of 30 meter strip to be done to establish the right of way boundaries.

The back filling to be done with loose rock free earth excavated from outside the 30 meter right of way limit. The section five feet either side of the centre line of pipe to be raised to provide final cover of minimum 30 inches. The level of the raised section to be taken and recorded on the as built survey drawings. The levels to be taken after proper compaction of the backfilled earth cover.

3.03.3 Coating Repair.

For small sections requiring repairs following procedure is to be followed. The damaged or exposed section where coating is found damaged to be repaired by use of RP tape. The damaged section to be removed and properly cleaned. The bare clean pipe to be

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primed and two layers of repair tape applied. The repair tape should extend six inches beyond the section being repaired.

3.03.4 Rectification of Pipe Casing Faults.

The casing which are shorted and showing faults are shown in drawing Nos. P/U/CP(MG/XING/002)SC 01/6 to P/U/CP(MG/XING/011)SC 06/6 and Table 5.

Rectification to be done by excavation of both ends of the casing. Removing the end seals if any. Cleaning the annulus between the Carrier pipe of O.D. 20 inch and casing pipe I.D. 23.5 inch by blowing air from one side and again from the other side. Air blowing to be done first at slow rate and then at higher rate to remove water and loose debris. The end seals to be replaced with Link-type end seal and over that Zipper type end seal to ensure leak tight ends. Subsequently potentials to be taken to ascertain improvement in condition of short circuit. After the short circuit has been isolated the annulus to be filled with the specified "Casing Filler". The detail procedure to be used must be submitted to the client for approval. All precautions to be taken to prevent entrapment of air during filling operation. Pipe to soil potentials to be taken prior to start of operation, after cleaning of annulus and after filling of the annulus with casing filler. Test Point to be installed at each casing with one wire connected to casing pipe, one to carrier pipe and one to Zn reference electrode.

3.03.5 Installation of By-passes and Shut-off Valves Hot Tapping and Stopple Operation.

One permanent bypass each is to be provided across each automatic shut-off valve. The locations of these three by-passes are shown in drawing Nos. P/U/CP(GD-M-016)BP 01/3, P/U/CP(MG/MISC/003/19)BP 02/3 and P/U/CP(MG/MISC/003/20)BP 03/3. The two automatic shut-off valves upstream and down stream across Guddu Barrage to be provided

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by-pass by installation of one each 20"x16"x20" conduit barrel split tee on either side of the automatic shut-off valves. The by-pass to be welded to this 3-way tee complete with two 16 inch plug valves. Before welding the by-pass to the 3-way tee it should be tested hydrostatically to 1500 Psi. All joints to be 100 percent X-rayed for conformance with API 1104 specification.

The 3-way conduit barrel split tee to be used for hot tapping the 20 inch pipe. Detail step by step procedure of the hot-tapping operation to be submit to the employer for approval. The procedure will include the exact alignment of bypass fixed and marked on site.

After the two hot tappings are complete and the bypasses operational, the same 3-way tapping tee to be used for stopping the gas inbetween the bypass oftakes. This would be done by used of two stopple machines. After sealing of the section the line would be cut at two places for installation of two full bore ball valves. After installation of these valves both the by-pass and mainline to be operational. After the line is cut for installation of ball valves in the main line an insulating flange is to be installed in this section as shown in the drawing Nos. P/U/CP(GD-M-016)IF 01/4,
P/U/CP(MG/MISC/003/19)IF 03/4 and
P/U/CP(MG/MISC/003/20)IF 04/4.

At Mari-Gas field by-pass is to be provided as shown in the drawing NO. P/U/CP(GD-M-016)SD 01/3. In this case as the pipelines are above ground the 3-way full encirclement tees are proposed. The operation is similar to the previous one. In this case the by-pass is of 12 inch diameter.

For providing these by-passes Williamson 1200 machines are suitable and available with both Sui Southern Gas Co. and Sui Northern Gas Co. Ltd. The gas companies do provide the services of hot tapping and stopple operations. The consumable items like cutters and sealing cup have been included in material quantities. So also some of the

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material/fittings like Class 400 adaptors have been provided as these are likely not to be available. The cost of fittings, installation, testing and cost of equipment or its rental charges to be included in the prices quoted. Bidder shown check carefully the availability of all fittings and equipment which maybe required. Bidder will be responsible for arranging with the gas companies and payment to gas companies of any charges. Bidders must also ensure that tapping and stopple machines with components to fit the Class 400 conduit barrel split tees and full encirclement tees other than specified are available to perform the full operation.

During this operation all emergency precautions must be laid down prior to start of work. Under no circumstances the work of hot tapping and stopple be started or progressed without the presence of the employees authorized engineer at all time till the operation is complete.

3.03.6 Installation of By-passes and Shut-off Valves by Shut-down of Gas Flow.

Incase it is possible to obtain a shut down of gas supply for a limited period the use of Hot Tapping and Stopple method can be avoided. In such a case in place of 3-way conduit barrel split tees and 3-way full encirclement tees ordinary weld tees of similar sizes would be welded in the cut sections. No hot tapping and stopple operation would be required.

Since shut-down of very short duration the bidders would need to use four separate independent teams to work at the three bypass locations and one insulating flange location as in this case one additional insulating flange is proposed.

The pipeline is operating at in pressure of 850 to 900 Psi. The line would need to be evacuated of gas and then purged using large slug of inert gas like Carbondioxide or Nitrogen. There are 8" Blow down valves

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available to reduce the time of this operation to minimum. Bidders should clearly give in their proposal the minimum time that they would require to purge the line and install the 3-by-passes including 3 insulating flanges and one insulating flange as per drawing No.P/U/CP(MG/MISC/003/12)IF 02/4. The minimum time to confirmed in the bid which will binding and guaranteed by bidder. The bidder will be responsible for purging the pipeline, installation of by-passes and recommissioning the gasline.

All installation of these by-passes and insulating flanges shall only be undertaken after detail procedure conforming to the requirements of API 1104, ANSI B31.8 and ANSI B31.4 including the safety requirements conforming to API 2201 is approved by the employer.

3.03.7 Potential Monitoring Posts at Pipeline Casings.

The potential monitoring posts shall be installed at locations specified in drawing Nos. P/U/CP(MG/XING/002)CTP 01/6 to P/U/CP(MG/XING/011)CTP 06/6. A portion of the post shall be embedded in the concrete/soil depending on its location in a manner that shall ensure physical stability of the post. All cables terminating into the posts with compression type lugs shall be adequately secured and clearly marked as to the facility (carrier pipe, casing, Zn reference) they are connected to.

Three cables which will each connect to carrier pipe, casing and Zn reference electrode by use of thermite welding will terminate at this post.

The cable connections should be done at time of exposing of casing end seals for investigation of faults and rectification of any faults at end seals.

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3.03.8 Rectification of Exposed Pipeline at Dehar Wah and Nehal Wah

The section of the pipeline is given in drawing No.P/U/CP(MG/MISC/003/6)EP 02/3. The pipe casing over the pipeline must be cut and removed. The tape coating in this section must also be removed. The pipe cleaned by sand blasting. The cleaned pipe is to be re-coated as per specification using 3 ply/ 2 ply Denso tape.

A culvert is to be constructed over this section as per drawing Nos.P/U/CP CRC 01/3 to P/U/CP CRC 03/3. The bidder must ascertain the actual requirements/dimensions and submit construction drawing for approval of employer.

3.03.9 Rectification of Exposed Pipeline at 200M from T-P 25 towards Guddu.

The section of pipe is given in drawing No. P/U/CP(MG/MISC/003/7) EP 03/3. This portion of exposed pipe should be covered by a RCC slab which should be bolted down on the top of the channel. A four inch thick RCC slab of 5'x4' size should be sufficient. Bidder may propose other alternative.

3.03.10 Topographic Survey

The alignment of the pipeline is to be exactly located by use of electronic instrument which should have capability of locating the pipeline alignment as well as its depth.

RCC pillar/marker posts to be fixed with a 5 foot offset at every 250 meter interval.

The topographic survey of the entire length to be done. The survey to cover 30 meter width preferably 15 meters either side of the confirmed centreline of the 20 inch pipe.

The scale of the survey to be 1:2000 Horizontal and 1:200 vertical. The 30 feet strip and pipeline centreline to be related

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to the survey of Pakistan coordinates. The 'L' section to be taken at each 30 meter interval. The crossection to be taken of the 30 meter inside strip at each 90 meter interval and at location where there are important changes. All structures in this 30 feet strip like trees, tube wells, channels, roads, culverts, huts, railway, bund, roads, pipelines, electric and telephone poles, cables, etc to be marked and located.

3.04 Testing and Commissioning

After rectification of all casing faults, installation of the test posts at the casings with faults a pipe to soil potential survey to be done and the potentials optimized to the minimum level necessary for protection of the pipeline.

The sectional flow of current across each insulating flange to be recorded and used in optimization and levelling of the potential curve.

The difference in potentials between carrier pipe and casing to be recorded.

The current output from each transformer rectifier to be optimized to a minimum level.

In case of installation of by-passes by shut-down of gas supply the detail procedure of recommissioning of the entire Mari-Guddu gasline to be submitted by the bidder for approval of Employer prior to start of work.

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SECTION NO.4

TO BE FILLED BY BIDDER
BILL OF QUANTITIES

List of Materials

	Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
1.	3-Way Conduit Barrel Split Tee 20"x16"x20" with LOR Flange and LOR Plug	4 Nos.			
2.	3-Way Full Encirclement Tee 12"x12" with LOR Flange and LOR Plug	1 No.			
3.	3-Way Full Encirclement Tee 16"x12" with LOR Flange and LOR Plug	1 No.			
4.	12" Sandwich Valve	2 Nos.			
5.	12" Williamson 1200 Tapping Machine Adaptor	1 No.			
6.	20" Williamson 1200 Tapping Machine Adaptor	1 No.			
7.	16" Sandwich Valve	1 No.			
8.	12" Stopple housing with 12" Plugging Head	1 No.			
9.	20" Stopple Cutter with Holder	4 Nos.			
10.	12" Stopple Cutter with Holder	2 Nos.			

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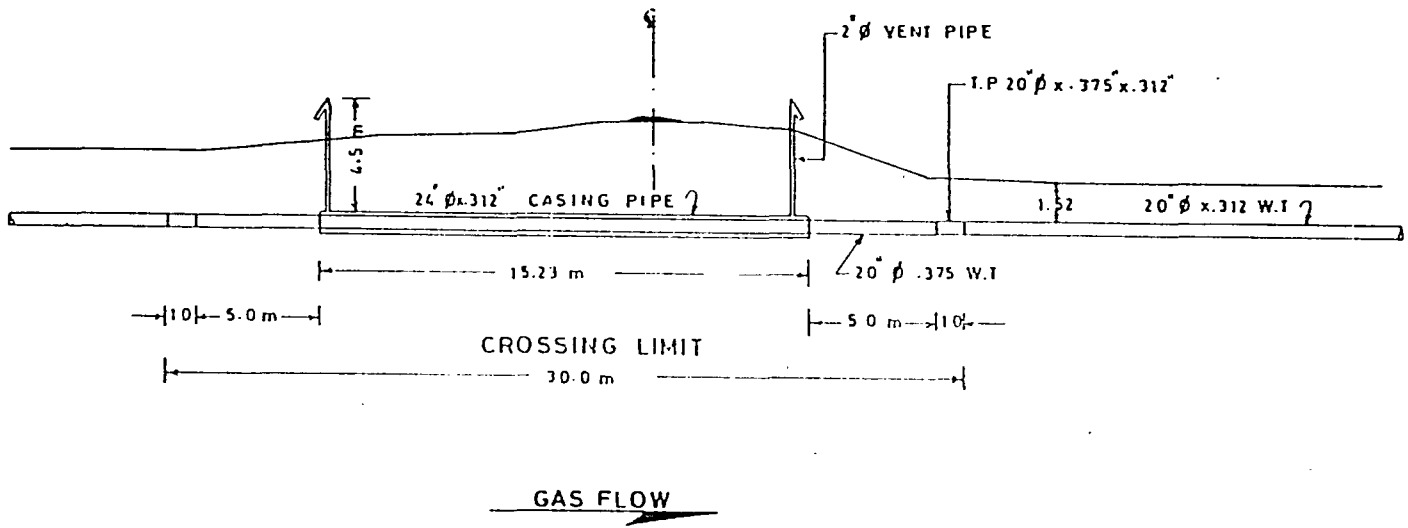
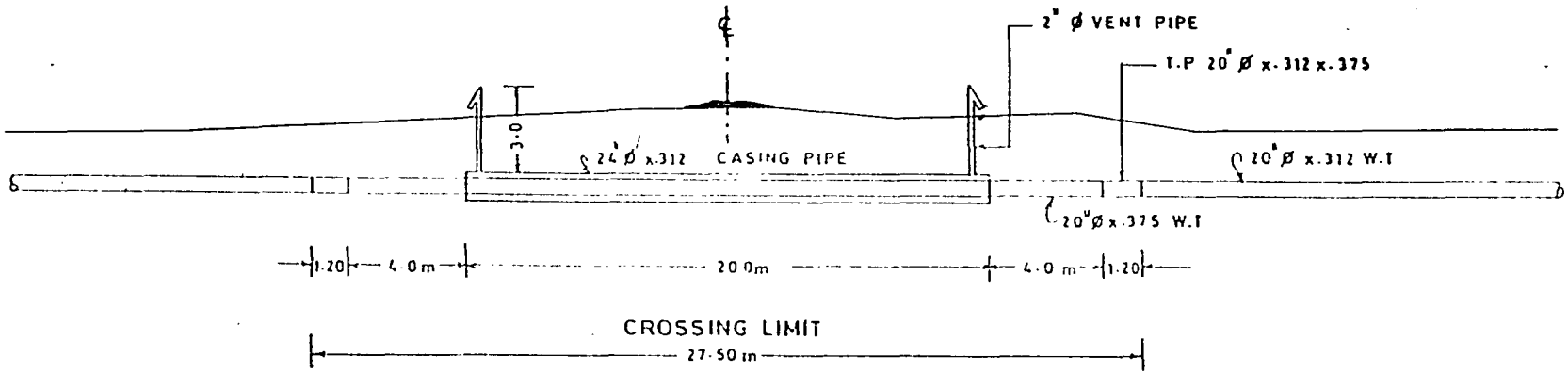


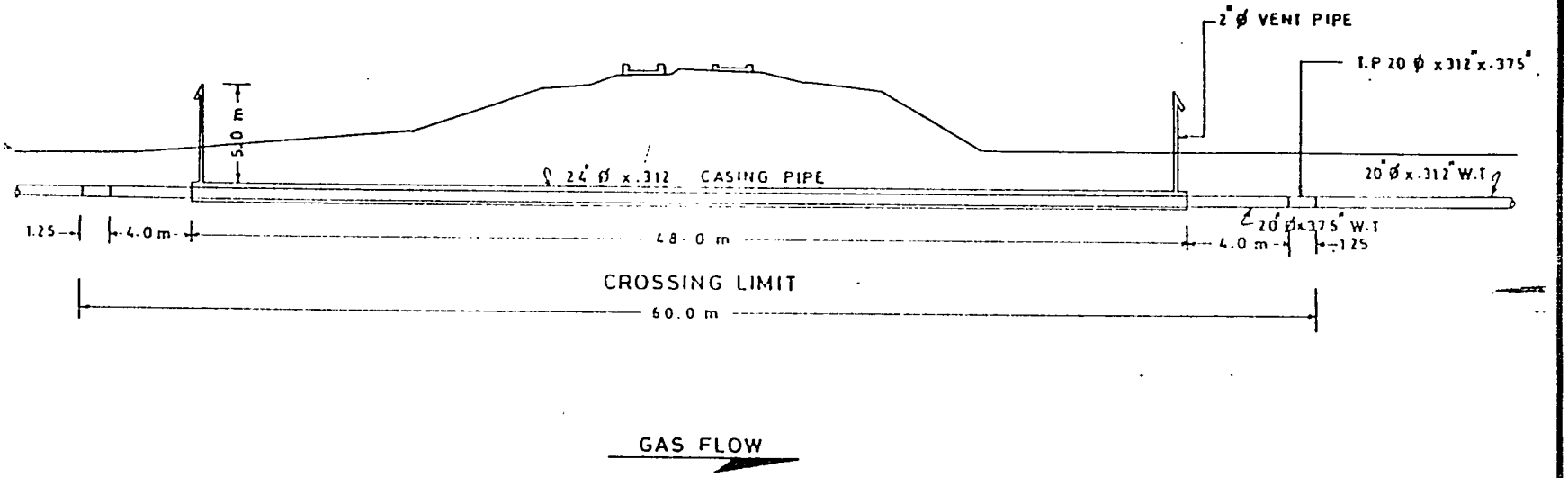
SHORTED CASING OF DHARKI/SANKHE ROAD	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/002) SC 01/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



GAS FLOW

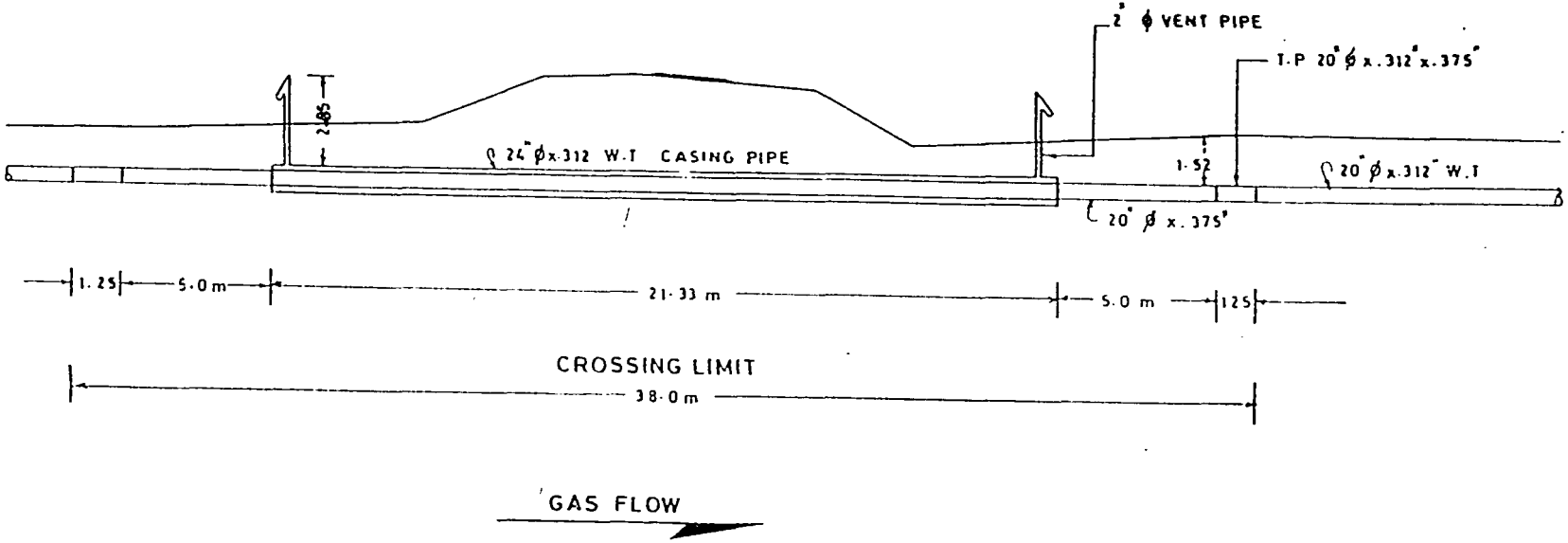
BEST AVAILABLE DOCUMENT

SHORTED CASING OF KANJU/ DHARKI ROAD	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/003) SC 02/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



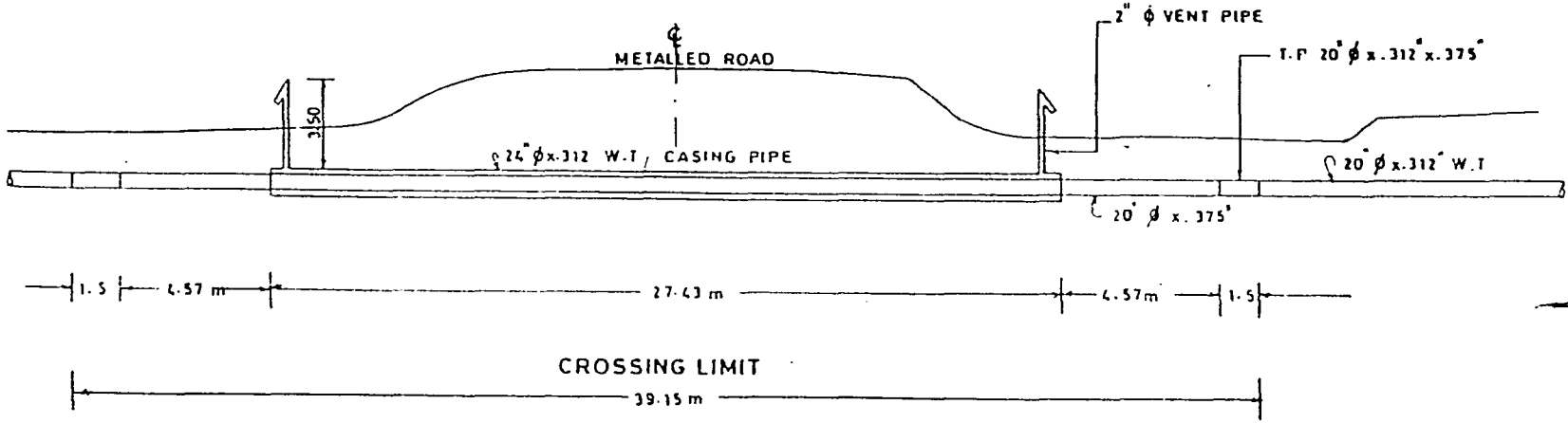
BEST AVAILABLE DOCUMENT

SHORTED CASING OF RAILWAY CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/004) SC 03/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



BEST AVAILABLE DOCUMENT

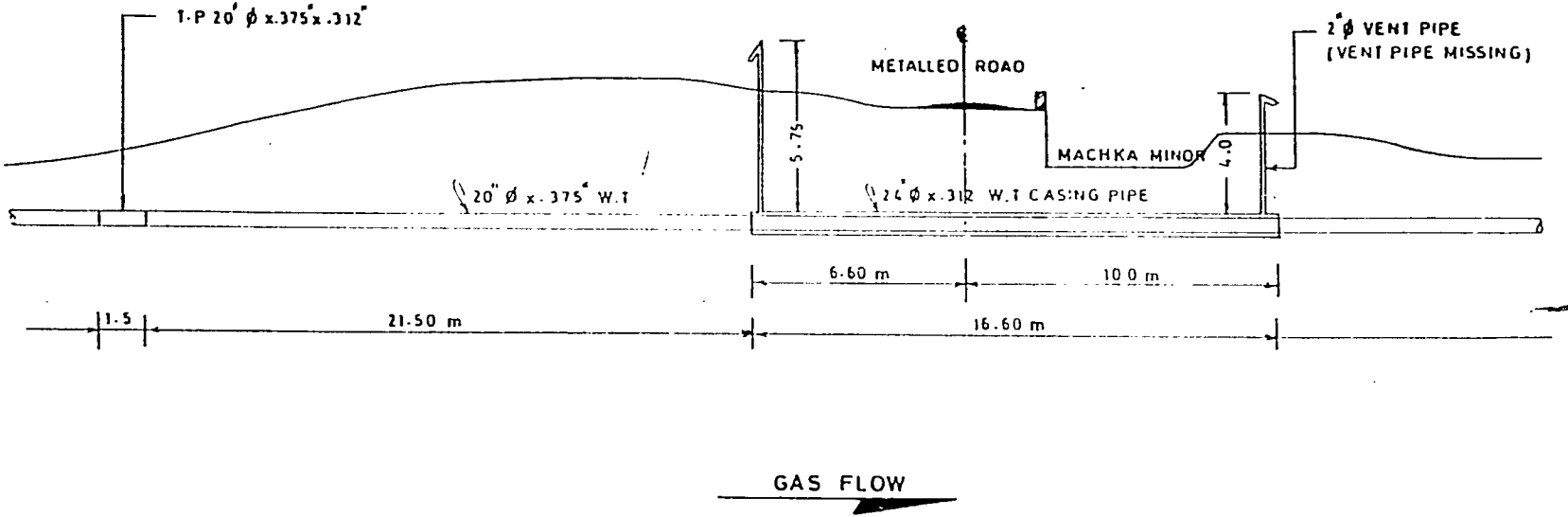
SHORTED CASING OF RETI ROAD	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/007) SC 04/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



GAS FLOW

BEST AVAILABLE DOCUMENT

SHORTED CASING OF NATIOANAL HIGHWAY	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/008) SC 05/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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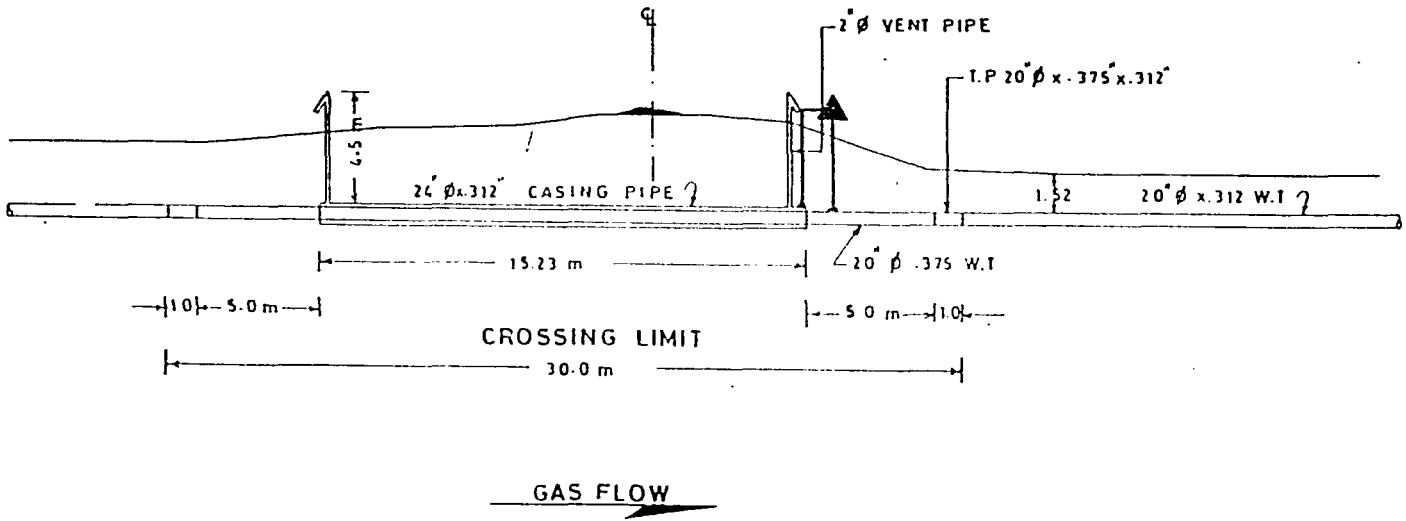
SHORTED CASING OF MACHKA ROAD, MACHKA MINOR AND KHAMBRA DISTRIBUTORY	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/XING/011) SC 06/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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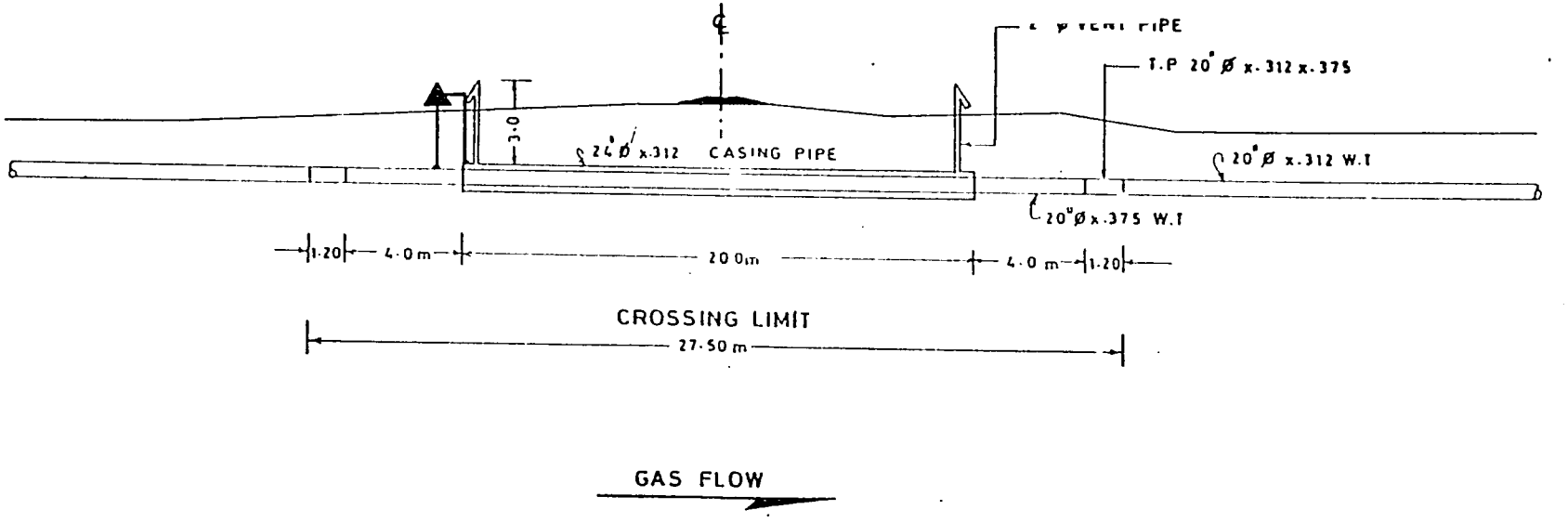
CASING TESTING POST LOCATIONS ▲	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/002)CTP 01/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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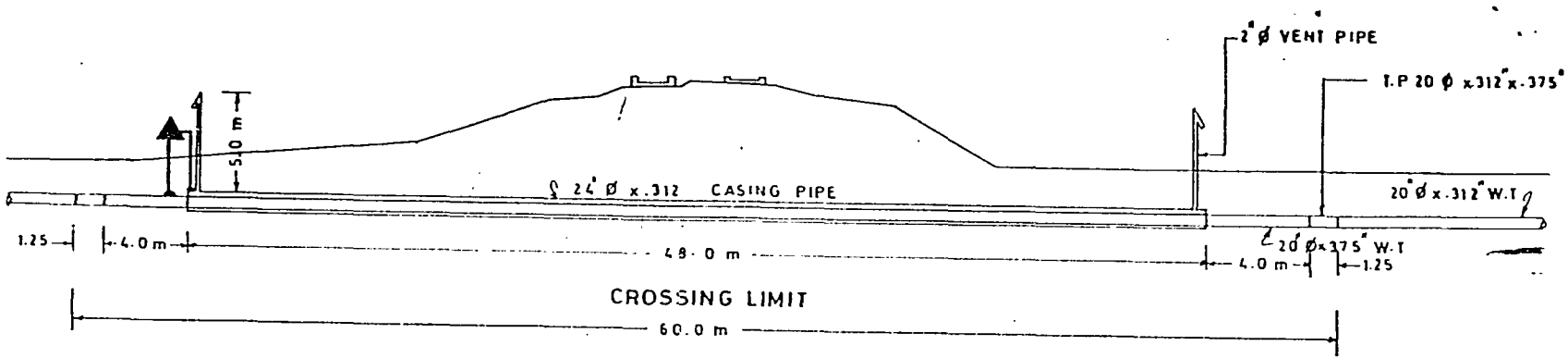
CASING TESTING POST LOCATIONS ▲	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/003)CTP 02/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



GAS FLOW

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CASING TESTING POST LOCATIONS ▲	600 -MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/004)CTP 03/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

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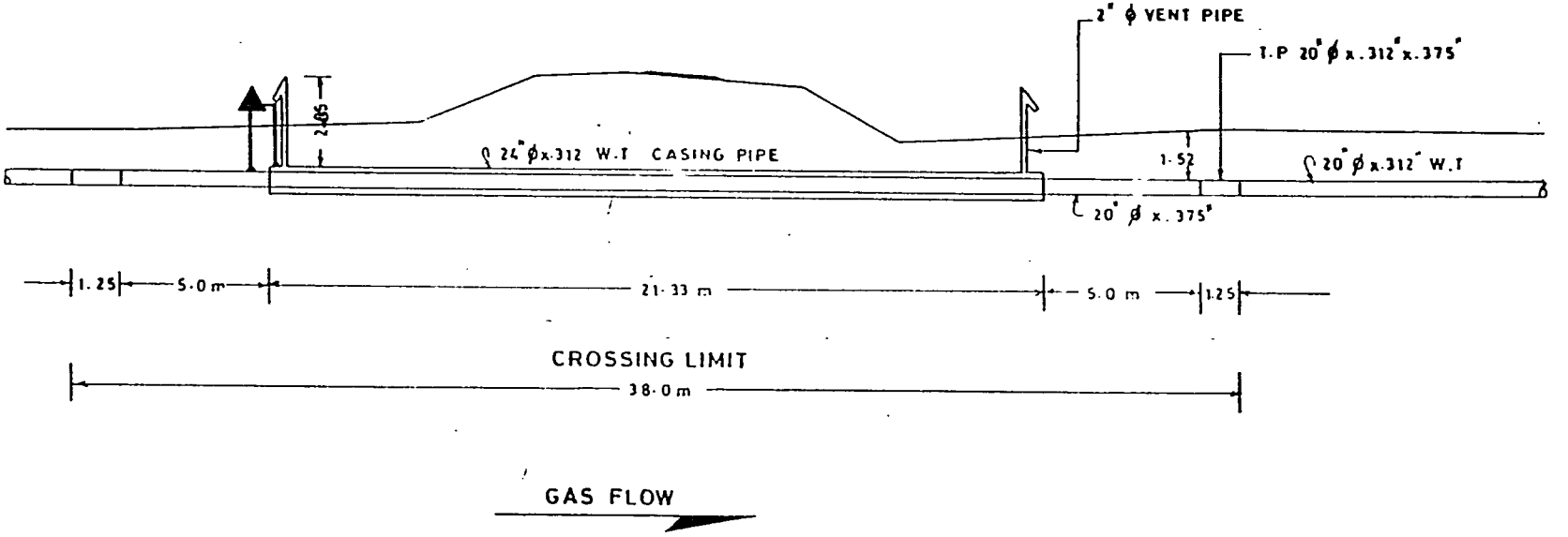

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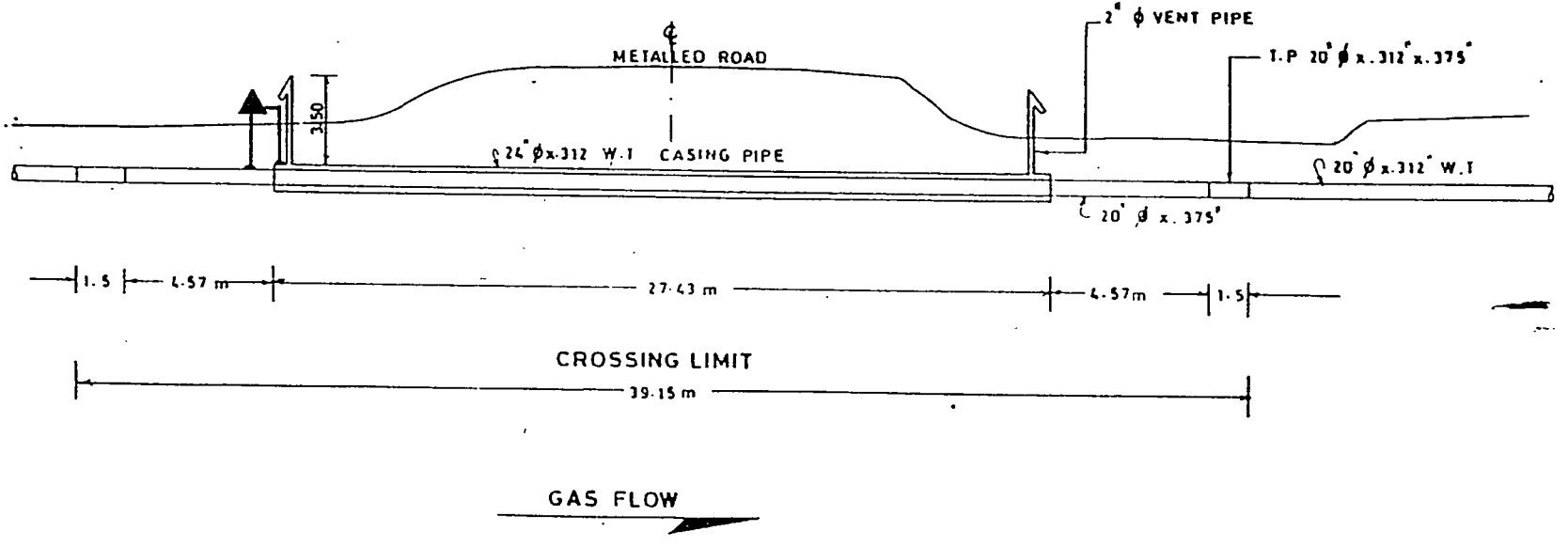
CASING TESTING POST LOCATIONS ▲	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/007)CTP 04/6
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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CASING TESTING POST LOCATIONS ▲	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/008)CTP 05/6
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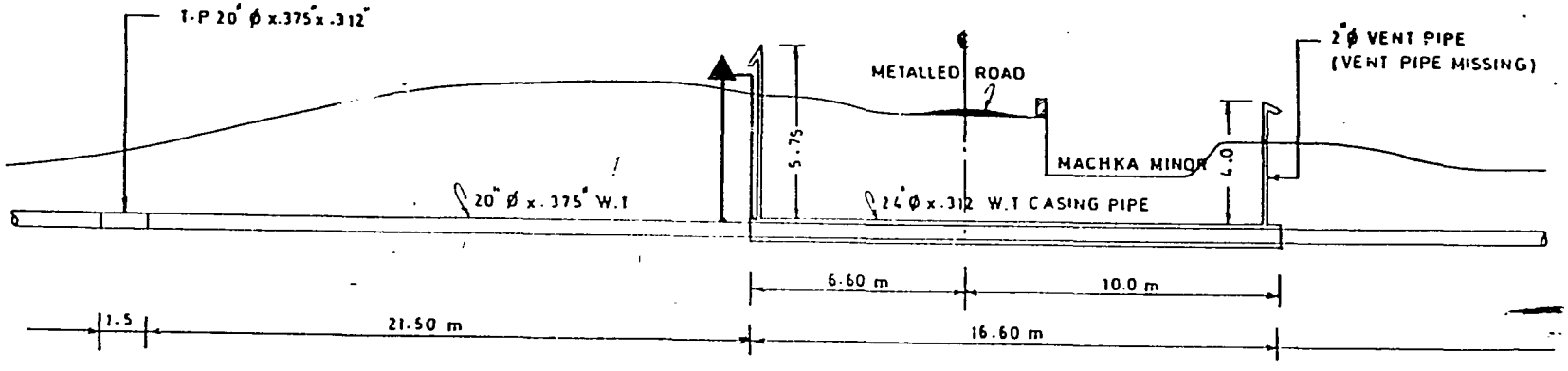

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CASING TESTING POST LOCATIONS ▲	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/XING/011)CTP 06/6
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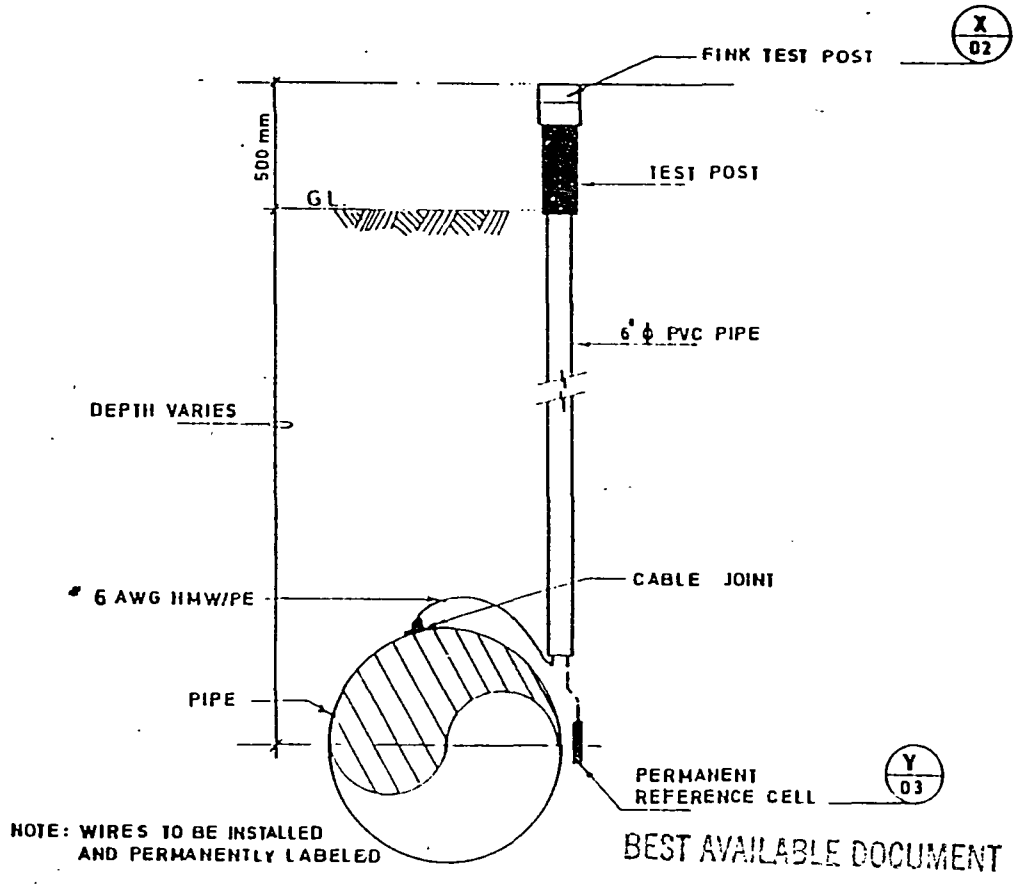

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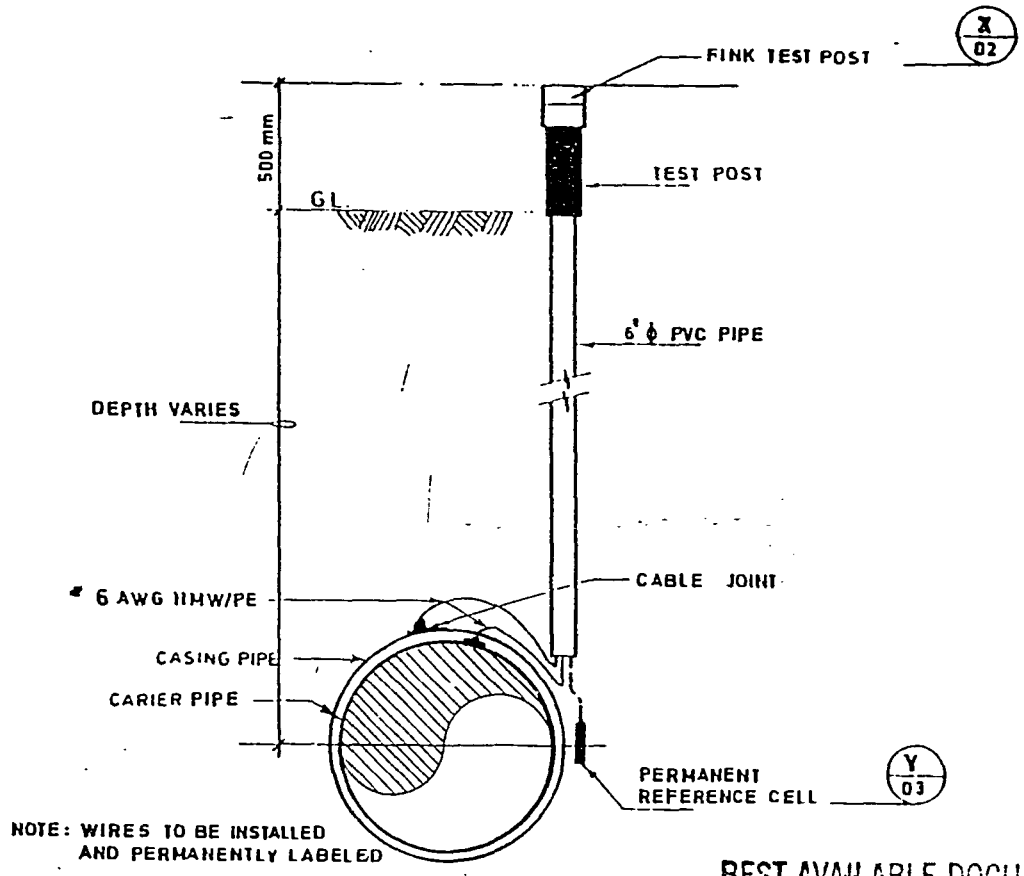
TYPICAL TEST STATION INSTALLATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP TS 01/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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TYPICAL TEST STATION INSTALLATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP TS 02/4
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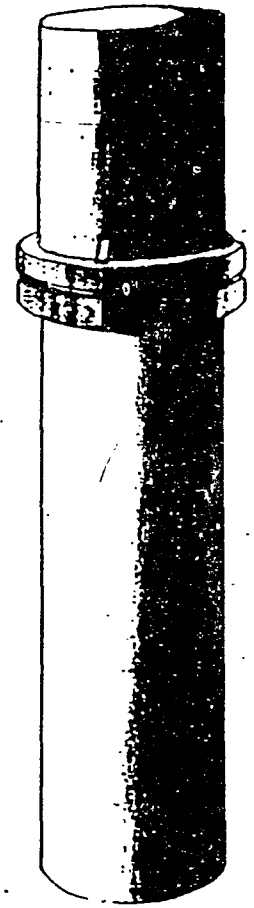
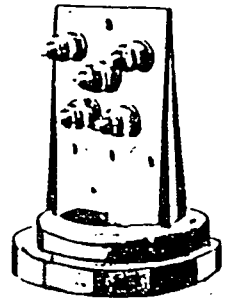


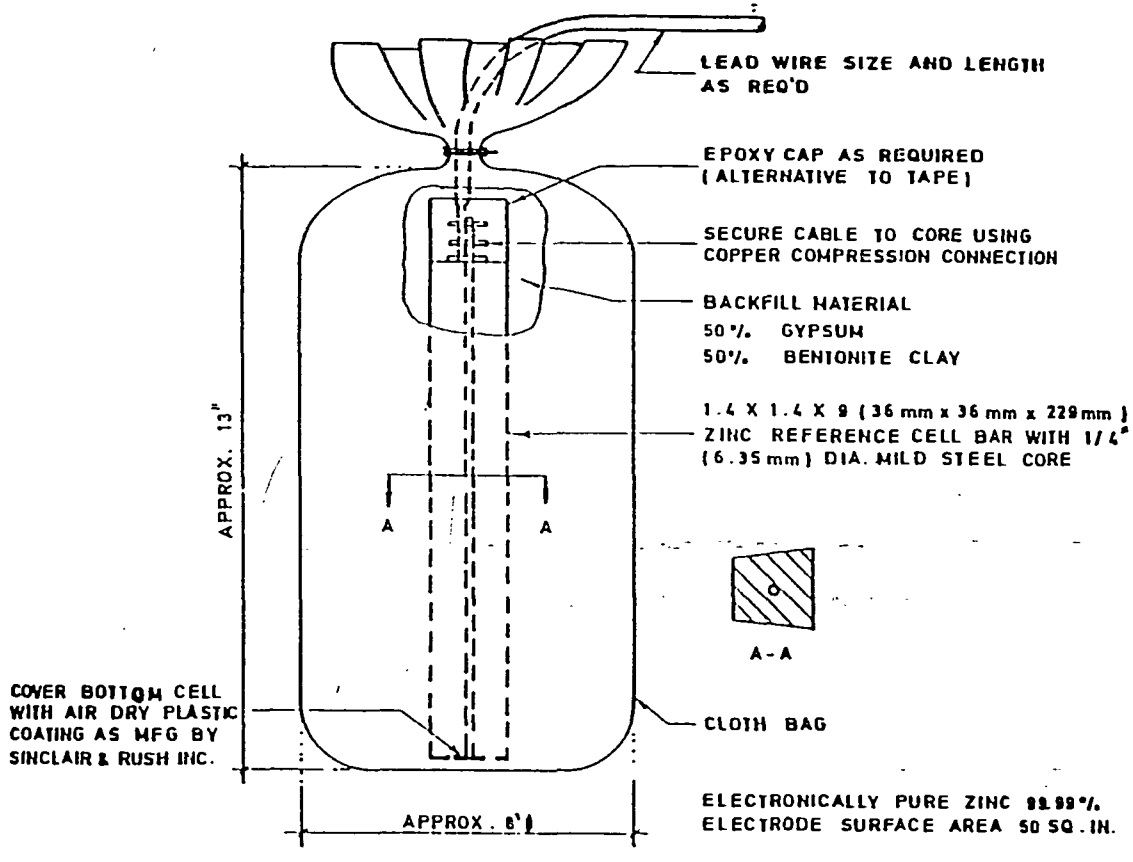


SINGLE (5 LEAD)
BIG FINK

SECTION DETAIL X/02

BEST AVAILABLE DOCUMENT

A TYPICAL VIEW OF FINK TYPE TEST POST	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP TS 03/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



SECTION DETAIL Y/03

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REFERENCE CELL	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP TS 04/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

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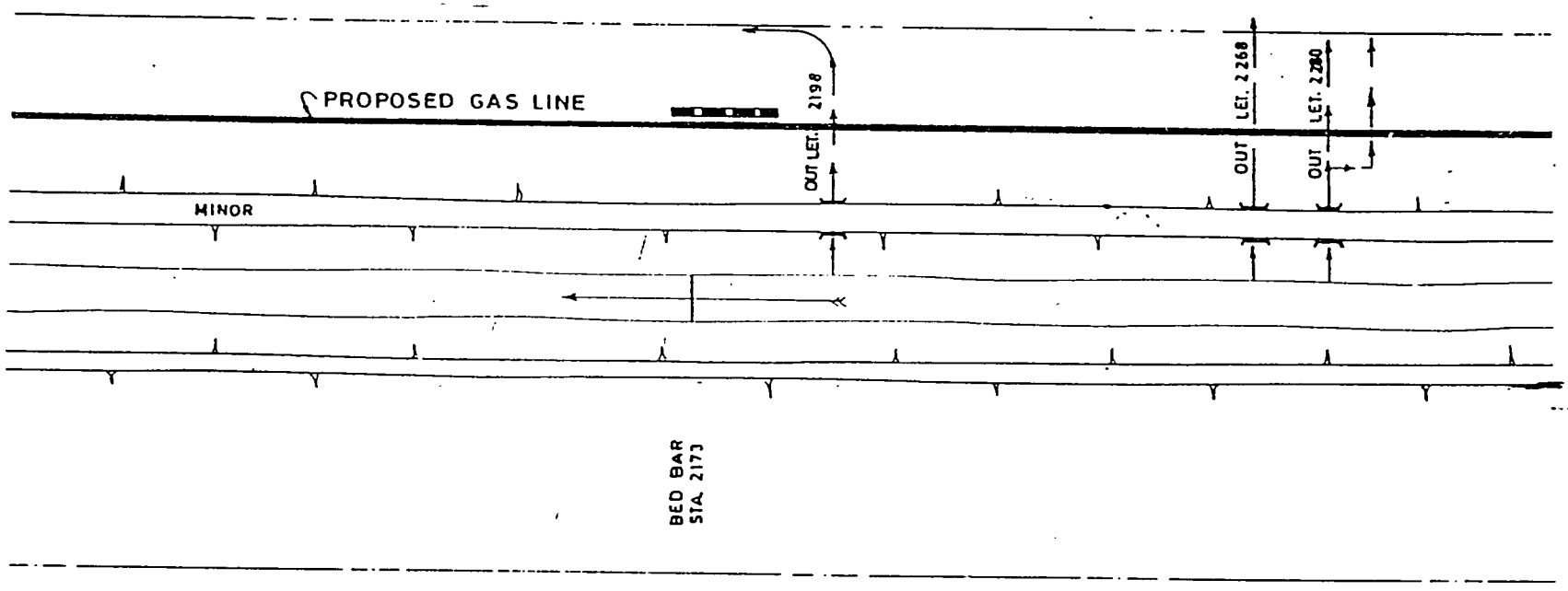

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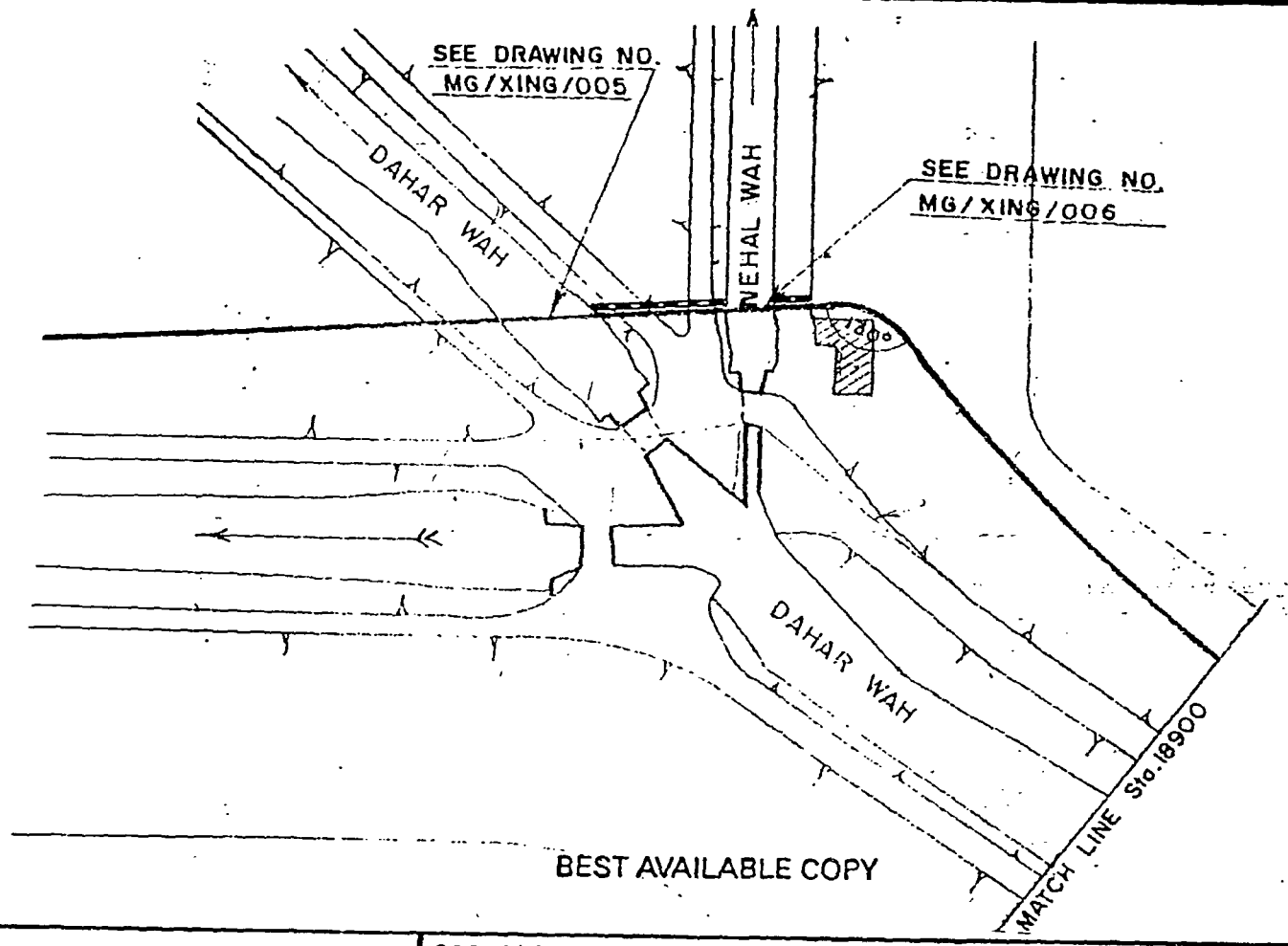
EXPOSED PIPE LOCATIONS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/1)EP 01/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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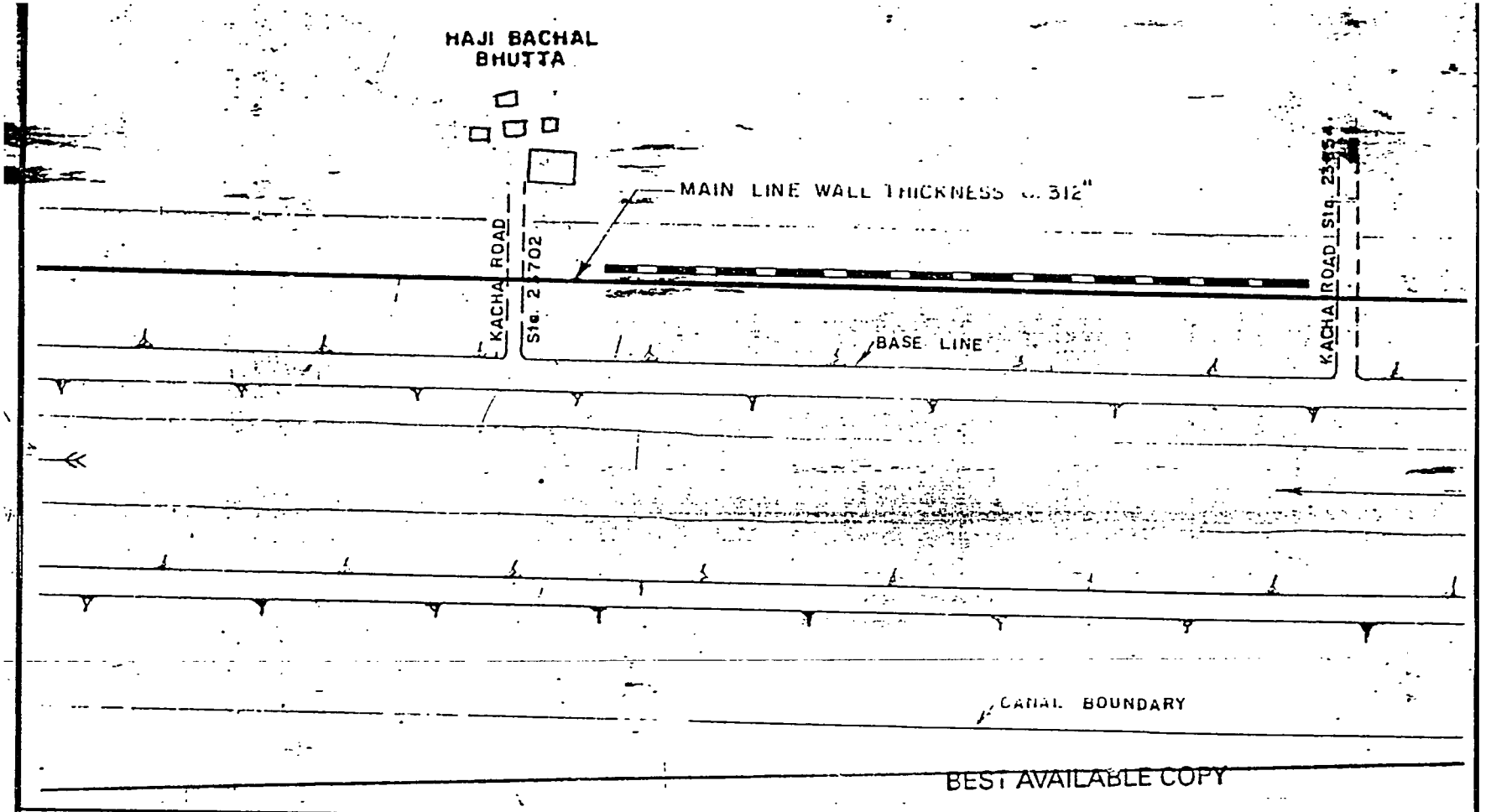
EXPOSED PIPE LOCATIONS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/6) EP 02/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

1.9



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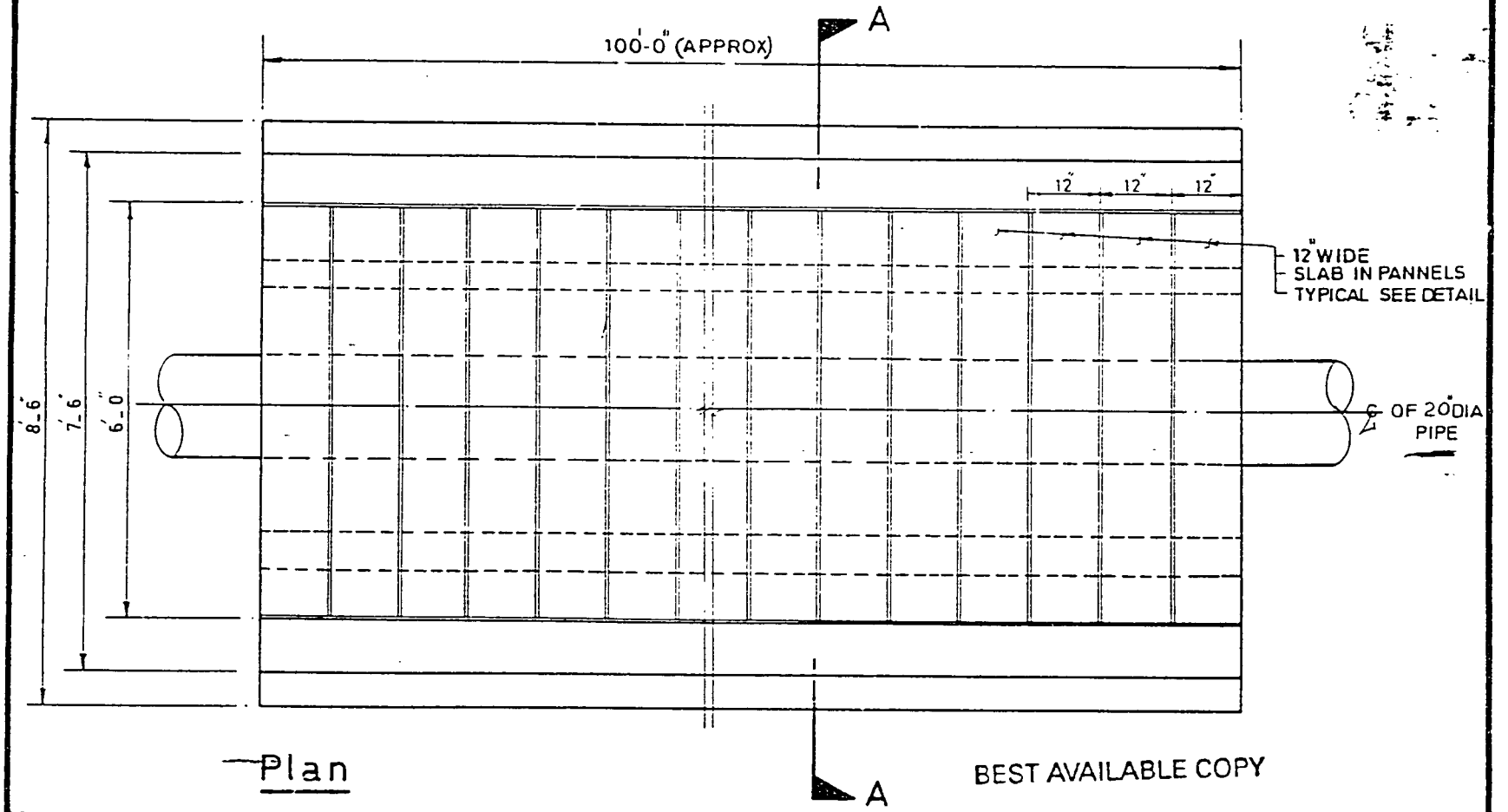
EXPOSED PIPE LOCATIONS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/7)EP 03/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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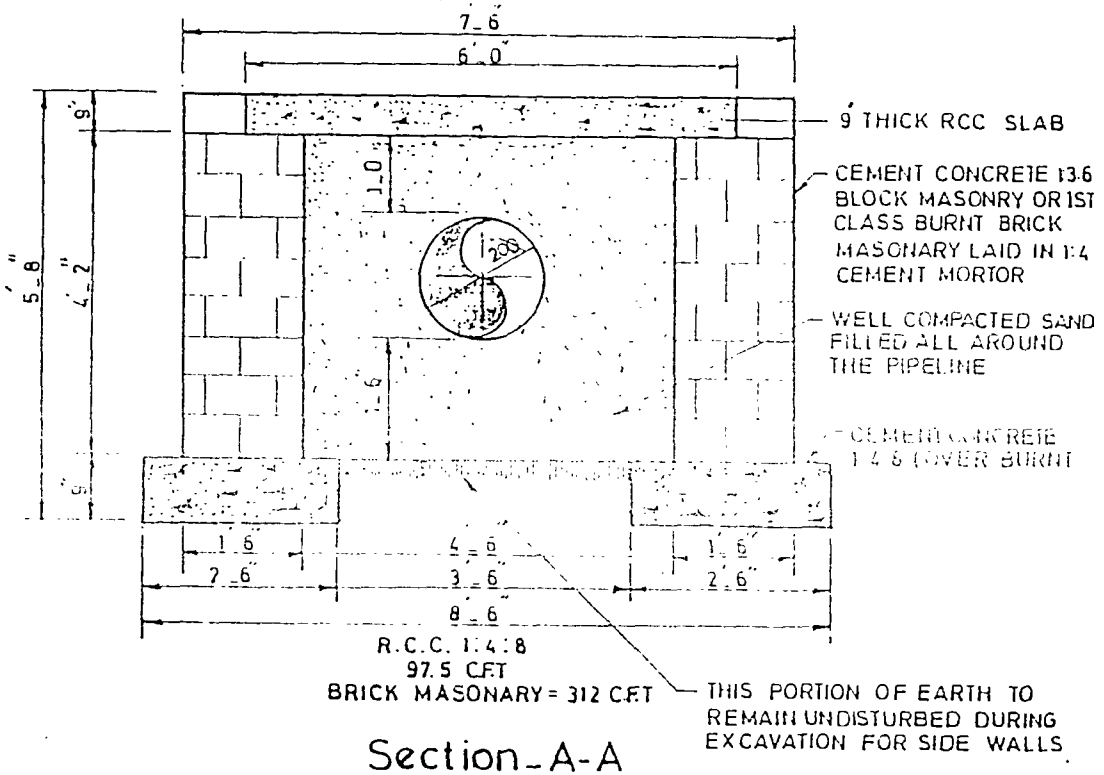
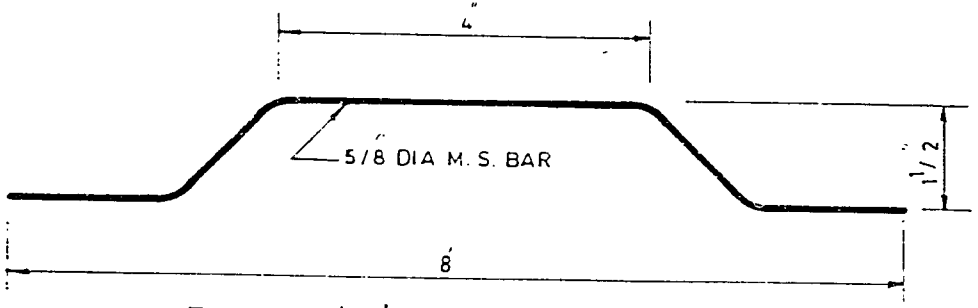
TYPICAL CULVERT FOR ROAD CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP CRC 01/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



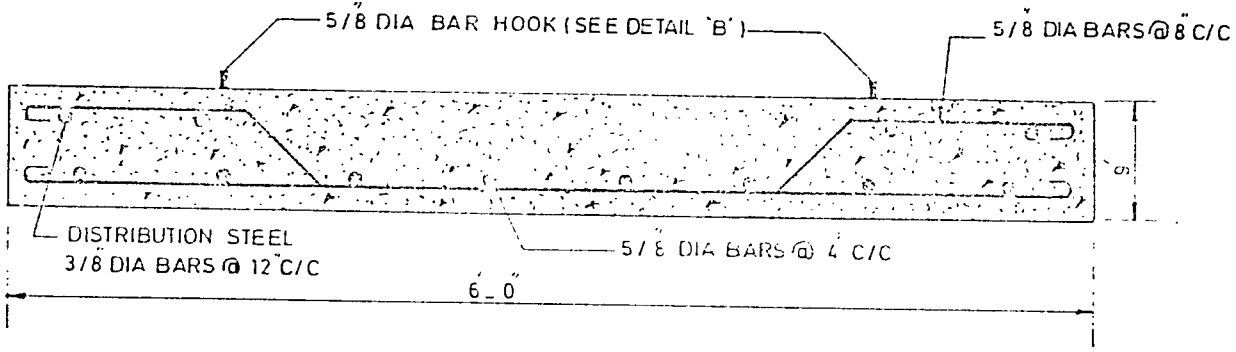
Section-A-A

BEST AVAILABLE COPY

TYPICAL CULVERT FOR ROAD CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP CRC 02/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



Detail 'B'

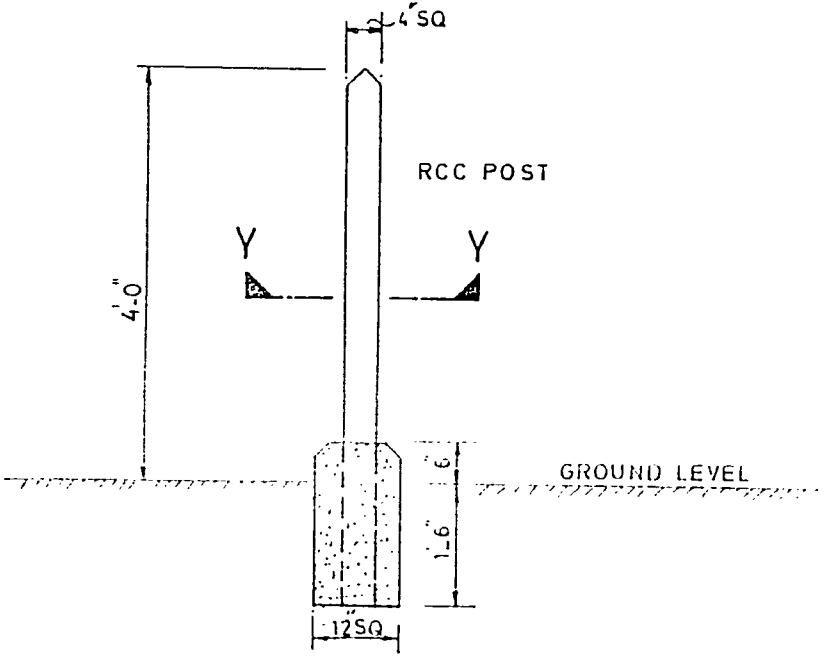


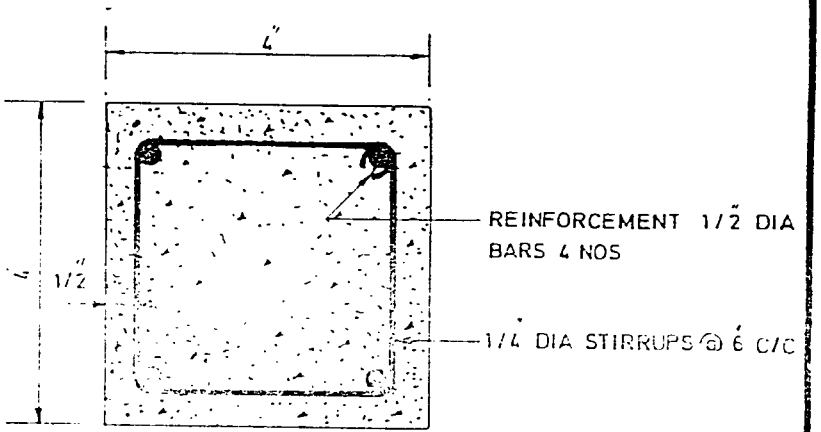
Detail Of Rcc Slab

R.C.C. 1:2:4
117 CFT
AVE LENGTH=26-0 (ASSUMED)

BEST AVAILABLE COPY

TYPICAL CULVERT FOR ROAD CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP CRC 03/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90





Section_Y-Y

R.C.C 1:2:4
3.52 C.F.T (With R.C.C. Post)

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TYPICAL PILLAR POST INSTALLATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP PP 01/1
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

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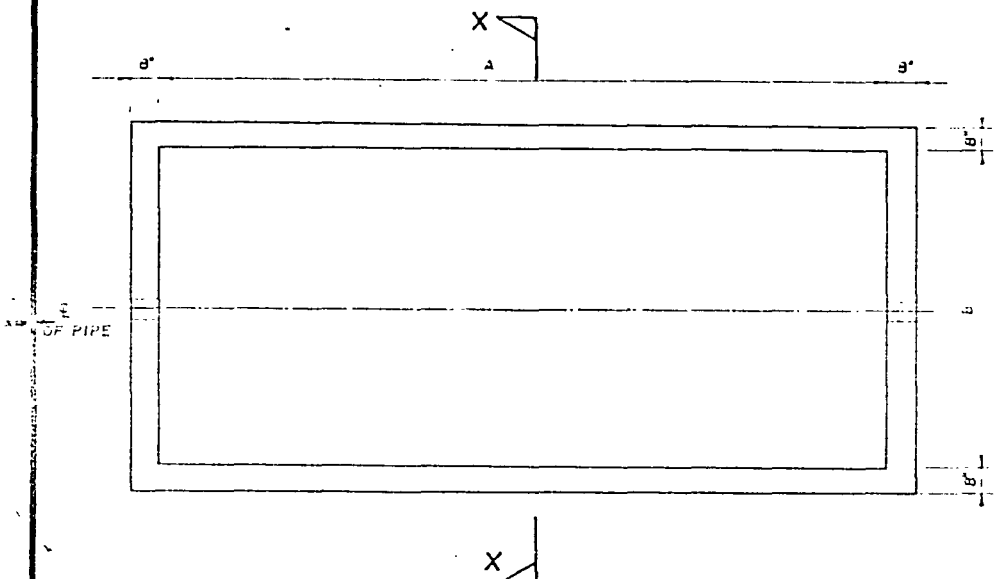
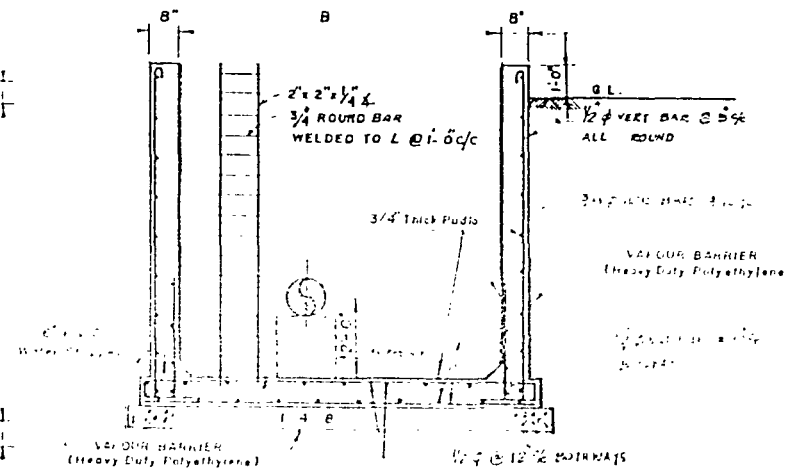


PLAN



SECTION X-X

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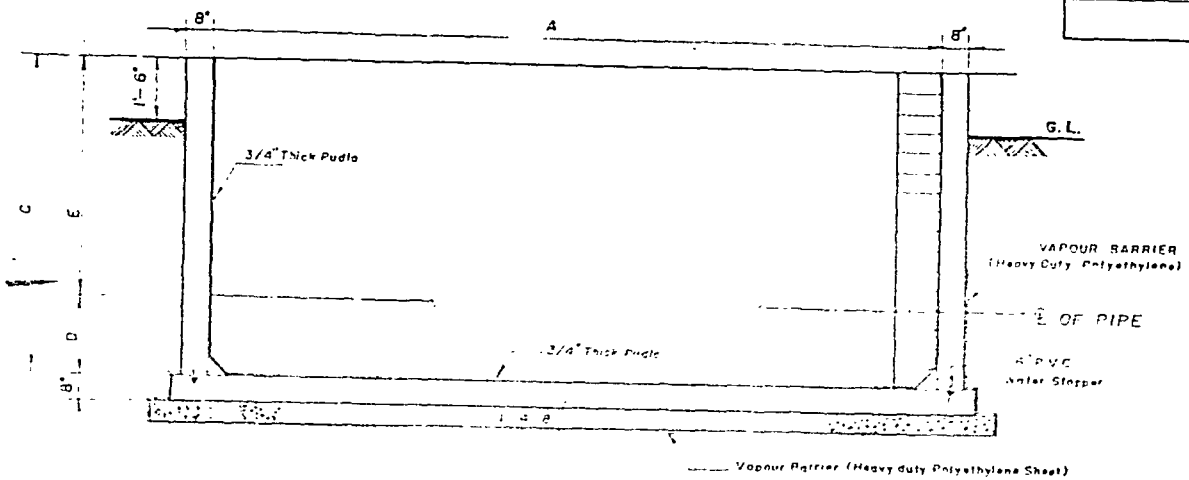
TYPICAL VALVE PIT DETAILS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP VP 01/2
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

SCHEDULE

SERVICES	A	B	C	D	E		R.C.C. 1:2:4
MAIN LINE BLOCK VALVE	18'-3"	8'-0"	7'-11"	2'-0"	5'-11"		422.31 CFt.



ELEVATION

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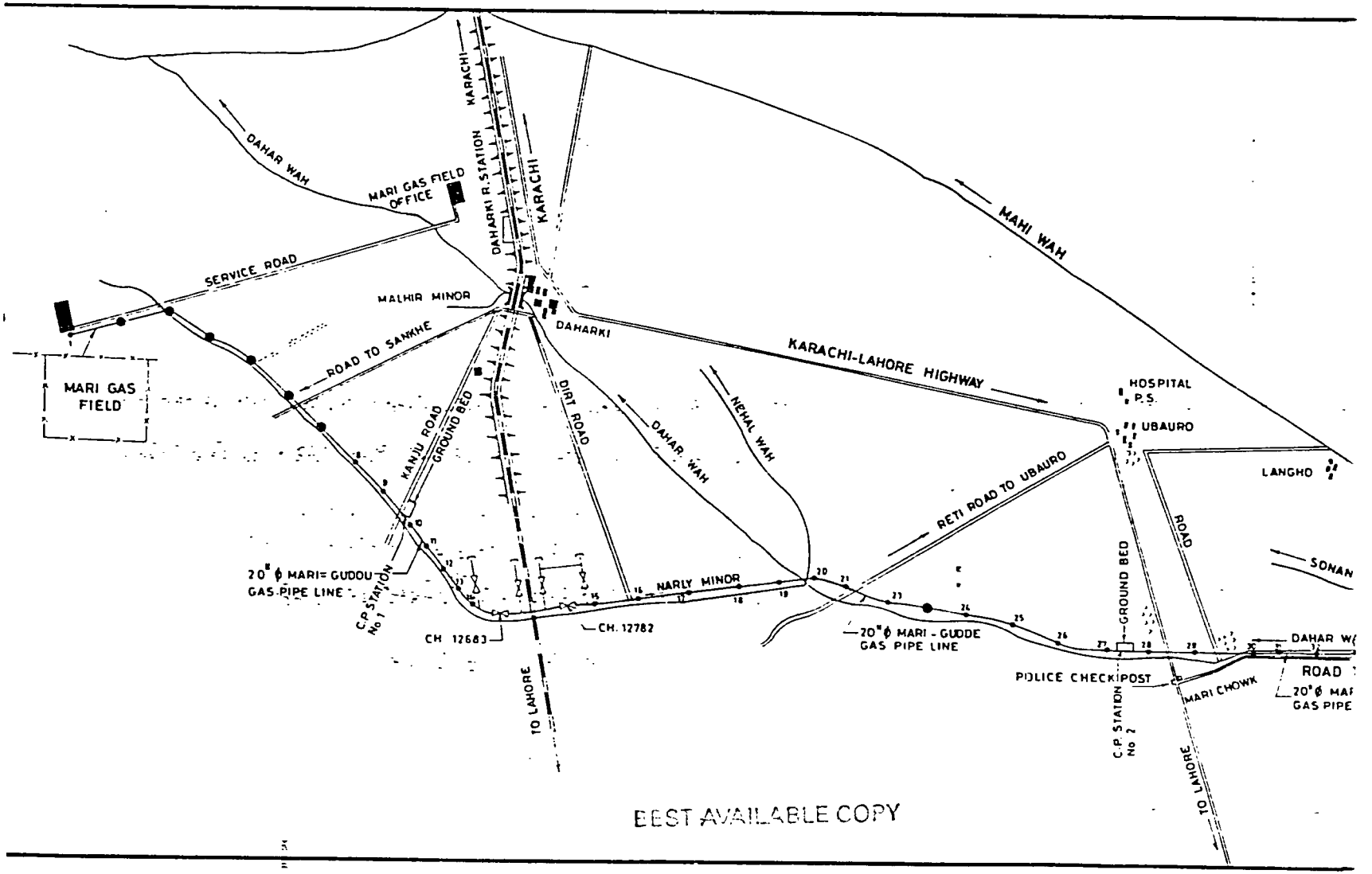
TYPICAL VALVE PIT DETAILS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI-GUDDU GAS PIPELINE	DRG. No. P/U/CP VP 021 2
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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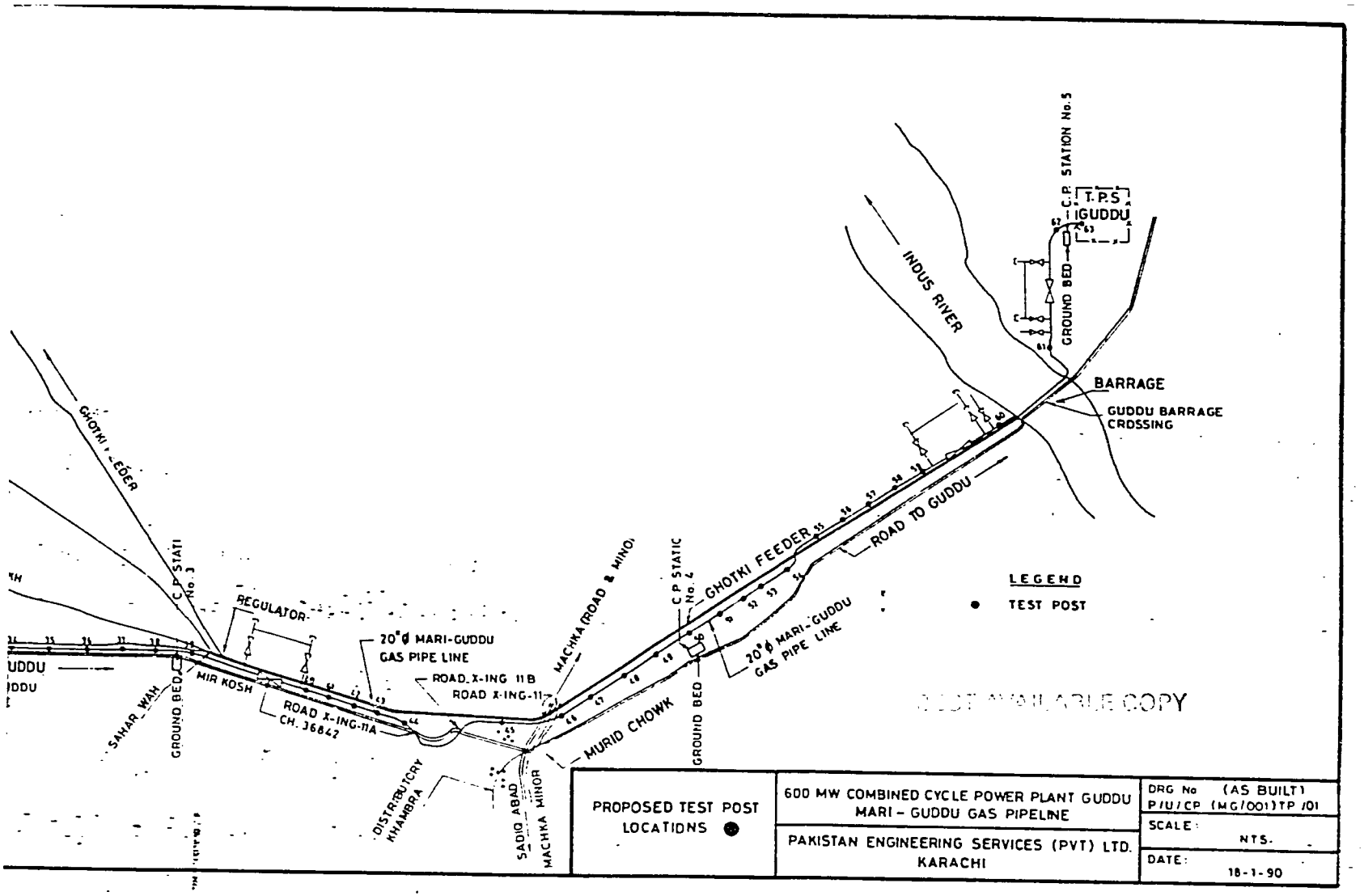
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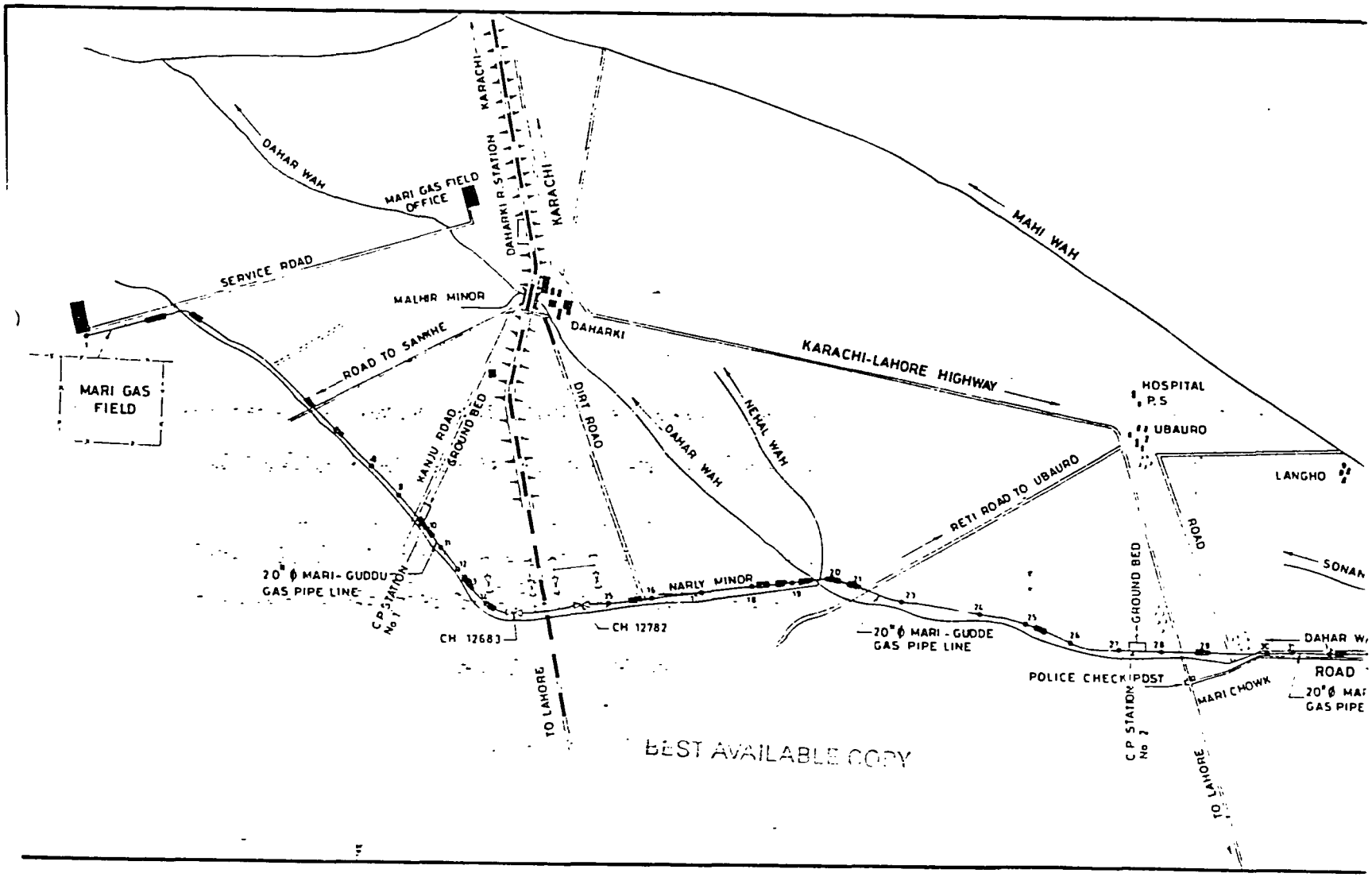
C.P. STATION No.5
T.P.S
GUDDU
GROUND BED
BARRAGE
GUDDU BARRAGE
CROSSING
ROAD TO GUDDU
GHOTKI FEEDER
C.P STATION
No. 2
MACHKA (ROAD & MINOR)
20"ϕ MARI-GUDDU
GAS PIPE LINE
ROAD X-ING 11B
ROAD X-ING-11
MURID CHOWK
GROUND BED
REGULATOR
C.P STATI
No. 3
GHOTKI FEEDER
MIR KOSH
ROAD X-ING-11A
CH. 36842
SAHAR WAH
GROUND BED
DISTRIBUTORY
KHAMBRA
SADIQ ABAD
MACHKA MINOR
LEGEND
TEST POST
BEST AVAILABLE COPY
PROPOSED TEST POST
LOCATIONS
600 MW COMBINED CYCLE POWER PLANT GUDDU
MARI - GUDDU GAS PIPELINE
PAKISTAN ENGINEERING SERVICES (PVT) LTD.
KARACHI
DRG No (AS BUILT)
P/U/CP (MG/001)TP /01
SCALE: NTS.
DATE: 18-1-90



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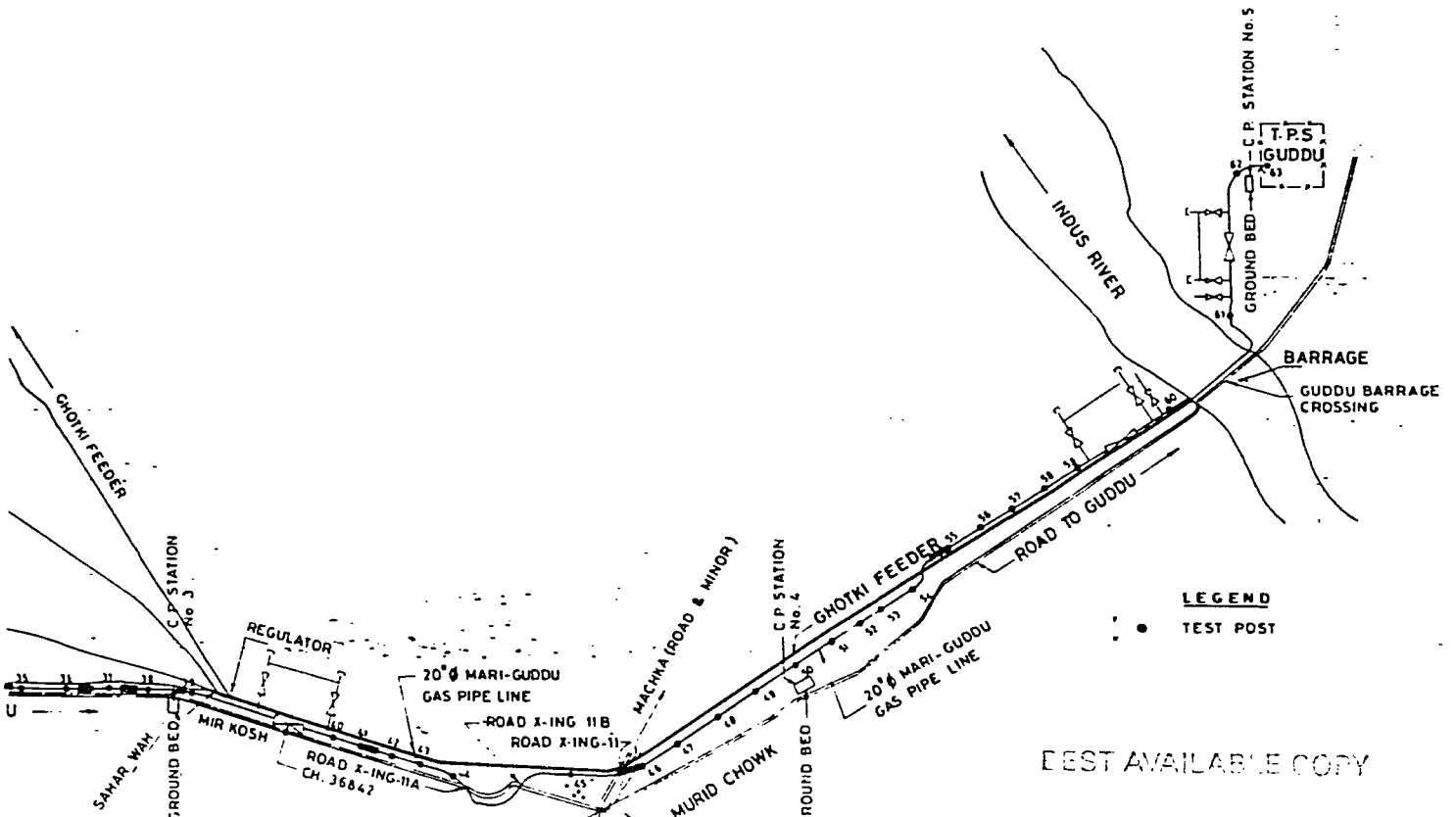

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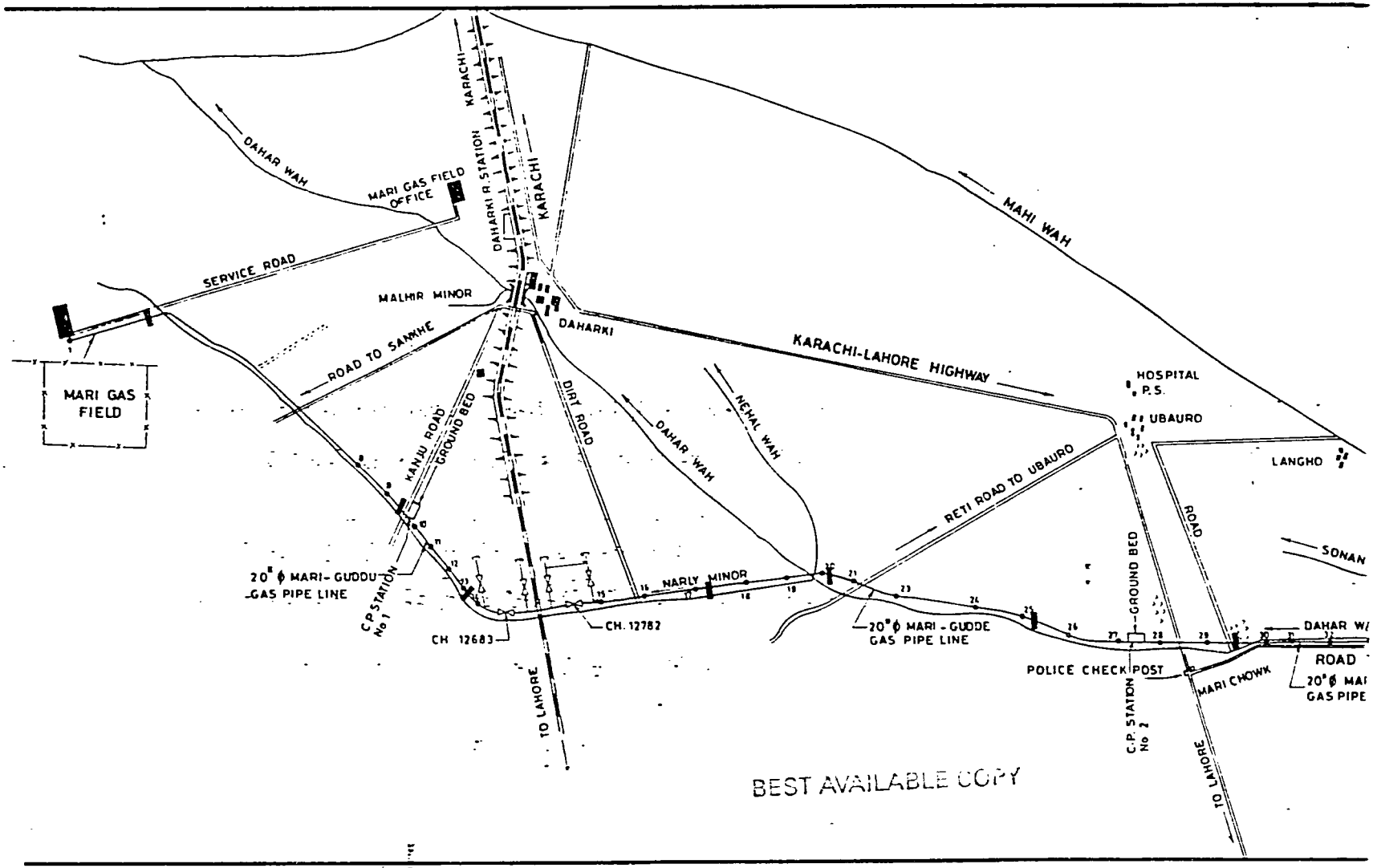
RE-COATING LOCATIONS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG No. (AS BUILT) P/U/CP (MG/001)RC/01
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	SCALE: NTS.
		DATE. 18-1-90



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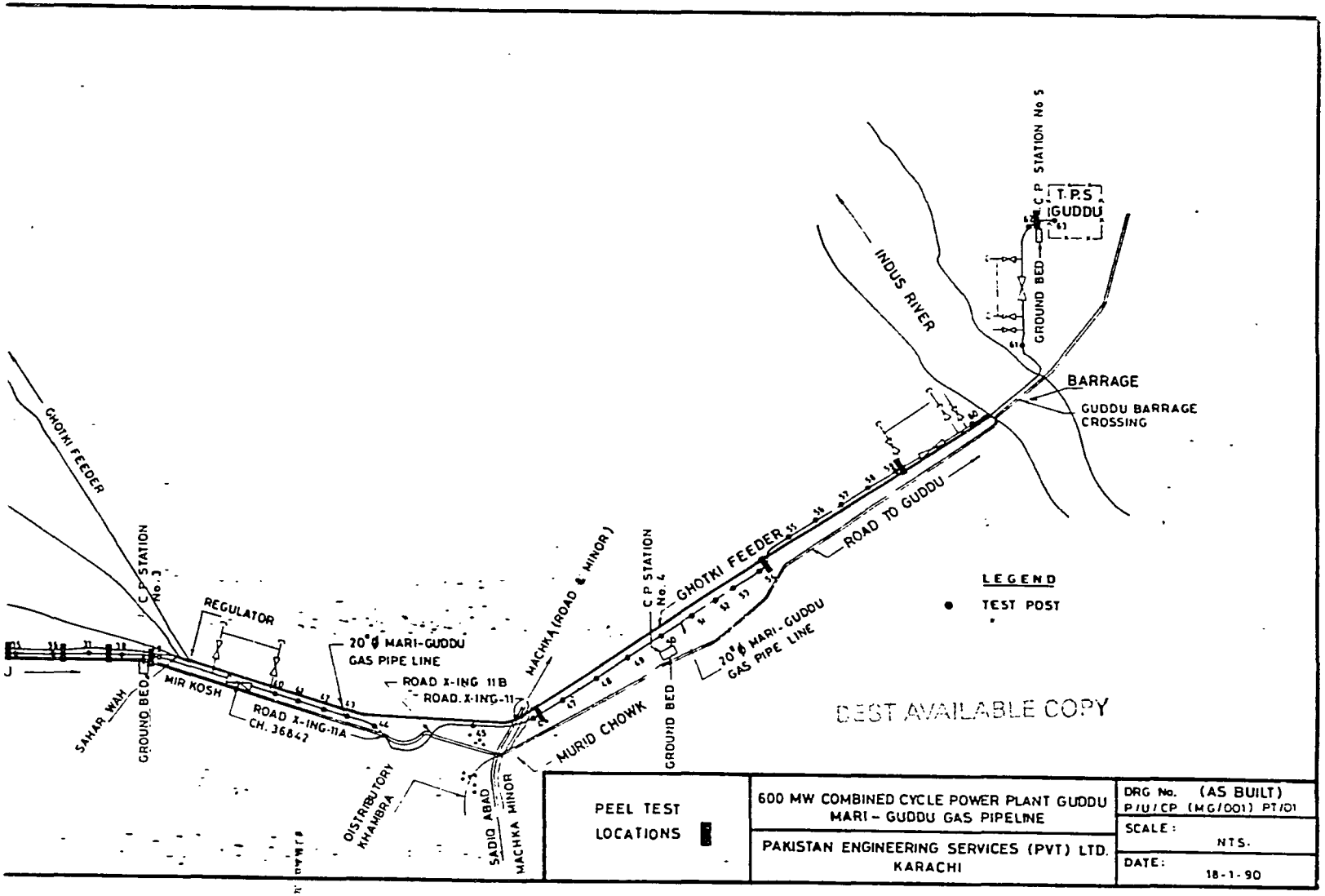
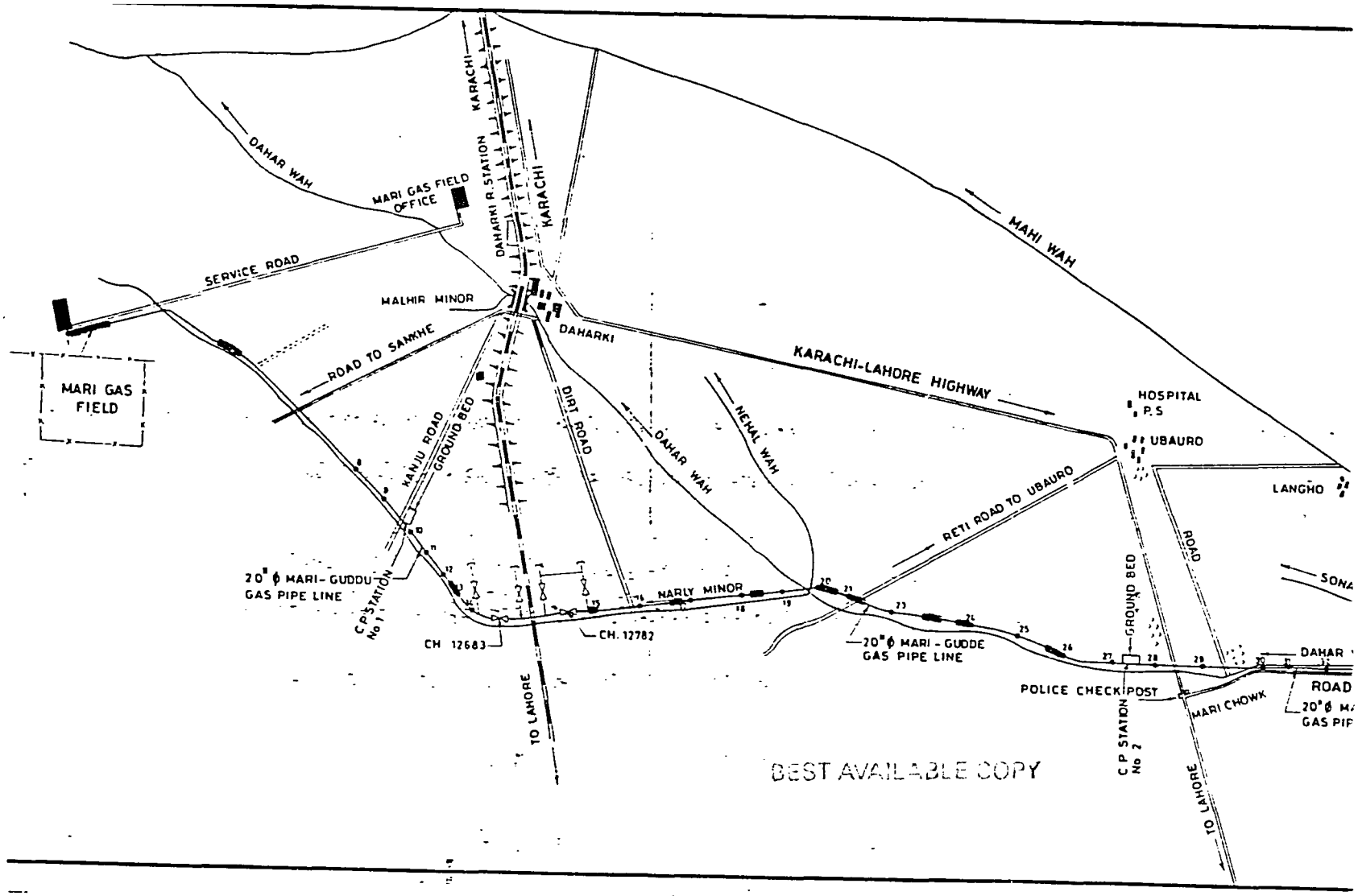
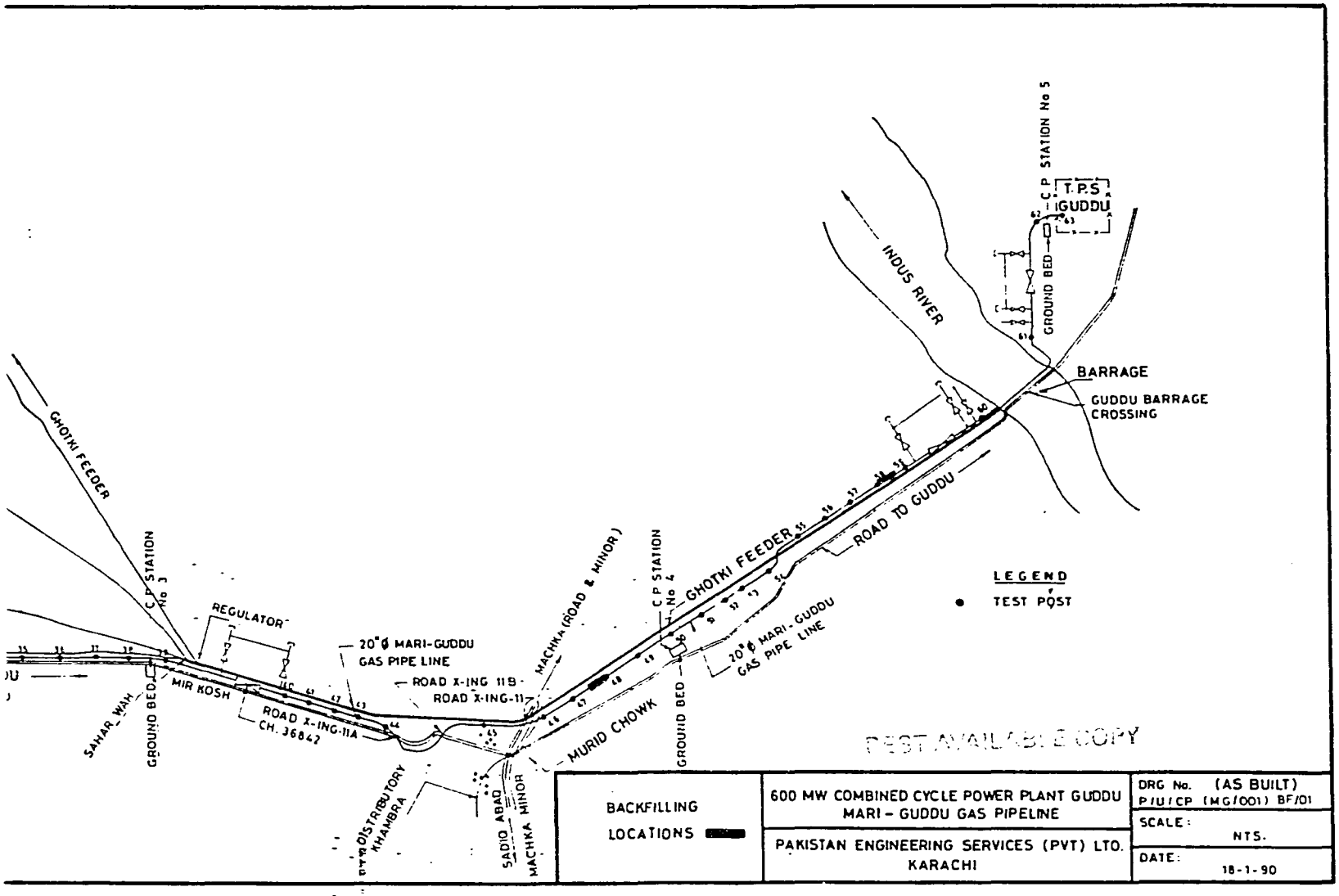
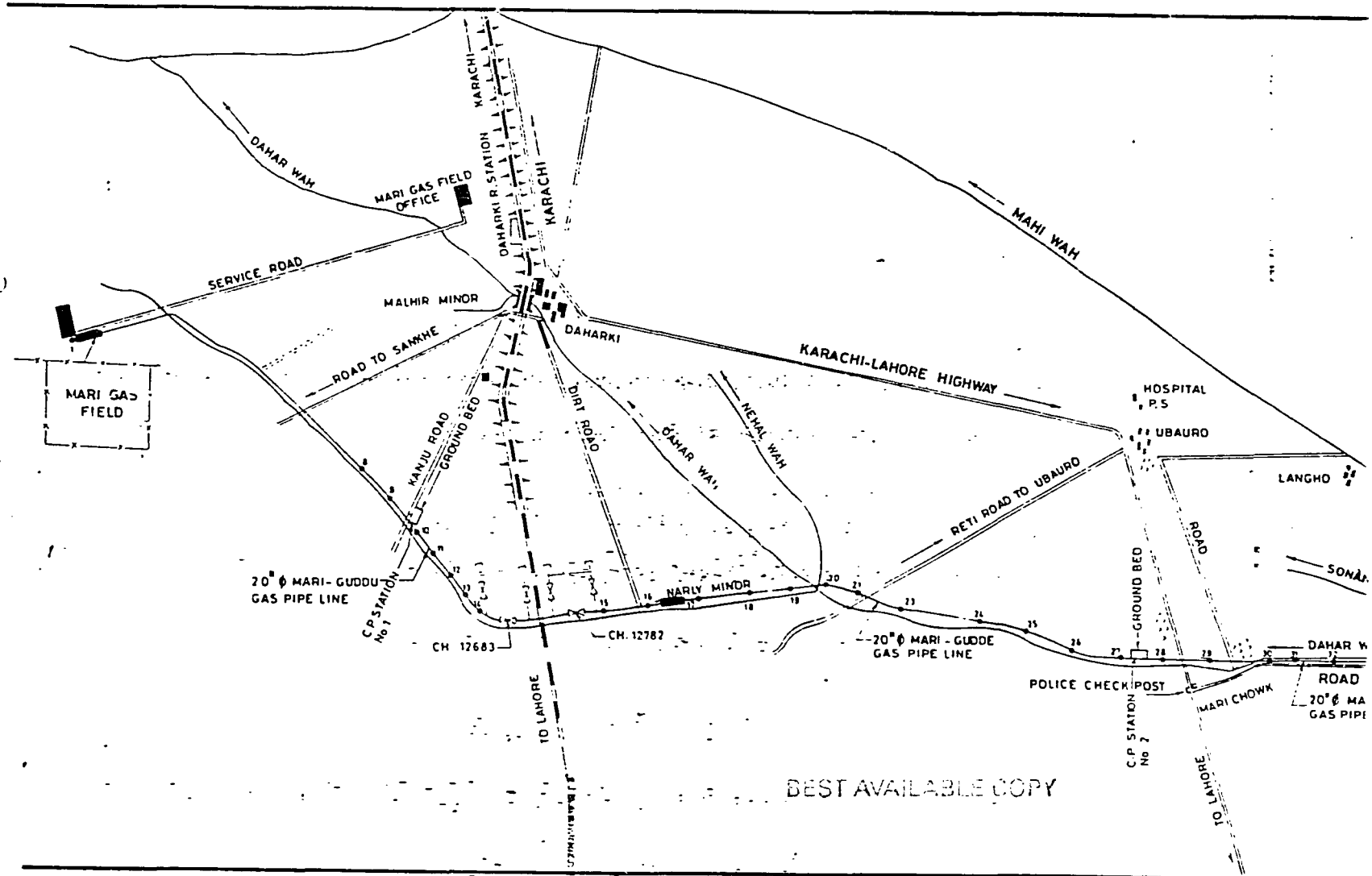


PEEL TEST LOCATIONS	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG No. (AS BUILT) P/U/CP (MG/001) PT/01
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	SCALE: NTS.
		DATE: 18-1-90


DAHAR WAH
MARI GAS FIELD OFFICE
SERVICE ROAD
MARI GAS FIELD
MALHIR MINOR
ROAD TO SAMKHE
KARACHI
DAHARKI R. STATION
KARACHI
DAHARKI
MAHI WAH
KARACHI-LAHORE HIGHWAY
HOSPITAL
P.S
UBAURO
LANGHO
NEHAL WAH
DAHAR WAH
DIRT ROAD
KANJU ROAD
GROUND BED
RETI ROAD TO UBAURO
20" ϕ MARI-GUDDU GAS PIPE LINE
C.P. STATION No 1
CH 12683
CH. 12782
NARLY MINOR
20" ϕ MARI - GUDDE GAS PIPE LINE
GROUND BED
ROAD
POLICE CHECKPOST
MARI CHOWK
C P STATION No 2
TO LAHORE
TO LAHORE
DAHAR
ROAD
SONA
BEST AVAILABLE COPY


GHOTKI FEEDER
C P STATION No 3
REGULATOR
20"Ø MARI-GUDDU GAS PIPE LINE
ROAD X-ING 11B
ROAD X-ING-11
ROAD X-ING-11A
CH. 36842
MIR KOSH
SAHAR WAH
GROUND BED
DISTRIBUTORY KHAMBRA
SADIQ ABAD
MACHKA MINOR
MACHKA (ROAD & MINOR)
MURID CHOWK
C P STATION No 4
GHOTKI FEEDER
20"Ø MARI-GUDDU GAS PIPE LINE
ROAD TO GUDDU
INDUS RIVER
C P STATION No 5
T.P.S GUDDU
GROUND BED
BARRAGE
GUDDU BARRAGE CROSSING
LEGEND
TEST POST
BEST AVAILABLE COPY
BACKFILLING LOCATIONS
600 MW COMBINED CYCLE POWER PLANT GUDDU
MARI - GUDDU GAS PIPELINE
PAKISTAN ENGINEERING SERVICES (PVT) LTD.
KARACHI
DRG No. (AS BUILT)
P/U/CP (MG/001) BF/01
SCALE: NTS.
DATE: 18-1-90


DAHAR WAH
MARI GAS FIELD OFFICE
SERVICE ROAD
MARI GAS FIELD
MALHIR MINOR
ROAD TO SAMMHE
KARACHI
DAHARKI R. STATION
KARACHI
DAHARKI
MAHI WAH
KARACHI-LAHORE HIGHWAY
HOSPITAL
P.S
UBAURO
LANGHO
KANJU ROAD
GROUND BED
DIRT ROAD
DAHAR WAH
NEHAL WAH
RETI ROAD TO UBAURO
20" ϕ MARI-GUDDU GAS PIPE LINE
C.P STATION No 1
CH 12683
NARLY MINOR
CH. 12782
20" ϕ MARI - GUDDE GAS PIPE LINE
GROUND BED
ROAD
POLICE CHECK POST
MARI CHOWK
C.P STATION No 2
TO LAHORE
TO LAHORE
ROAD
BEST AVAILABLE COPY

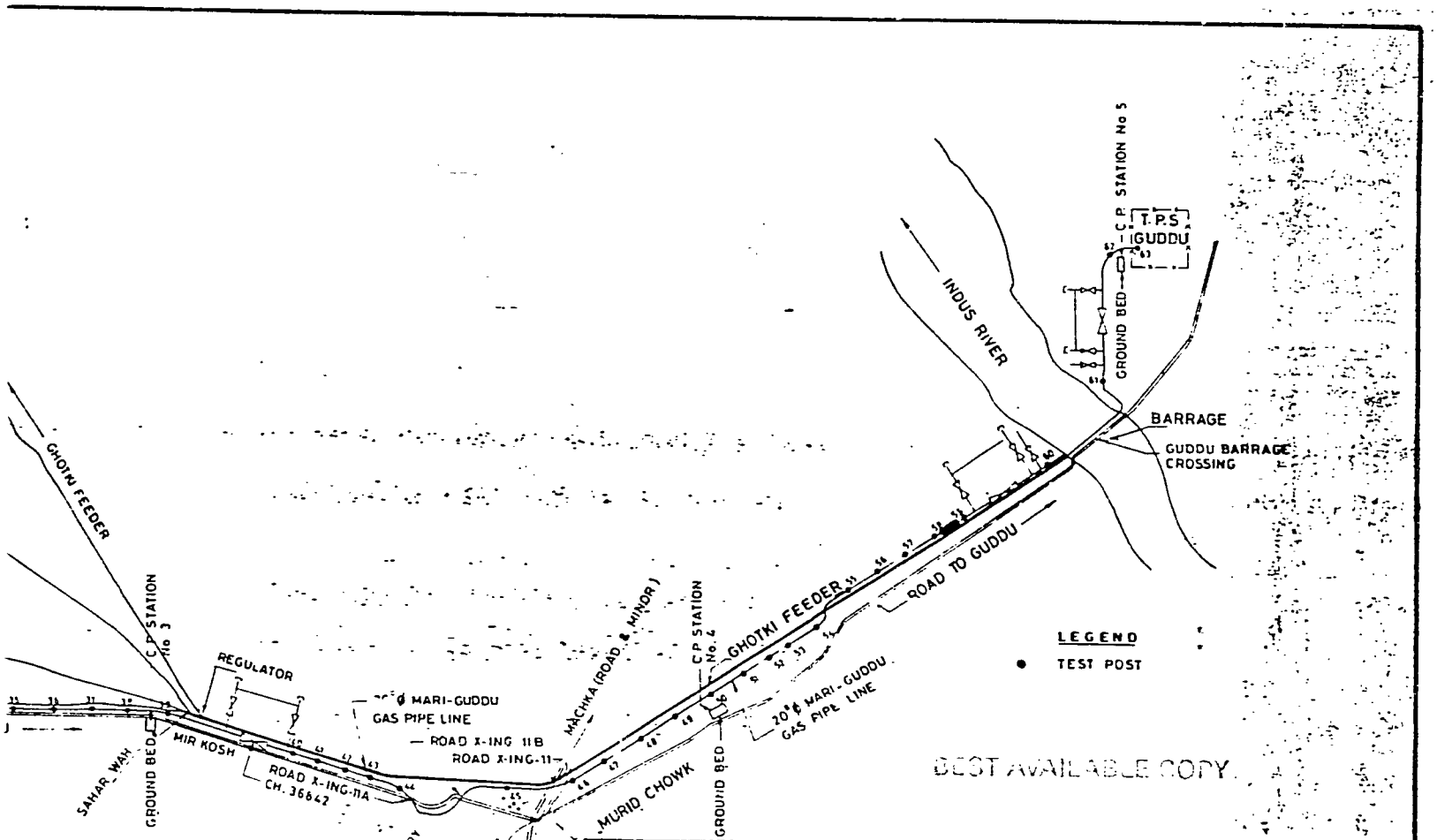

GHOTKI FEEDER
C.P. STATION No 3
REGULATOR
SAHAR WAH
GROUND BED
MIR KOSH
ROAD X-ING-11A
CH. 36642
ROAD X-ING 11B
ROAD X-ING-11
MARI-GUDDU
GAS PIPE LINE
MACHKA (ROAD & MINOR)
DISTRIBUTORY
KHAMBRA
SADIO ABAD
MACHKA MINOR
MURID CHOWK
C.P. STATION
No. 4
GROUND BED
GHOTKI FEEDER
20" ϕ MARI-GUDDU
GAS PIPE LINE
ROAD TO GUDDU
INDUS RIVER
C.P. STATION No 5
T.P.S
GUDDU
GROUND BED
BARRAGE
GUDDU BARRAGE
CROSSING
LEGEND
TEST POST
BEST AVAILABLE COPY
TRENCH WEIGHT
LOCATIONS
600 MW COMBINED CYCLE POWER PLANT GUDDU
MARI - GUDDU GAS PIPELINE
PAKISTAN ENGINEERING SERVICES (PVT) LTD.
KARACHI
DRG No.: (AS BUILT)
P/U/CP (MG/001)TW/01
SCALE: N.T.S.
DATE: 18-1-90

Table 1-A

List of As-Built Drawings Identified by P.E.S

SR. NO.	DRAWING NO.	TITLE
1.	MG/VA/001	Valve Assembly at U/S of Railway Crossing.
2.	MG/VA/002	Valve Assembly at Mirkosh.
3.	MG/VA/003	Valve Assembly at U/S of Barrage Crossing.
4.	MG/VA/004	Valve Assembly at D/S of Railway Crossing.
5.	MG/VA/005	Valve Assembly at D/S of Barrage Crossing.
6.	MG/XING/001	Crossing Details Crossing NO. MG-1 Nearby Minor.
7.	MG/XING/002	Crossing Details Crossing NO. MG-2 Dharki/Sankhe Road.
8.	MG/XING/003	Crossing Details Crossing NO. MG-3 Rangu - Dharki Road.
9.	MG/XING/004	Crossing Details Crossing NO.MG-004 Railway Crossing.
10.	MG/XING/006	Crossing Details NO.MG/005 & 006 Nenna Wah.
11.	MG/XING/007	Crossing Details Crossing NO.MG-007 Roti Road.
12.	MG/XING/008	Crossing Details NO. MG/008 National Highway.
13.	MG/XING/009	Crossing Details NO. MG/009 Dahar Wah.

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Table 1-A

14.	MG/XING/010	Crossing Details NO. MG/010 Sahar Wah.
15.	MG/XING/011	Crossing Details NO. MG/011 Machka Road, Machka Minor & Khambra Distributry.
16.	MG/XING/011-A	Crossing Details NO/011-A Metalled Road Crossing at Chainage NO.41713
17.	MG/XING/011-B	Crossing Details NO. MG/011-B Metalled Road Crossing at ch:41873.
18.	MG/XING/012	Crossing Details NO. MG/012 Ghotki Feeder.
19.	MG/XING/013	Crossing Details Crossing NO.MG-013 Railway Crossing Near Gate NO.5.
20.	MG/XING/014	Crossing Details Crossing NO.MG-014 Road Crossing Near Gate-5.
21.	MG/XING/015	Crossing Details Crossing NO.MG-015 U/S Road Cross Guddu Barrage.
22.	MG/XING/016	Crossing Details Crossing NO.MG-016 Crossing of T.W. outlet Channel.
23.	MG/XING/016-A	Crossing Details Crossing NO. MG/016A Road Crossing D/S Guddu Barrage.
24.	MG/001	Route Map of 20" dia Mari-Guddu Gas Pipeline.
25.	MG/002	20" dia Mari-Guddu Gas Pipeline flow diagram.
26.	MG/003	Filter Station at T.P.S.
27.	MG/004	Pig Launching Area.
28.	MG/005	Mari Pipeline at Guddu Barrage Crossing.

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Table 1-B

List of Construction Drawings
Identified by P.E.S.

SR. NO.	DRAWING NO.	TITLE
1.	GD-PL-002	Route Map of 20" dia Mari-Guddu Gas Pipeline
2.	GD-M-016	General Arrangement of Mari Gas Dehydration and Pig Launching Area.
3.	MG/MISC/003/1 TO MG/MISC/003/21	Route Plan (21 sheets).
4.	C.P-C/3	Pipe/Soil Potential Results.
5.	C.P-C/5	Route of Pipeline.
6.	C.P-C/14	Pipe to Soil Potential Posts/ Installation.
7.	C.P-C/15	Installation Locations of Zinc Anodes.
8.	C.P.-C/16	Installation Locations of Surge Diverters.
9.	C.P.-C/17	Bond-Box Installation.
10.	MG/CP/09	Dia-Gramatic Route of Pipeline.
11.	MG/CP/11	Proposed PSP Posts Installation.
12.	MG/CP/10	Proposed Route Map.
13.	MG/CP/12	Proposed Cathodic Protection Installation.
14.	MG/CP/14	Proposed C.P Station Location NO.1

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Table 1-B

15.	MG/CP/15	Proposed C.P Station Location NO.2
16.	MG/CP/16	Proposed C.P Station Location NO.3
17.	MG/CP/17	Proposed C.P Station Location NO.4
18.	MG/CP/18	Proposed C.P Station Location NO.5
19.	MG/CP/21	Surge Diverter, Bond Box Installation Locations.

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Table-2

PEEL TEST SURVEY OF 20" MARI-GUDDU GAS PIPELINE

S.NO.	LOCATIONS	PEEL TEST READINGS N/10mm	ATTENU-ATION READINGS mB/M	WALL THICKNESS READINGS mm	DEPTH OF PIPE FROM G/L
1.	1250M from T-P 1 towards D/S (Guddu)	NO BOND	7.25	7.1	3'-6"
2.	600M from T-P 9 towards D/S (Guddu)	NO BOND	8.26	7.1	1'
3.	85M from T-P 13 towards D/S (Guddu)	3.92	5.62	7.2	1'
4.	300M from T-P 17 towards D/S (Guddu)	3.92	4.55	7.2	1'
5.	50M from T-P 20 towards D/S (Guddu)	3.92	4.62	7.1	2'-6"
6.	300M from T-P 25 towards D/S (Guddu)	13.72	10.7	7.2	2'-6"
7.	500M from T-P 29 towards D/S (Guddu)	15.68	4.07	7.2	2'-9"
8.	100M from T-P 35 towards U/S (Mari)	11.76	10.4	7.2	1'-11"
9.	200M from T-P 35 towards D/S (Guddu)	27.44	7.08	7.2	2'-4"

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Table-2

S.NO.	LOCATIONS	PEEL TEST READINGS N/10mm	ATTENU-ATION READINGS mB/M	WALL THICKNESS READINGS mm	DEPTH OF PIPE FROM G/L
10.	400M from T-P 37 towards D/S (Guddu)	3.92	17.1	7.2	2'-0"
11.	25M from T-P 39 towards U/S (Mari)	3.92	10.4	7.2	2'-4"
12.	30M from T-P 46 towards D/S (Guddu)	1.96	2.12	7.2	2'-4"
13.	700M from T-P 54 towards D/S (Guddu)	NO BOND	8.21	7.1	3'-6"
14.	210M from T-P 60 towards U/S (Mari)	5.88	-	7.2	3'-2"
15.	60M from T-P 62 towards D/S (Guddu)	13.72	-	7.2	3'-6"

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Table-3

Survey of Mari-Guddu Gas Pipeline Showing Re-coating Locations

SR. NO.	LOCATION	FROM DISTANCE IN METERS	TO DISTANCE IN METERS	RE-COATING LENGTH IN METERS	ATTENUATION READING mB/M
1.	T.P-1	1000	1400	400	8.84
2.	O/H Crossing of Narliwan	O/H Crossing	100	100	22.3
3.	R.D-46 of Narliwah	100	250	150	9.24
4.	R.D-43 of Narliwan	R.D-43	150	150	5.05
5.	T.P-9	600	750	150	12.3
6.	T.P-10	T.P-10	100	100	45.76
7.	T.P-12	750	1150	400	11.00
8.	T.P-14	300	400	100	7.59
9.	T.P-15	600	700	100	5.49
10.	T.P-18	50	80	30	5.25
11.	T.P-18	400	500	100	5.03
12.	T.P-19	200	325	125	4.99
13.	T.P-20	T.P-20	200	200	6.7
14.	T.P-21	U/S of T.P-21	60	60	6.41
15.	T.P-25	255	365	110	11.1
16.	T.P-29	U/S of T.P.29	85	85	49.4
17.	T.P-32	230	250	20	5.19
18.	T.P-33	340	360	20	17.6

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Table-3

SR. NO.	LOCATION	FROM DISTANCE IN METERS	TO DISTANCE IN METERS	RE-COATING LENGTH IN METERS	ATTENUATION READING mB/M
19.	T.P-35	110M U/S of T.P-35	140	30	10.4
20.	T.P-36	65	265	200	7.8
21	T.P-37	400	460	60	17.1
22.	T.P-39	30M U/S of T.P-39	45	15	10.4
23.	T.P-41	T.P-41	60	60	7.36
24.	T.P-46	U/S of T.P-46	100	100	8.39
25.	T.P-55	U/S of T.P-55	50	50	8.21
				2915 Meter OR 3 K.M (Approx.)	

Note:

1) Survey started from U/S (T-P 1) and Traverse towards D/S. (T-P 63)

2) U/S means Traverse towards 'MARI' and D/S means Traverse towards 'GUDDU'

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Table-4

Survey of Mari-Guddu Gas Pipeline Showing the Locations for Backfilling

SR. NO.	LOCATION	FROM DISTANCE IN METER	TO DISTANCE IN METER	BACKFILLING LENGTH IN METER	PIPE DEPTH
1.	T-P 1	T-P 1	1300	1300	1'-2" to 2'-1"
2.	R-D 44	R-D 44	R-D 43	275	1'-5"
3.	T-P 13	U/S of T-P 13	50	50	2'-0"
4.	T-P 15	U/S OF T-P 15	207	207	1'-6"
5.	T-P 16	500	600	100	0'-6"
6.	T-P 18	300	400	100	2'-2"
7.	T-P 20	T-P 20	600	600	1'-9"
8.	T-P 21	T-P 21	100	100	1'-9"
9.	T-P 24	330M U/S OF T-P 24	430	100	2'-0"
10.	T-P 24	U/S OF T-P 24	100	100	1'-1" to 2'-1"
11.	T-P 26	U/S OF T-P 26	300	300	1'-5"
12.	T-P 48	U/S OF T-P 48	220	220	2'-4"
13.	T-P 58	T-P 58	800	800	1'-6"
				4252 Meters OR 4.5 Km (Aprrox.)	

Note: 1) Survey started from U/S (T.P 1) and Traverse was made towards D/S (T.P 63).

2) U/S means Traverse towards 'Mari' and D/S means Traverse towards 'Guddu'.

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Table-5

Survey of Mari-Guddu Gas Pipeline Showing the Shorted Casings

S.No.	Locations	PSP Reading Volts	Casing Length Meters	Reference Drawings No.
1.	Dharki/Sankhe Road	0.65	15.23	MG/XING/002
2.	Kanju/Dharki Road	1.1	20.0	MG/XING/003
3.	Railway Crossing	0.6	48.00	MG/XING/004
4.	Reti Road	0.7	21.33	MG/XING/007
5.	National Highway	1.0	27.43	MG/XING/008
6.	Machka Road, Machka Minor and Khambra Distributory	0.6	16.60	MG/XING/011

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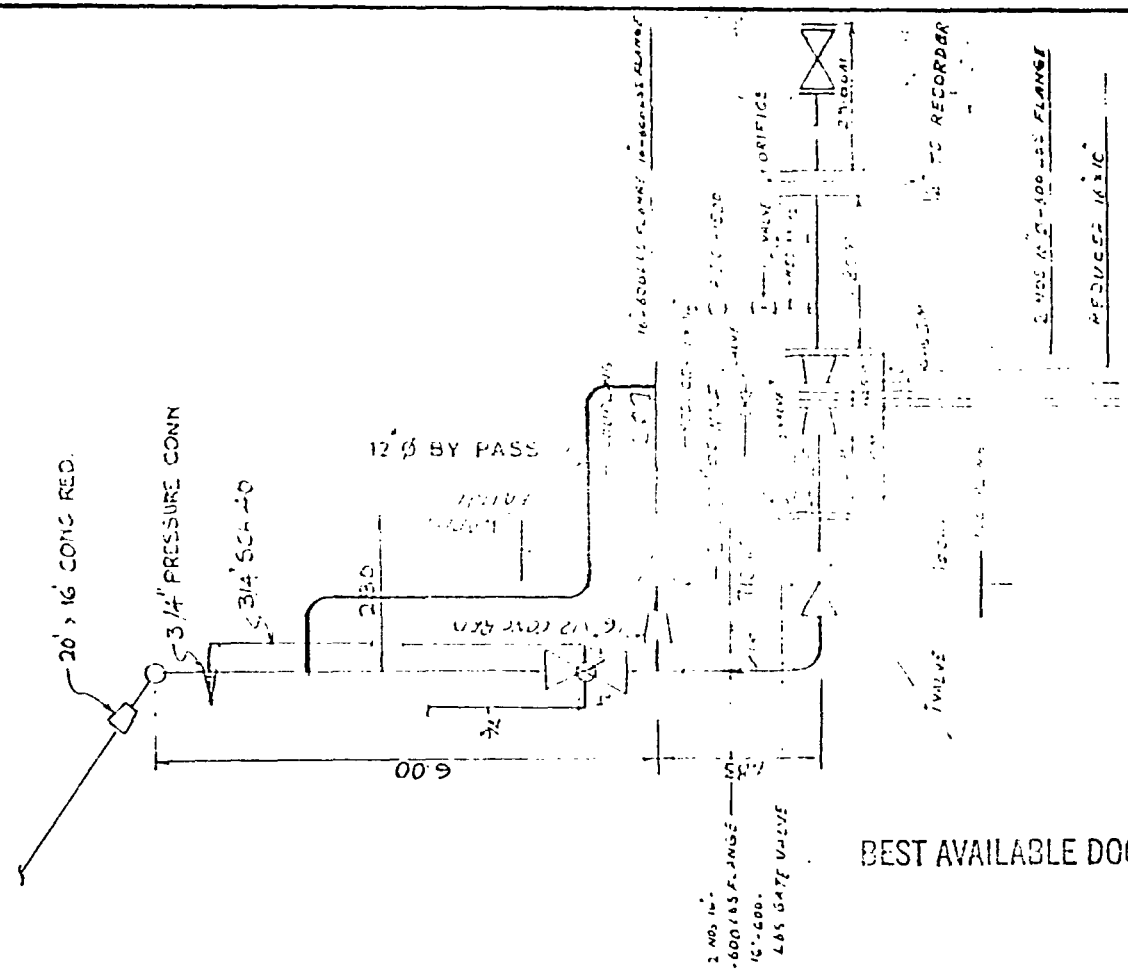

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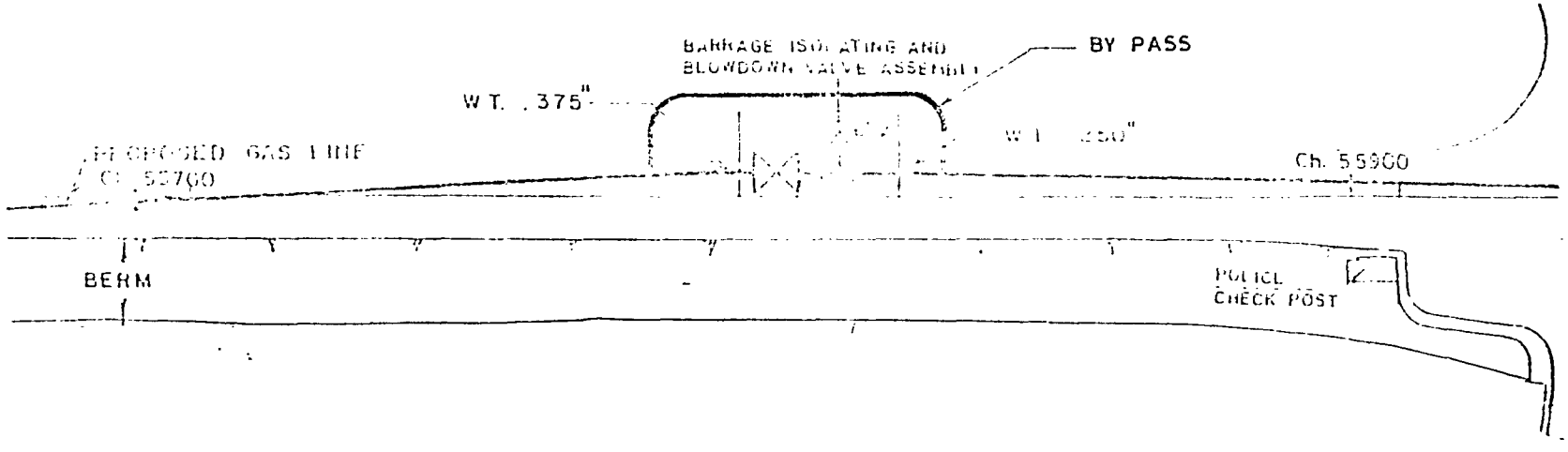
BY PASS LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (GD-M-016) BP 01/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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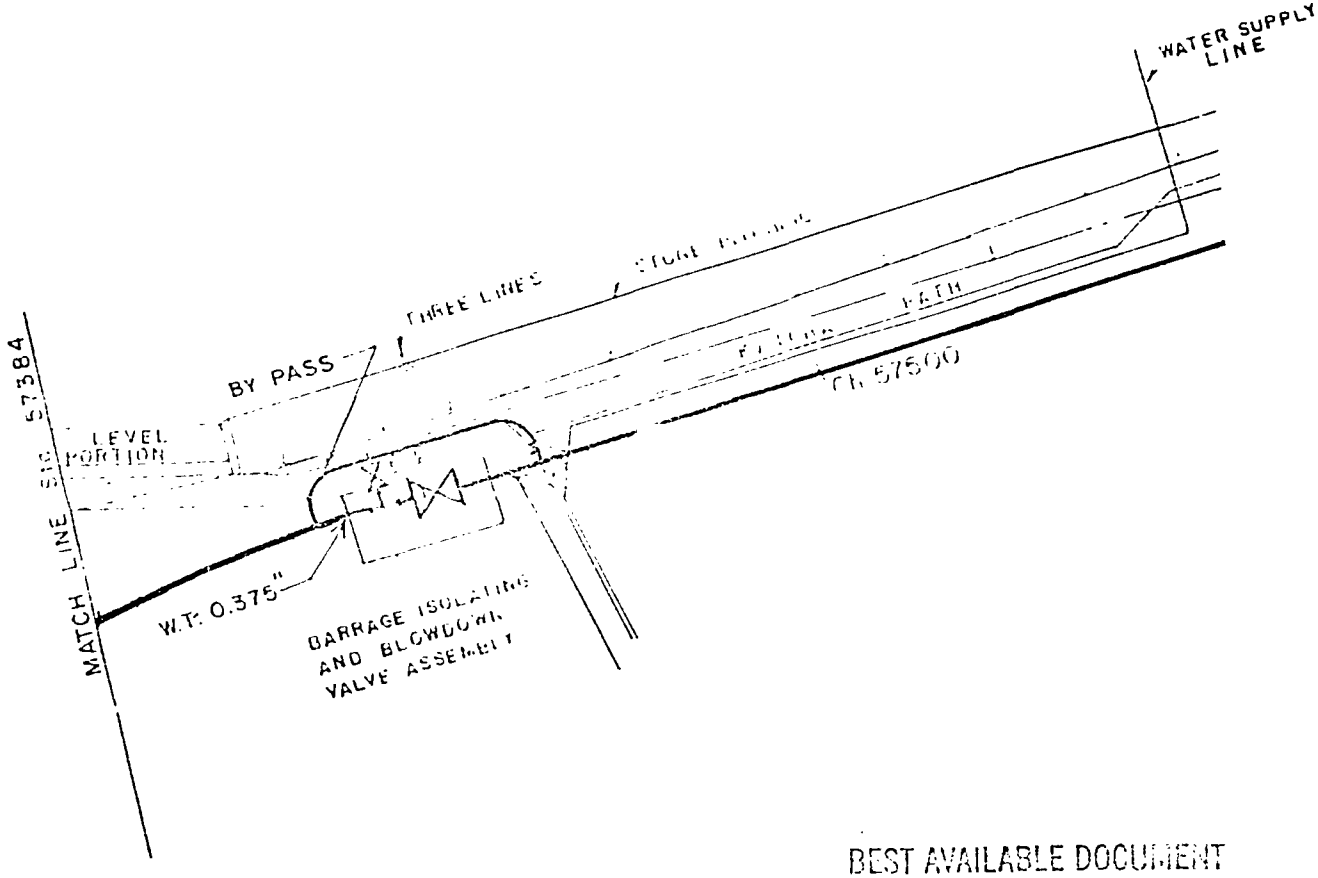
BY PASS LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/MISC/003/19)BP 02/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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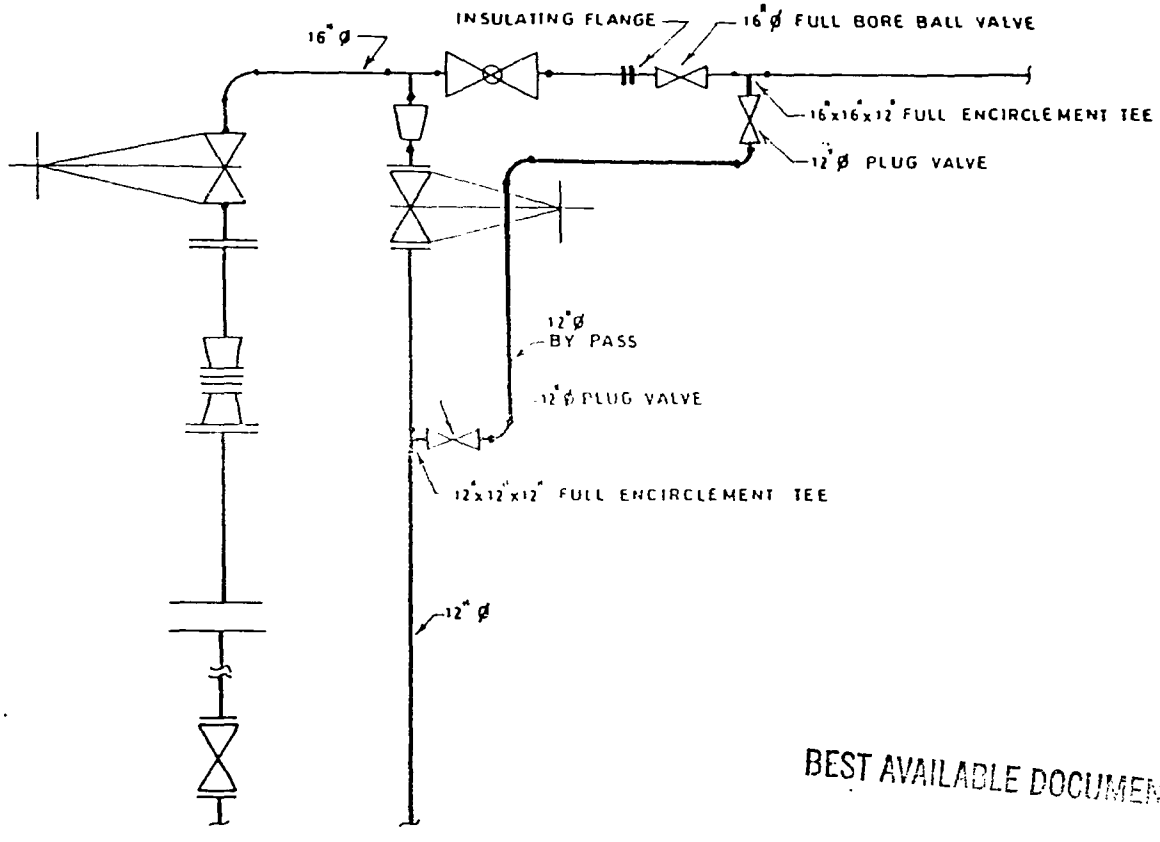
BY PASS LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/20)BP 03/ 3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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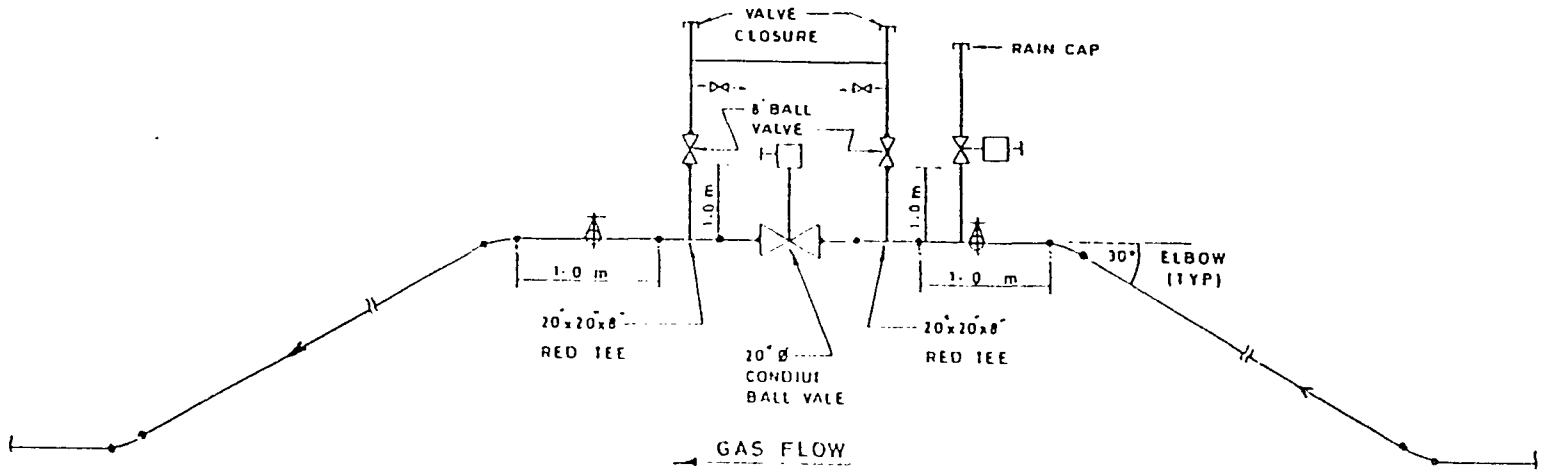
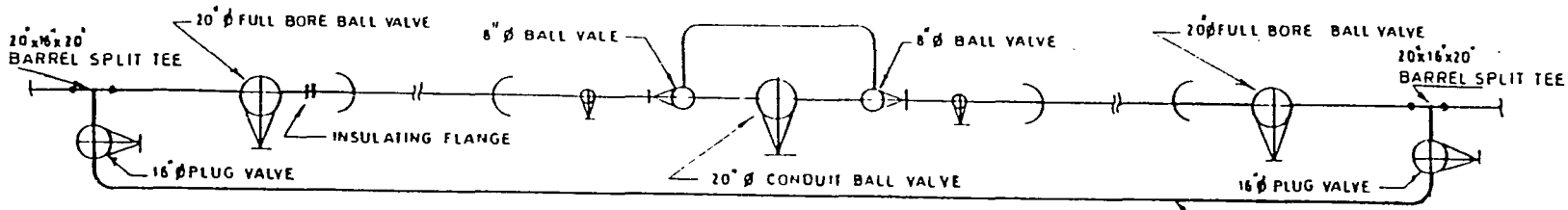
SCHEMATIC DIAGRAM OF BY PASS ON MARI GAS FIELD	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (GD-M-016) SD 01/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



ELEVATION



PLAN

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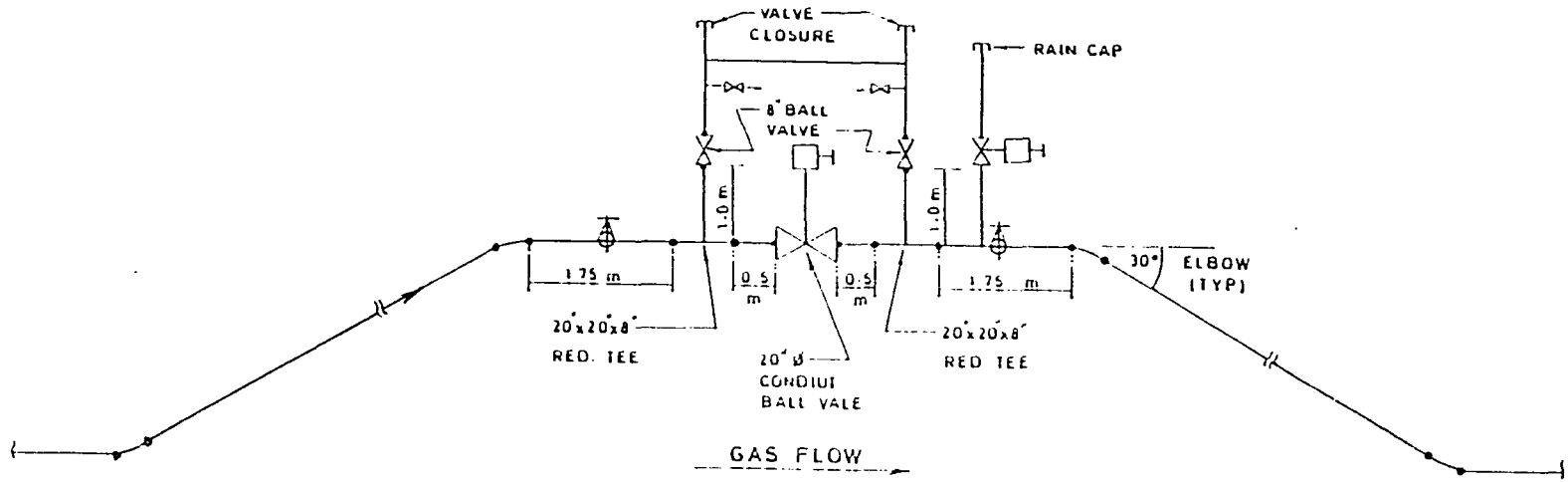
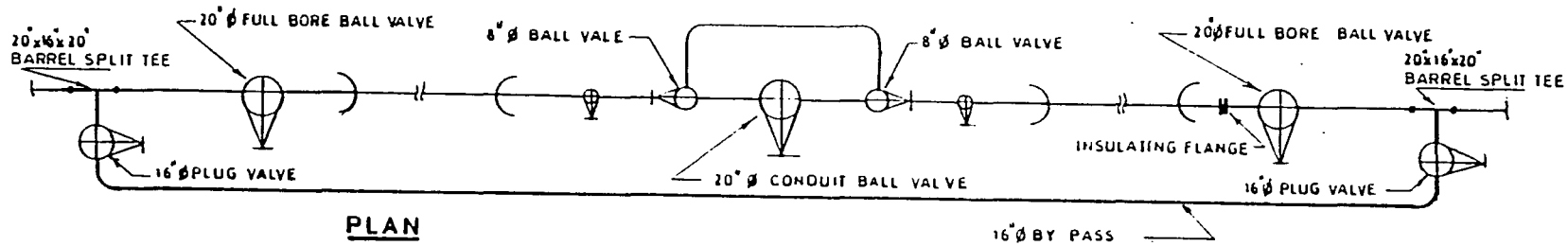
SCHEMATIC DIAGRAM OF BYPASS ON VALVE ASSEMBLY AT U/S OF BARRAGE CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (MG/VA/003) SD 02/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



ELEVATION



PLAN

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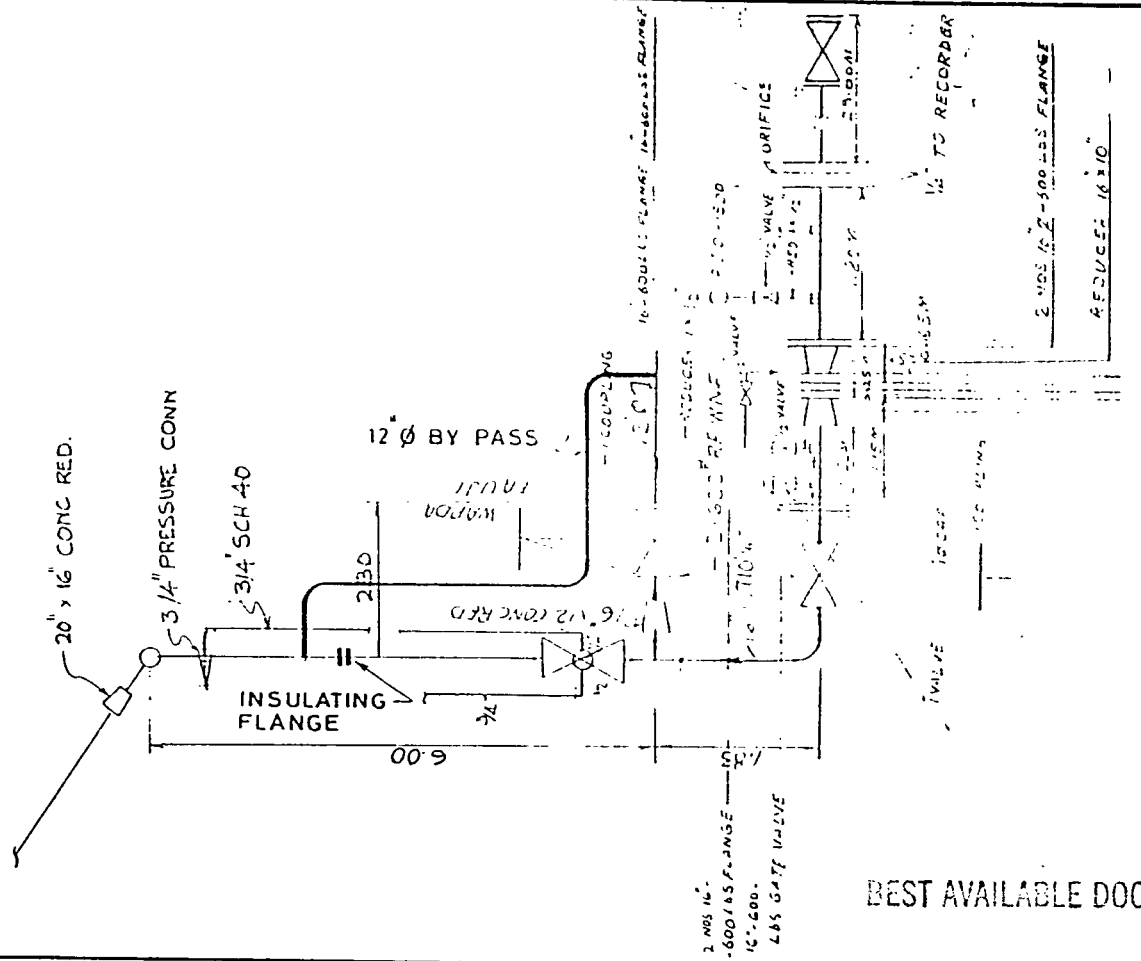
SCHEMATIC DIAGRAM OF BY PASS ON VALVE ASSEMBLY AT D/S OF BARRAGE CROSSING	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/VA/005)SD 03/3
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90



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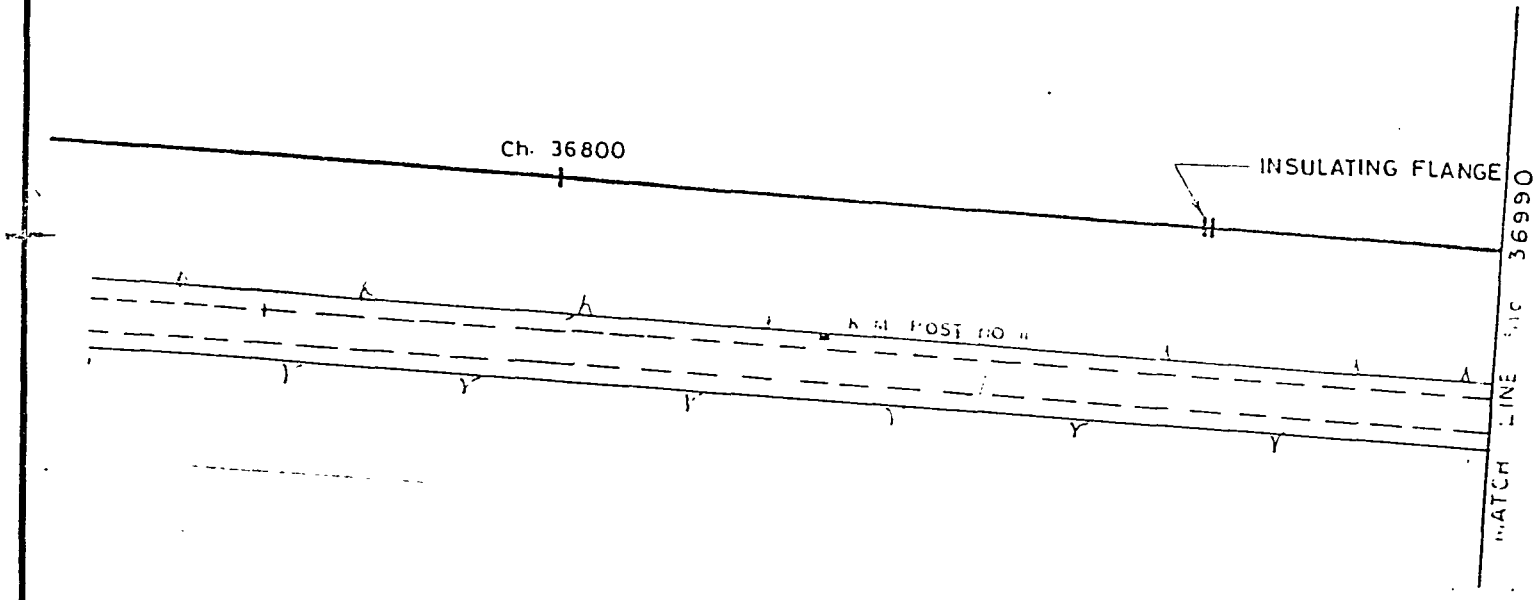
INSULATING FLANGE LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP (GD-M-016) IF 01/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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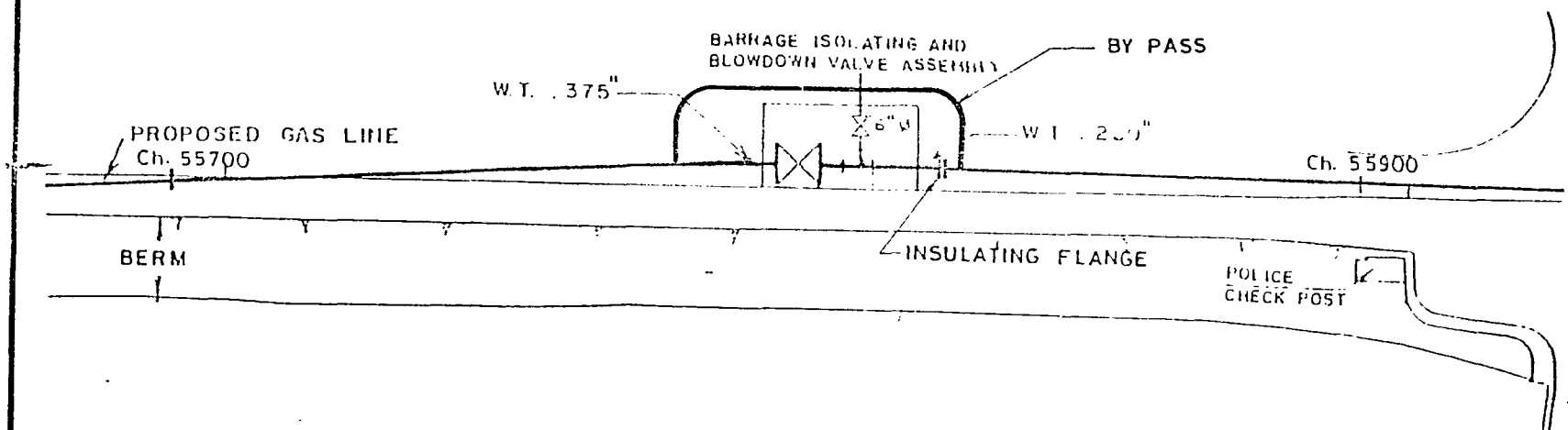
INSULATING FLANGE LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/12)IF 02/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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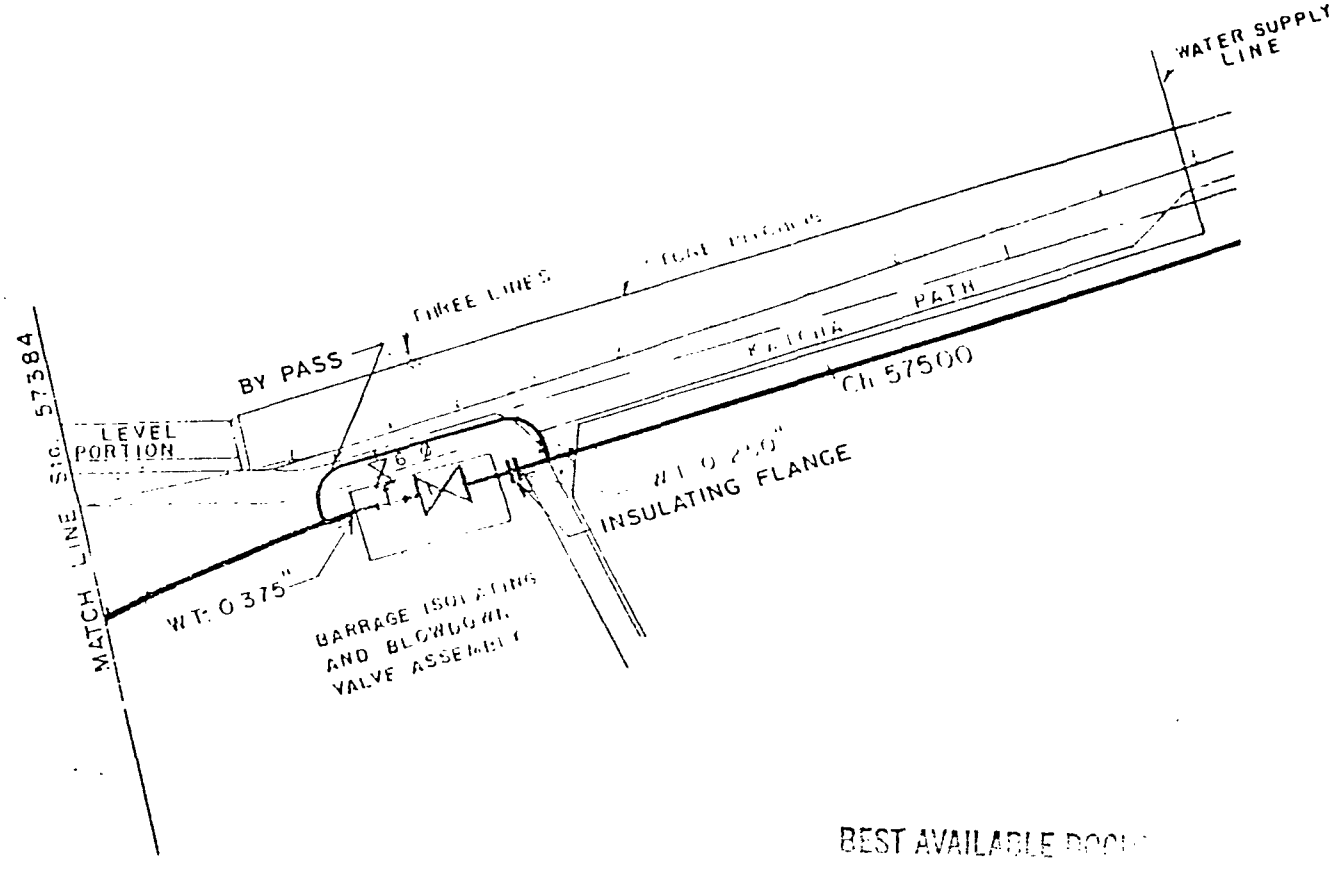
INSULATING FLANGE LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/19)IF 03/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



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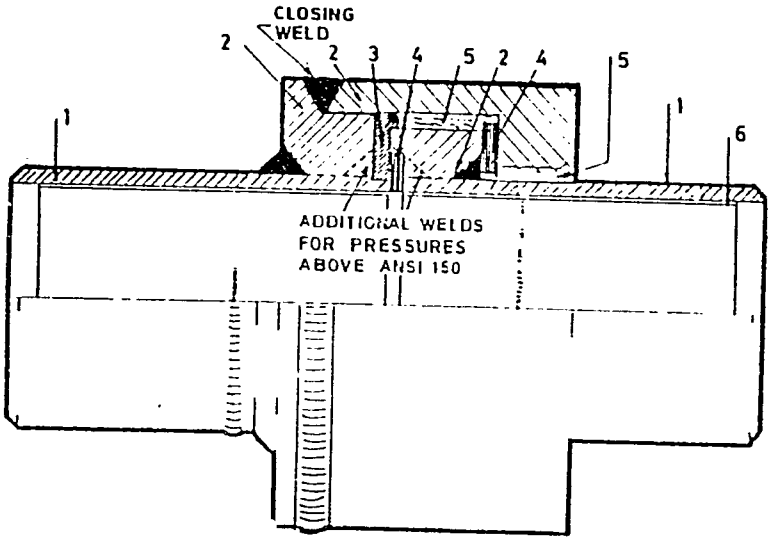
INSULATING FLANGE LOCATION	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI - GUDDU GAS PIPELINE	DRG. No. P/U/CP(MG/MISC/003/20) 1F 04/4
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 19-1-90



LEGEND

1 – PIPE PUPS
2 – STEEL SECTIONS
3 – SEALING GASKETS
4 – INSULATING RINGE
5 – DIELECTRIC FILLER
6 – INTERNAL LINING

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TYPICAL ISOLATING JOINT	600 MW COMBINED CYCLE POWER PLANT GUDDU MARI – GUDDU GAS PIPELINE	DRG. No. P/U/CP IJ 01/1
	PAKISTAN ENGINEERING SERVICES (PVT) LTD. KARACHI	DATE: 1-2-90

Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
11. 16" Stopple Cutter with Holder	2 Nos.			
12. Rubber Sealing Cup for 12 inch Stopple Head	3 Nos.			
13. Rubber Sealing Cup for 16" inch Stopple Head	3 Nos.			
14. Rubber sealing Cup for Stopple Head	8 Nos.			
15. Blind Flanges				
12" ANSI 400	1 No.			
20" ANSI 400	4 Nos.			
16" ANSI 400	1 No.			
16. Elbows				
16" -90 Deg.	8 Nos.			
12" -90 Deg.	6 Nos.			
16" -45 Deg.	3 Nos.			
17. Flanges				
16 inch	10 Nos.			
12 inch	5 Nos.			
18. Plug Valves				
16 inch	4 Nos.			
12 inch	2 Nos.			
1 inch	6 Nos.			
19. Ball Valves				
20 inch	4 Nos.			
16 inch	1 No.			
20. Pipe				
16 inch x 0.344 x 52	100 M			
12 inch x 0.312 x 52	20 M			
21. Trench Weight Packing Material Densolen Rockshield DRM 1050mm (WIDE)x50M (LONG)	2 Rolls			

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Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
22. Tape Coating Machine Densomat VI with Power Pac. For coating of 20 inch pipeline in trench with 3 ply/2 ply tape with 50% overlap. Roll Size 150mm/100M/125M	3 Nos.			
23. Studs and Bolts	Lot			
24. Tape				
Denso S/20. Size 100M/150mm	1051 Rolls.			
Denso R/20. Size 125M/150mm	840 Rolls.			
Denso Primer MT/25	1200 Litres			
Repair Tape Densolen RP 10M/100mm	250 Rolls			
25. Insulating Flange				
-Fuel Gas (O.D 20")	3 Nos.			
-Fuel Gas (O.D 16")	1 No.			
Test Posts				
Type: Fink Type	15 Nos.			
27. Reference electrodes	15 Nos.			
28. Cables Single-Core				
-AWG NO. 6	200 M			
-AWG NO.10	150 M			
29. Thermite Welds	25 Nos.			
30 Casing Filler	66 Drums (3432 Gallons)			

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Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
31. Casing End Seals				
-Zipper End Seals	15 Nos.			
-Link Seals	15 Nos.			
32. Casing Filler Pump	1 No.			

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List of Installation

Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
1. Installation of 12" By-pass as per drawing No. P/U/CP(GD-M-016)SD01/3				
a) by hot tapping and stopple operation	each.			
b) by shut-down of gas supply	each.			
2. Installation of 16" By-pass as per drawing No. P/U/CP(MG/VA/003)SD 02/3.				
(a) by hot tapping/ stopple operation	each			
(b) by shut-down of gas supply	each.			
3. Installation of 16" By-pass as per drawing No. P/U/CP/(MG/VA/005)SD03/3				
(a) by hot tapping and stopple operation	each.			
(b) by shut-down of gas supply	each.			
4. Installation of Insulating Flange as per drawing No. P/U/CP(MG/MISC/003/12)IF02/4				
-by shut down of gas supply	each.			

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Description	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
5. Excavation of pipe decoating, cleaning, priming, coating and backfilling of earth	Per M			
6. Excavation of casing ends, installation of end seals, cleaning of annulus and filling of annulus with casing filler.	each.			
(a) Casing as per drawing No. P/U/CP(MG/XING/002)SC01/6				
(b) Casing as per drawing No. P/U/CP(MG/XING/003)SC02/6				
(c) Casing as per drawing No. P/U/CP(MG/XING/004)SC03/6				
(d) Casing as per drawing No. P/U/CP(MG/XING/007)SC04/6				
(e) Casing as per drawing No. P/U/CP(MG/XING/008)SC05/6				
(f) Casing as per drawing No. P/U/CP(MG/XING/011)SC-06/6				
7. Installation of Test Posts	each.			
8. Removing of Casing at Nehal Wah and Dehar Wah and Construction of Culvert.	lumpsum			

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	escription	Qty.	Unit Price FOB at port	Unit Price CNF	Total CNF
.	Placing road shield under trench weights.	each.			
0.	Providing additional earth cover on pipeline on 10ft. strip upto 30 inches from top of pipeline.	per 100 cft			
1.	Carrying out detail topographic, elevation survey 30 meter strip of approximate 60 Kilometer.	per Km.			
2.	Carrying out electronic depth and alignment survey to locate depth of pipeline with accuracy of +/- 3 inches.	per Km.			
3.	Supply and fixing of RCC pillar at each 250 meter along the pipeline.	per pillar			
4.	Construction of RCC valve boxes for below ground 16 inch plug valves.				

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ECTION NO-5

.0 COST ESTIMATE

5.01 Material Cost

This cost estimate is based on all imported materials. The CNF prices are given. The import duty and taxes on imported material has not been taken into account as project will be financed by USAID Grant. The cost estimate assumes that job will be carried out by contractors who have substantial experience in such work.

5.01.1	Material for hot tapping and stopple operation.	USD	270,000
	-Contingency 25%	USD	67,500
	-Freight and Documentation	USD	84,375
	-CNF Karachi	USD	421,875
5.01.2	Valves, Fittings and, Pipe	USD	274,560
	-Contingency 25%	USD	68,640
	-Freight and Documentation	USD	85,800
	-CNF Karachi	USD	429,000
5.01.3	Additional Fittings in case of gas supply shut-down	USD	20,000
	-Contingency 25%	USD	5,000
	-Freights and Documentation	USD	6,250
	-CNF Karachi	USD	31,250
5.01.4	Casing Filler CNF	USD	37,740

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5.01.5	Coating and Wrapping material	USD	154,585
	-Contingency 25%	USD	38,646
	-Freight and Documentation	USD	48,308
	-CNF Karachi	USD	241,539
5.01.6	Test Posts, Cables, Thermite Weld, Zinc Reference Electrodes, End Seals, Surge Diverters	USD	10,000
5.01.7	Insulating Flanges	USD	2,000

5.02 Installation Cost

5.02.1	Installation of 12" By-pass as per drawing No.P/U/CP(GD-M-016)SD01/3		
	(a) By hot tapping and stopple operation	Rs.	900,000
	(b) By shut-down of gas supply	Rs.	400,000
5.02.2	Installation of 16" By-pass as per drawing No.P/U/CP(MG/VA/003)SD02/3		
	(a) by hot tapping and stopple operation	Rs.	1,000,000
	(b) by shut-down of gas supply	Rs.	500,000
5.02.3	Installation of 16" By-pass as per drawing No.P/U/CP(MG/VA/005)SD03/3		
	(a) by hot tapping and stopple operation	Rs.	900,000
	(b) by shut-down of gas supply	Rs.	500,000

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5.02.4	Installation of Insulating Flange as per drawing No. P/U/CP(MG/MISC/003/12)IF02/4 by shut-down of gas supply.	Rs.	50,000
5.02.5	Excavation of pipe, decoating, cleaning, priming, coating and backfilling Rs. 300/M for 3000 meters	Rs.	900,000
5.02.6	Excavation of casing ends for installation of end seals, cleaning the annulus and filling the annulus with Casing filler. Details as per Table 5.	Rs.	1,200,000
5.02.7	Installation of Test Post Rs. 4000 each.	Rs.	60,000
5.02.8	Placing of Rockshield under trench weight Rs. 4000 each.	Rs.	232,000
5.02.9	Carrying out detail topographic and elevation survey on 100 feet strip of approx. 60 Km Rs.9000/Km	Rs.	540,000
5.02.10	Carrying out electronic depth and alignment survey to locate depth of pipeline with accuracy of +/- 3" Rs. 3000/Km approx. 60 km	Rs.	180,000
5.02.11	Supply and fixing of RCC marker pillar post as per drawing No. P/U/CP PP01 at every 250 meter interval Rs. 1500 per pillar.	Rs.	360,000

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5.02.12	Construction of RCC valve pit for 16 inch plug valves Rs. 50,000 per pit.	Rs. 200,000
5.02.13	Removing of casing at Nehal Wah and Dehar Wah and Construction of Culvert	Rs. 100,000
5.02.14	Providing additional earth cover over pipeline at Rs.300 per 100 cft.	Rs. 600,000
5.02.15	Project supervision	Rs. 1.25 millio
	Total installation cost of hot tapping and stopple	Rs. 8,422,000
	Contingency 15%	Rs. 1,263,300
	Total Cost	Rs. 9,685,300 (USD 450,479)
	Total Installation cost by shut-down of gas supply	Rs. 7,072,000
	Contingency 15%	Rs. 1,060,800
	Total Cost	Rs. 8,132,800 (USD 378,270)
	Total material cost by hot tapping	USD 1.142,154
	Total material cost by shut-down of gas supply	USD 751,529
	Total material+Installation by hot tapping	USD 1.59 million
	Total material+Installation by shut-down of gas supply	USD 1.13 million

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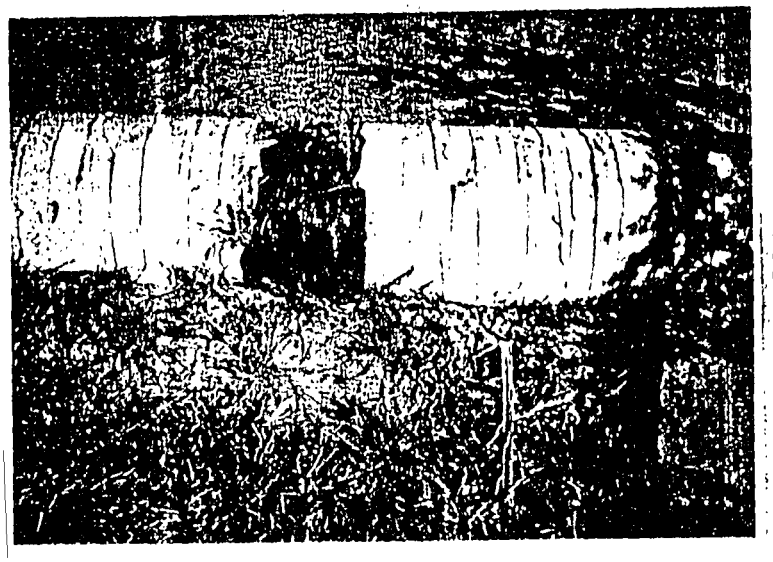
(1)

Exposed pipe showing growth of grass into the tape coating near Dhar Wah Crossing end. Refer DRG.NO: MG/MISC/003/6

xposed pipe showing growth f grass near Nehal Wah rossing end. Refer RG.NO: MG/MISC/003/6



(3)

Exposed pipe showing growt of grass roots near Dhar Wah crossing. Refer DRG.NO: MG/MISC/003/6

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(4) Casing without end seals and exposed carier pipe without protection near Nehal Wah and Dhar Wah crossir shown in DRG. NO: MG/MISC/003/6

(5) Casing without end seals and separators near Nehal Wah and Dhar Wah crossing shown in DRG.NO: MG/MISC/003/6

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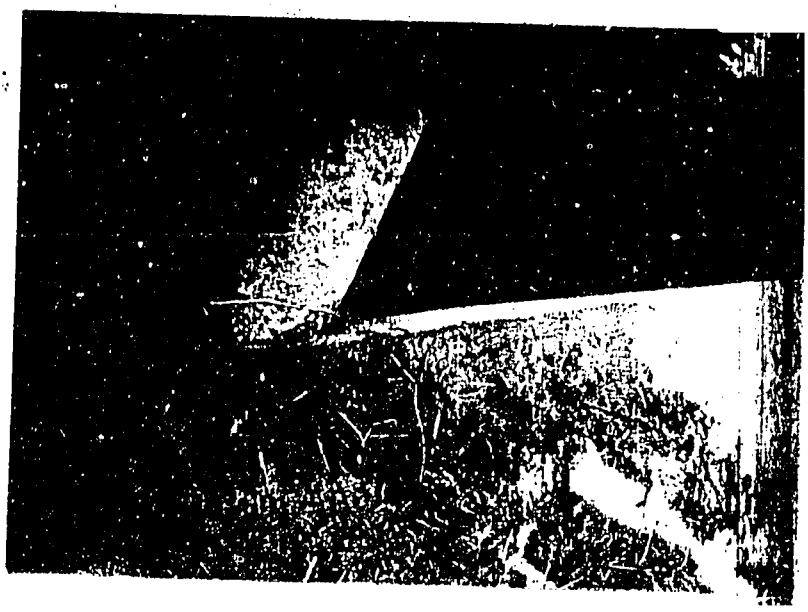

(6) Exposed pipe without protection under Nalla near R-D 55 of Nerli Minor.

(7) Damaged Coating after 200 meter from T-P 25 towards Gudda.

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