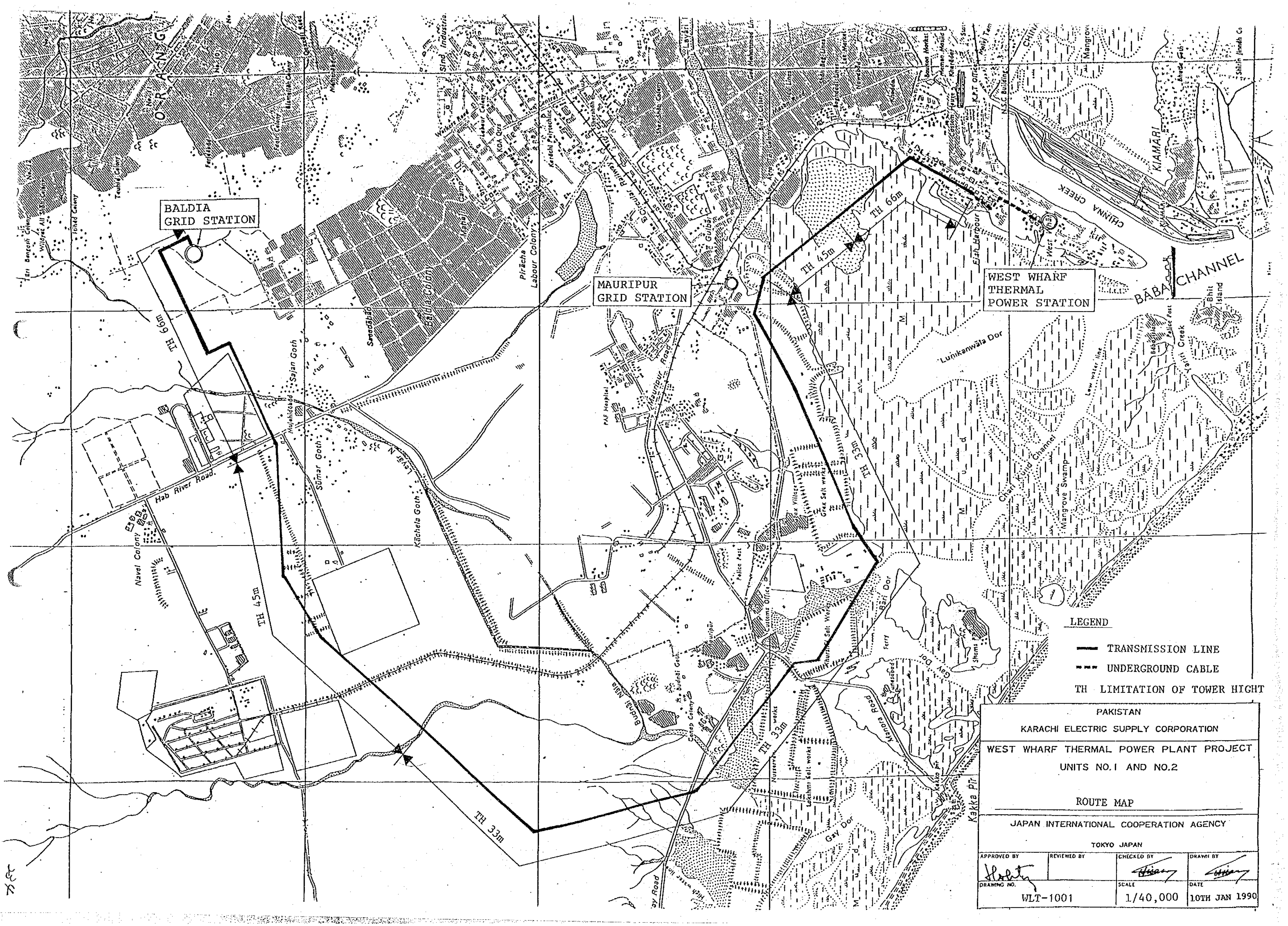
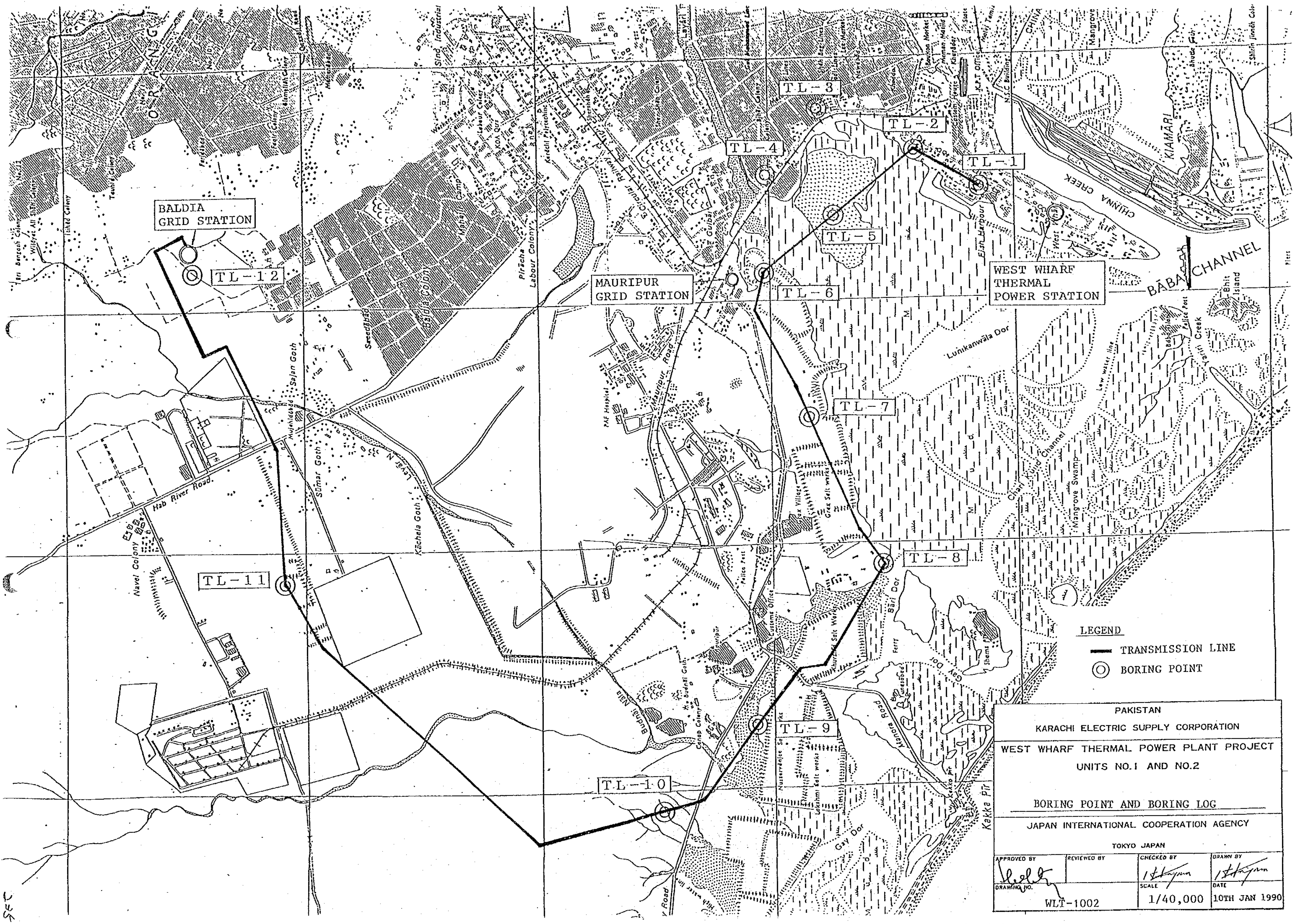


PAKISTAN			
KARACHI ELECTRIC SUPPLY CORPORATION			
WEST WHARF THERMAL POWER PLANT PROJECT UNITS NO.1 AND NO.2			
ROUTE MAP			
JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO JAPAN			
APPROVED BY	REVIEWED BY	CHECKED BY	DRAWN BY
DRAWING NO. WLT-1001		SCALE 1/40,000	DATE 10TH JAN 1990


BALDIA
GRID STATION
MAURIPUR
GRID STATION
WEST WHARF
THERMAL
POWER STATION
TL-1
TL-2
TL-3
TL-4
TL-5
TL-6
TL-7
TL-8
TL-9
TL-10
TL-11
TL-12
KIAMARI
CHINA CREEK
BABA CHANNEL
Hab River Road
Mauripur Road
LEGEND
TRANSMISSION LINE
BORING POINT
PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION
WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2
BORING POINT AND BORING LOG
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN
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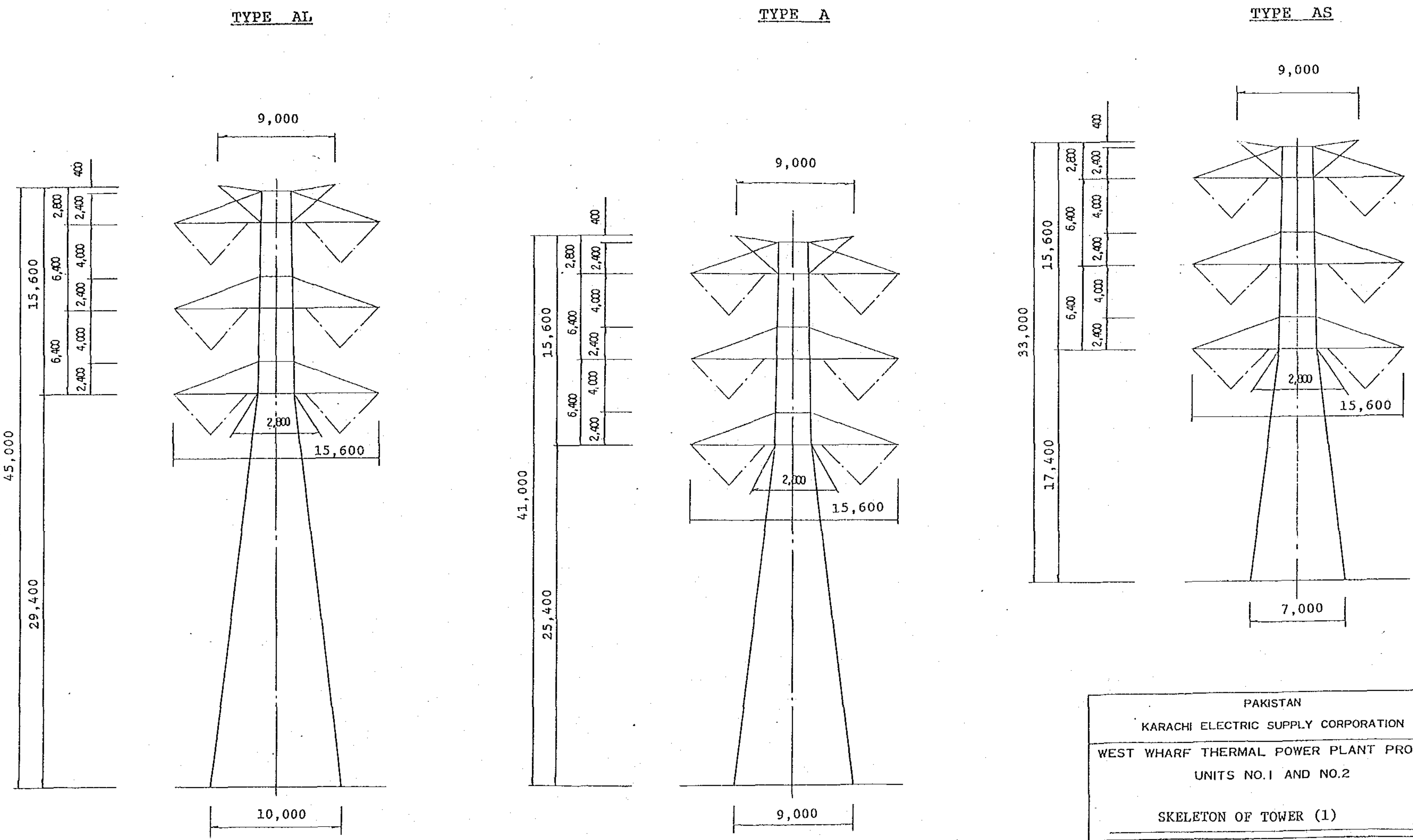
WLT-1002
SCALE
1/40,000
DATE
10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

SKELETON OF TOWER (1)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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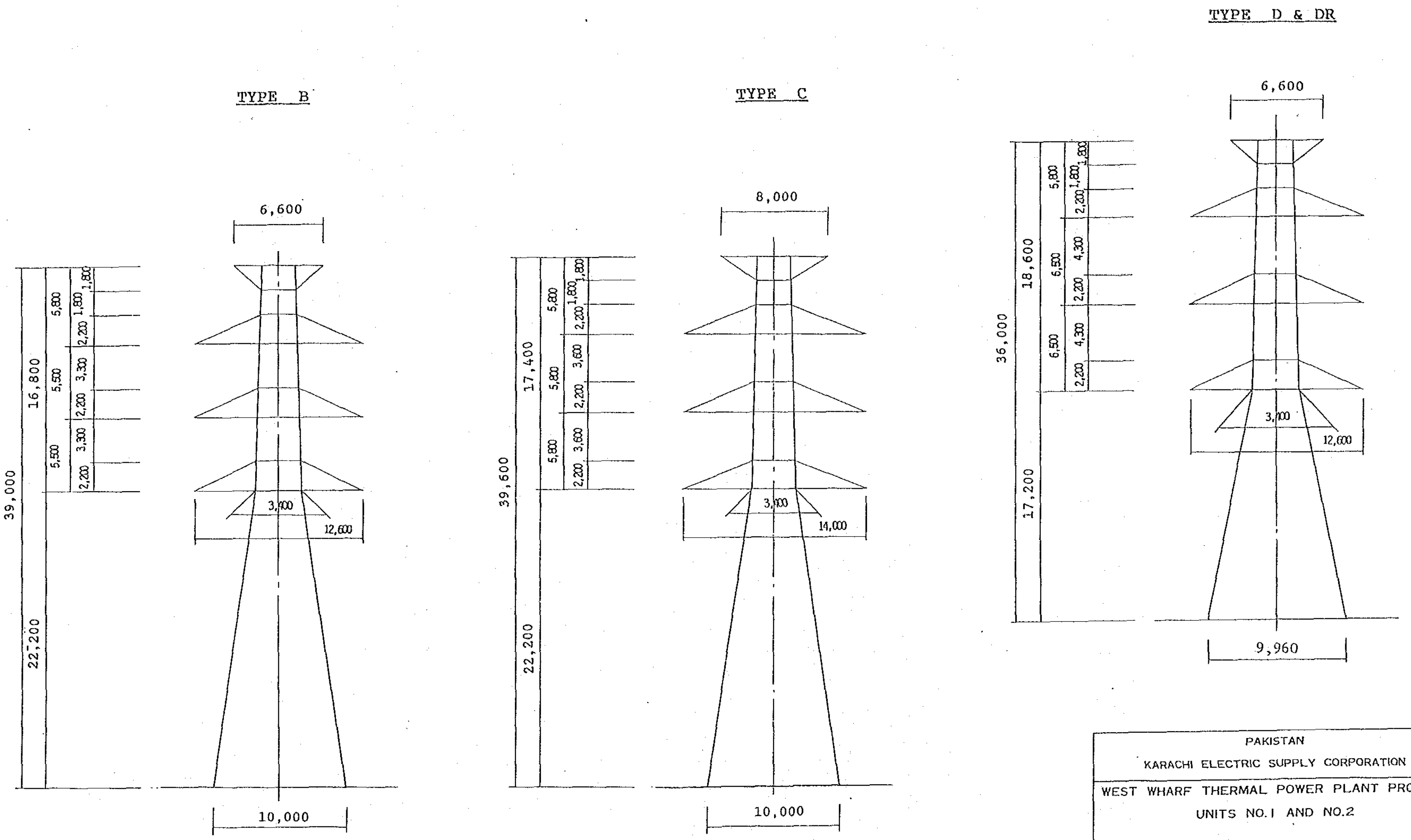

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

SKELETON OF TOWER (2)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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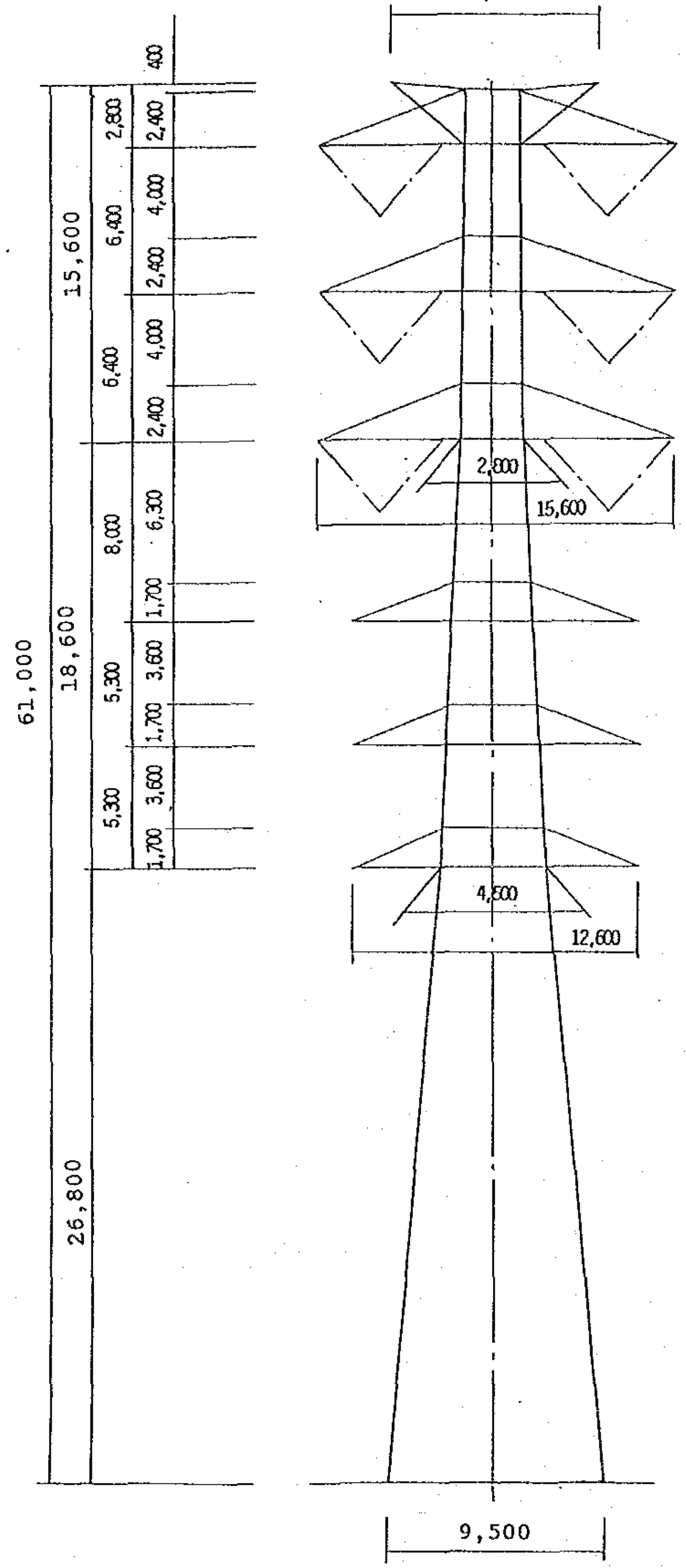

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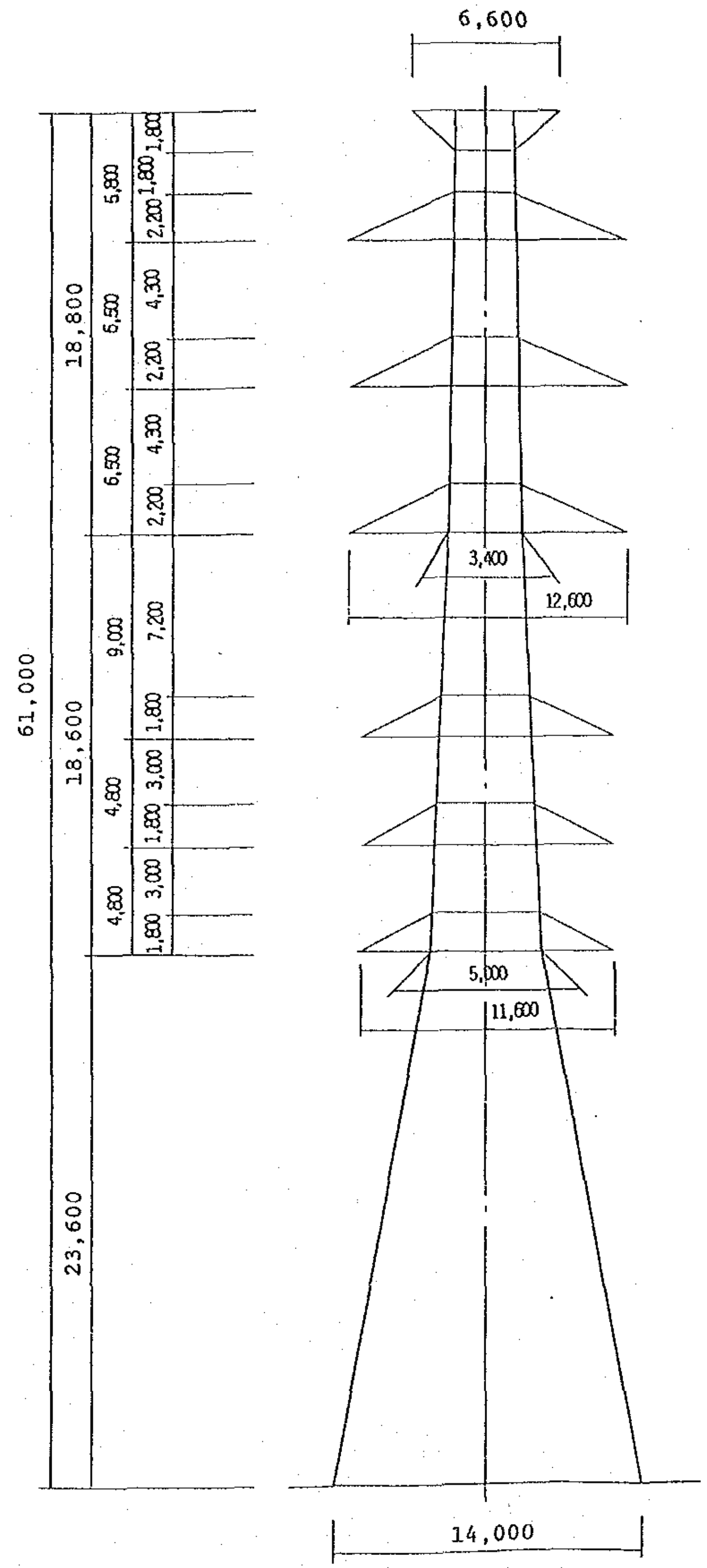

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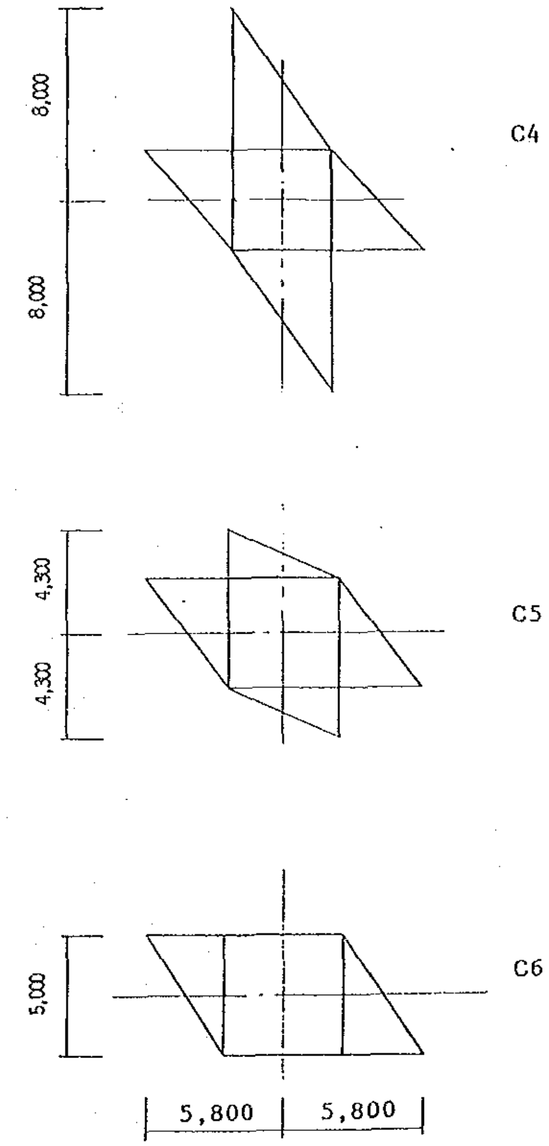

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

SKELETON OF TOWER (3)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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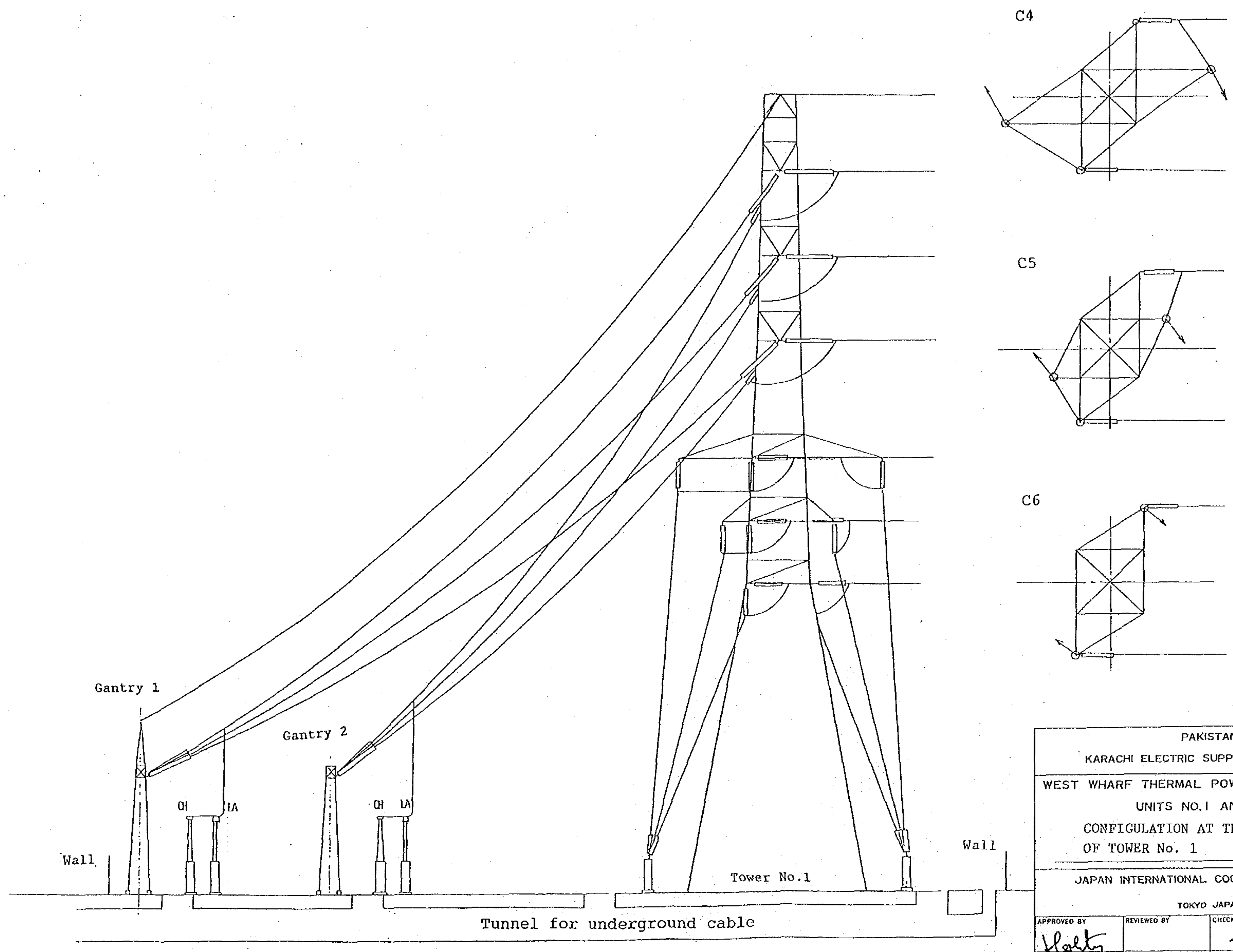

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

CONFIGULATION AT THE PLACE OF TOWER No. 1

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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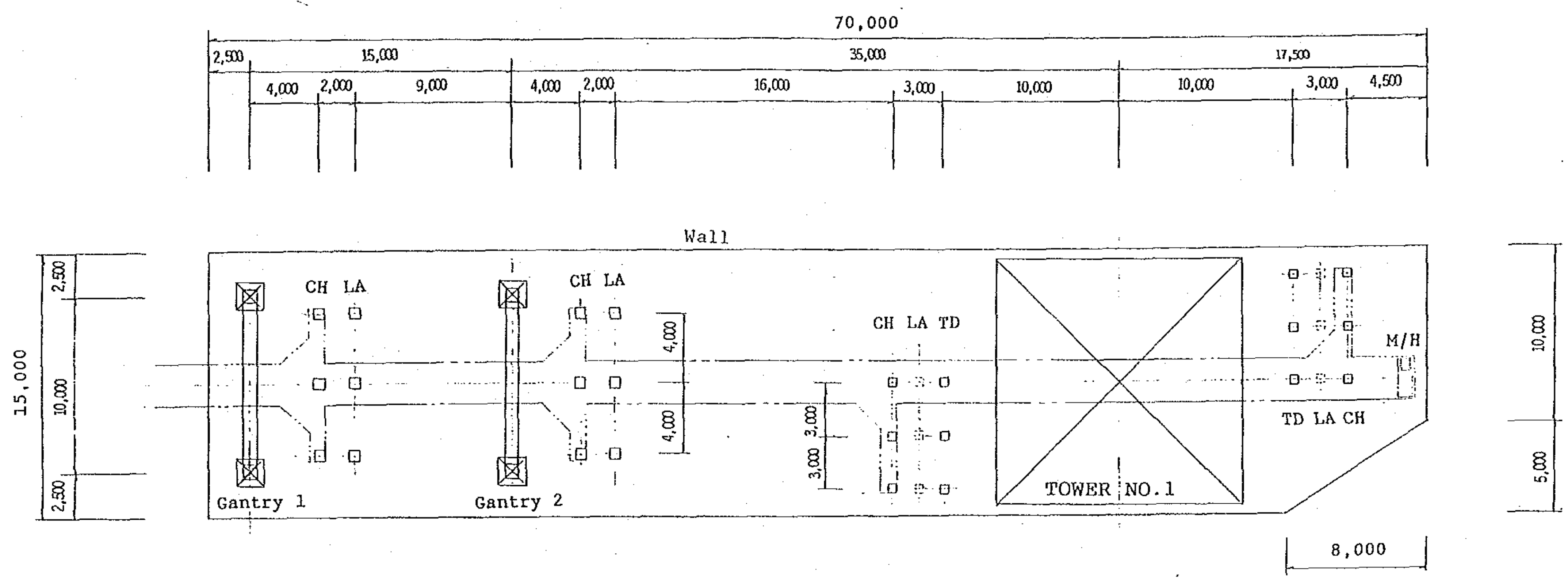
DRAWING NO. WLT-1104		SCALE 1/300	DATE 10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

PLAN AT THE PLACE OF TOWER No.1

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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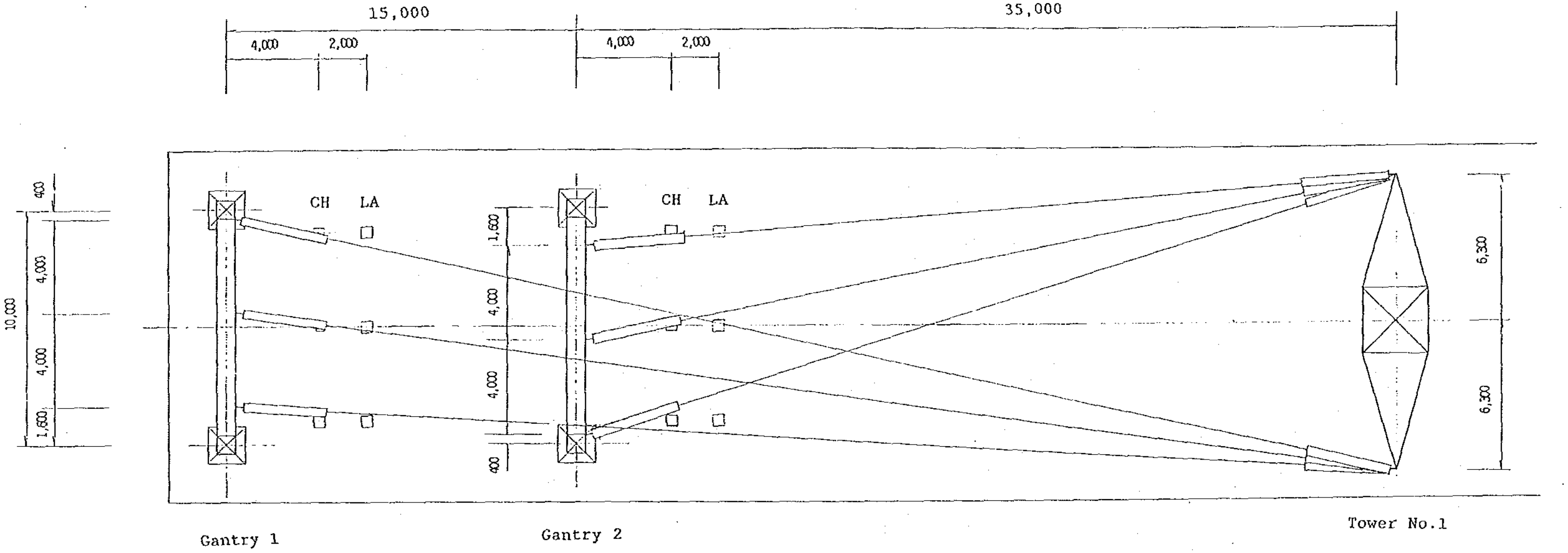
DRAWING NO. WLT-1105		SCALE 1/300	DATE 10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

ARRANGEMENT OF 220 kV INCOMING LINES AT TOWER No.1

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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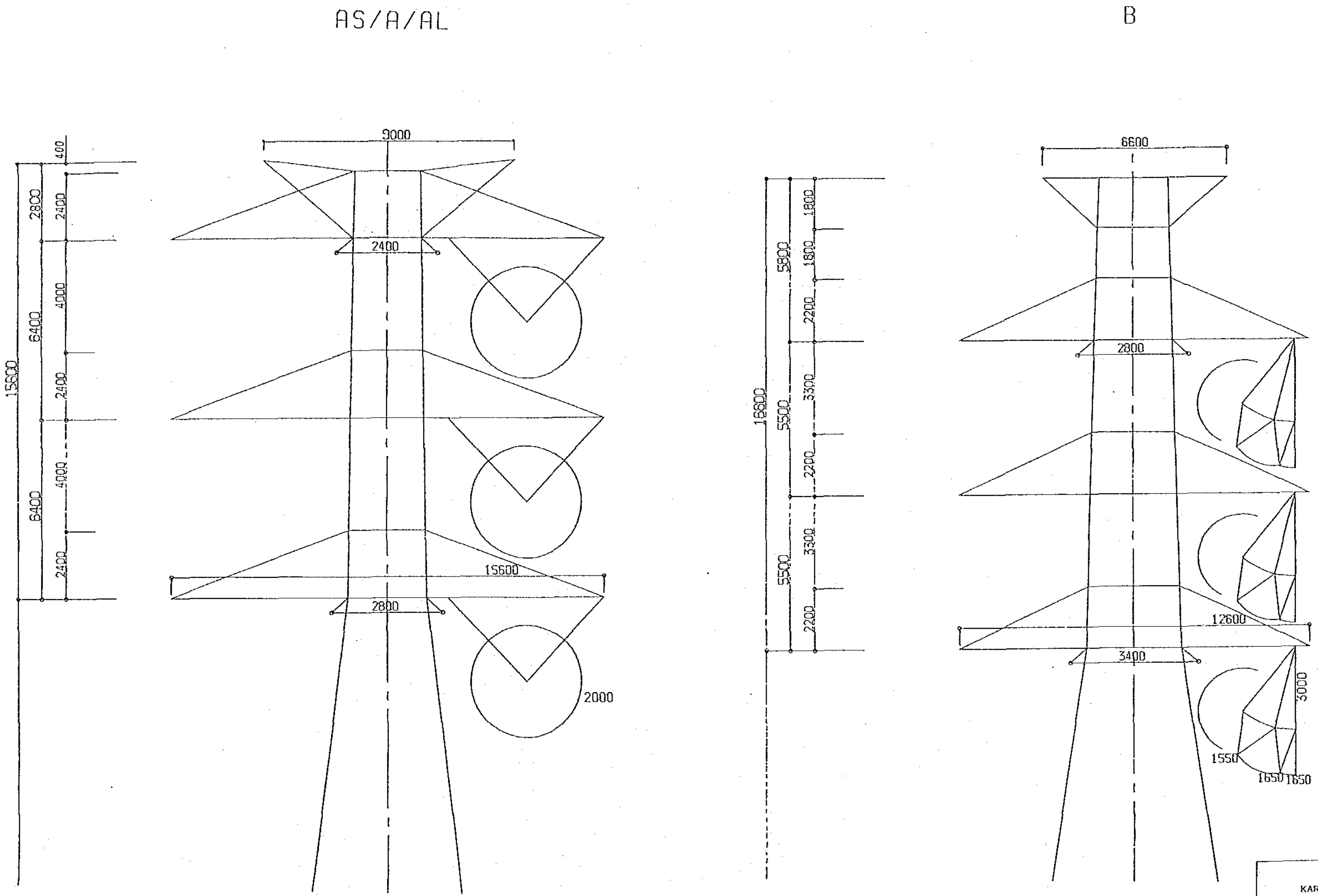
DRAWING NO. WLT-1106		SCALE 1/200	DATE 10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

CLEARANCE DIAGRAM (1)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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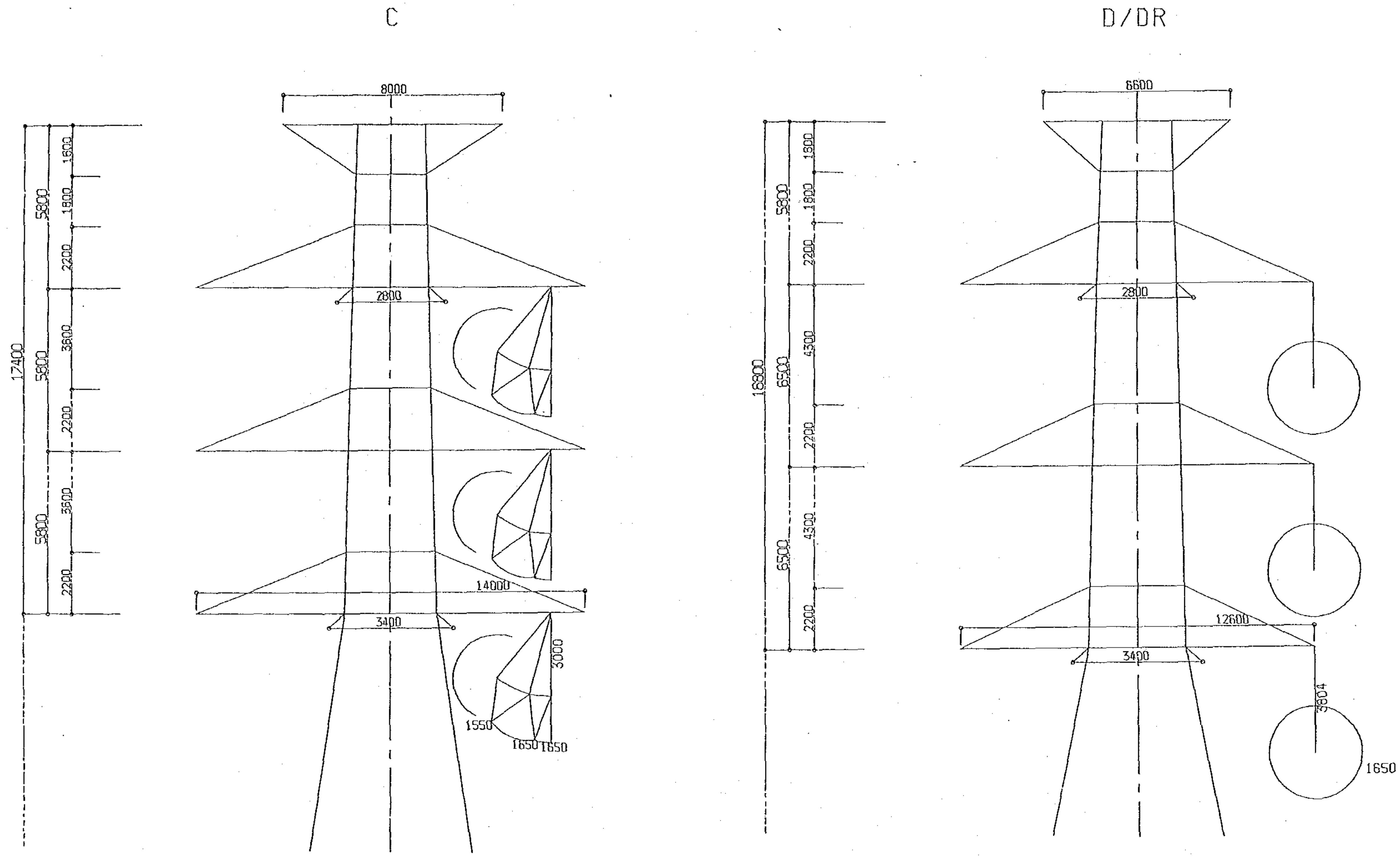
DRAWING NO WLT-1107		SCALE	DATE 10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2

CLEARANCE DIAGRAM (2)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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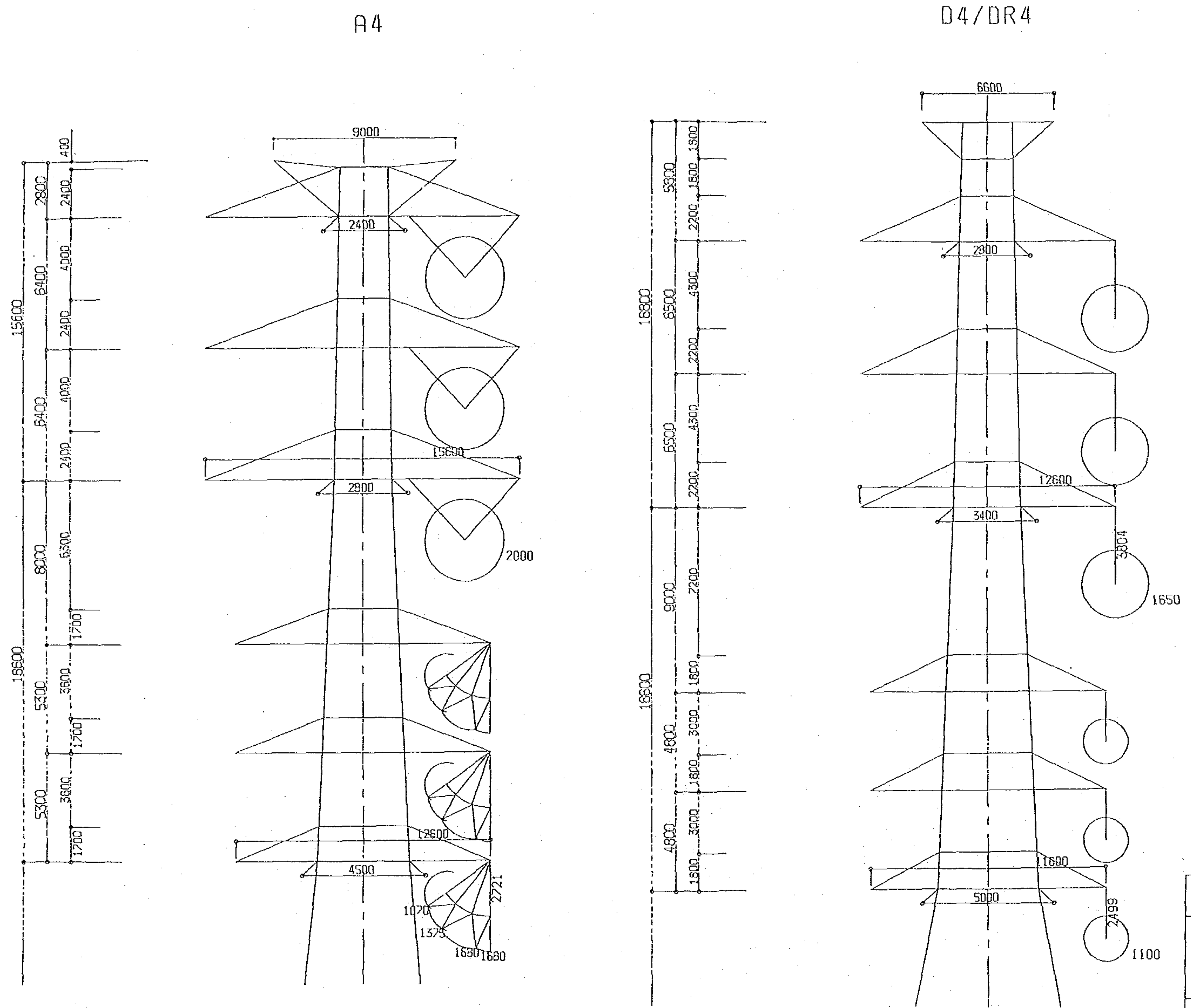
DRAWING NO. WLT-1108		SCALE	DATE 10TH JAN 1990



PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2

CLEARANCE DIAGRAM (3)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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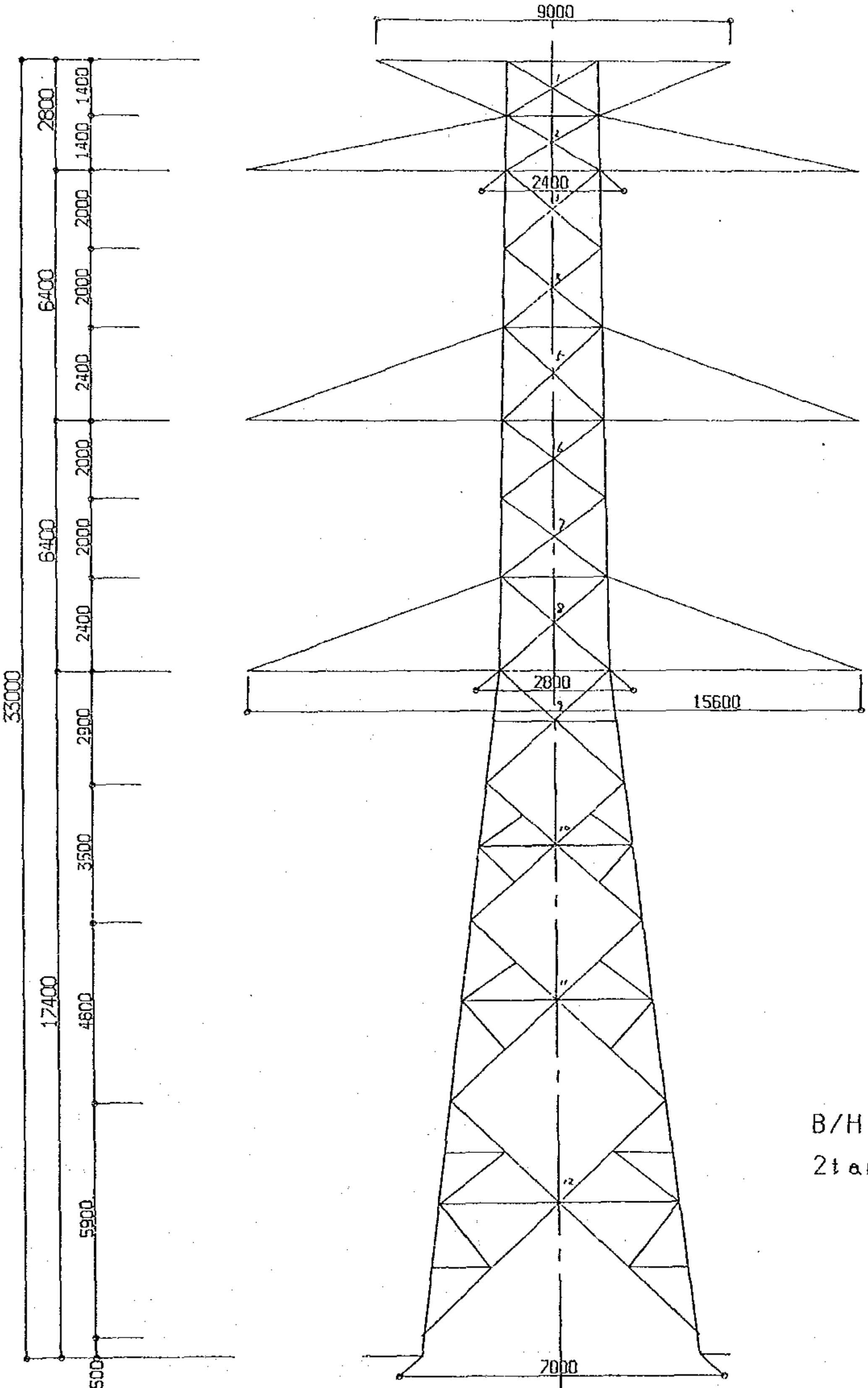
DRAWING NO. WLT-1109		SCALE	DATE 10TH JAN 1990

As

S=1 / 150



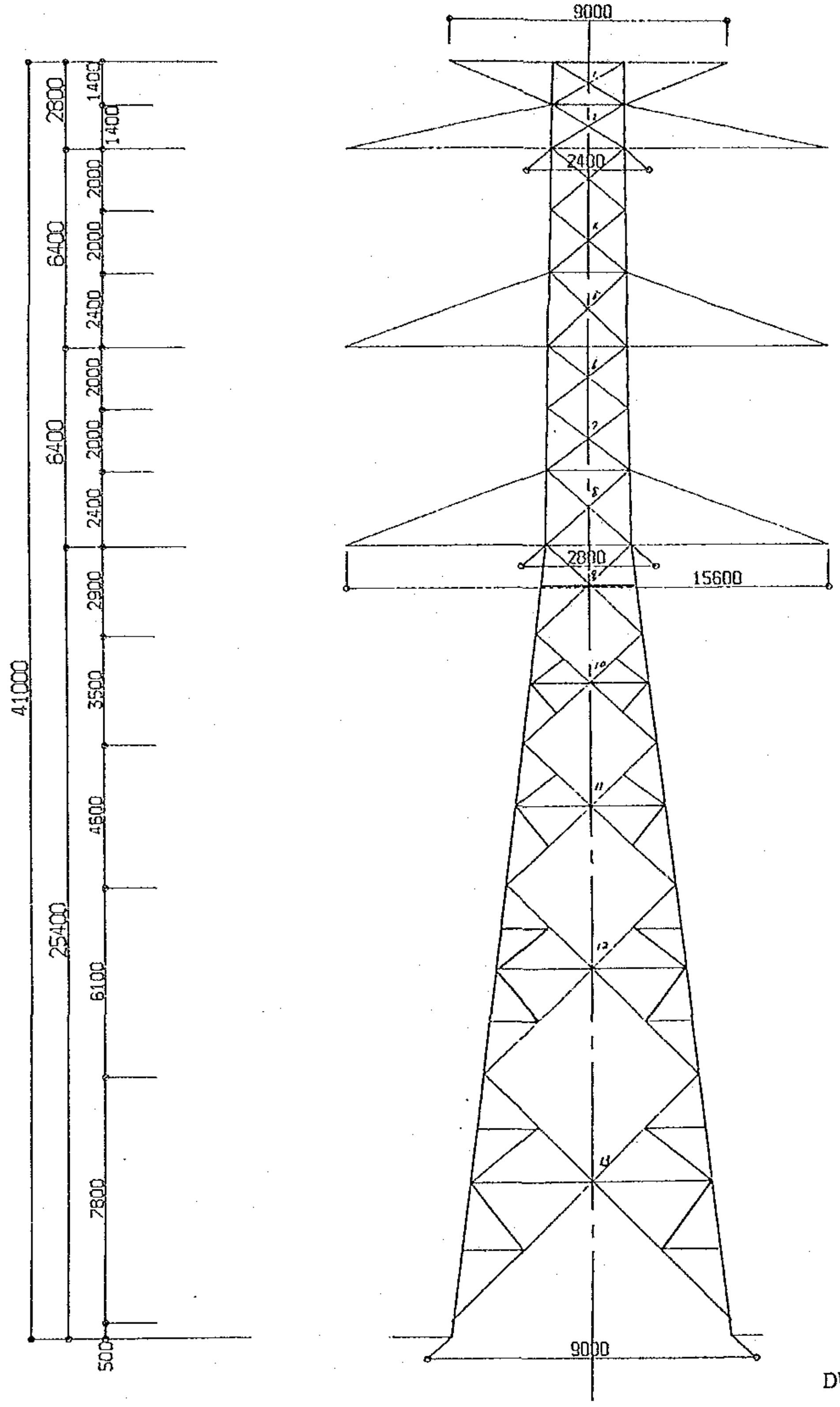
B/H = 1 / 4.71

2tanθ= .241

DWG.NO. TLT-01

A

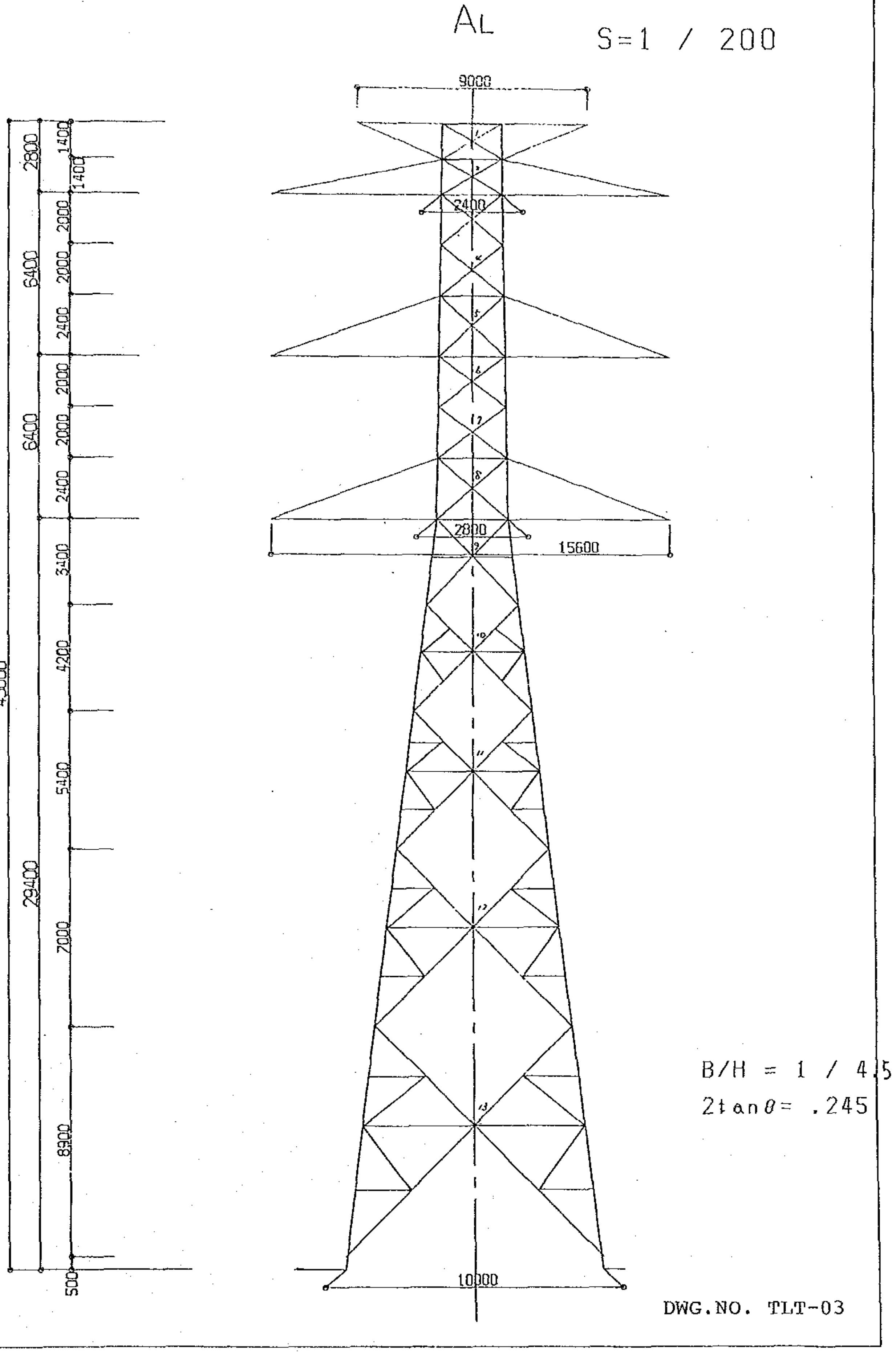
S=1 / 200



B/H = 1 / 4.56
2tan θ= .244

DWG.NO. TLT-02

246



AL
S=1 / 200
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2800
15600
10000
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6400
29400
45000
1400
1400
2000
2000
2400
2000
2000
2400
3400
4200
5400
7000
8900
500
B/H = 1 / 4.5
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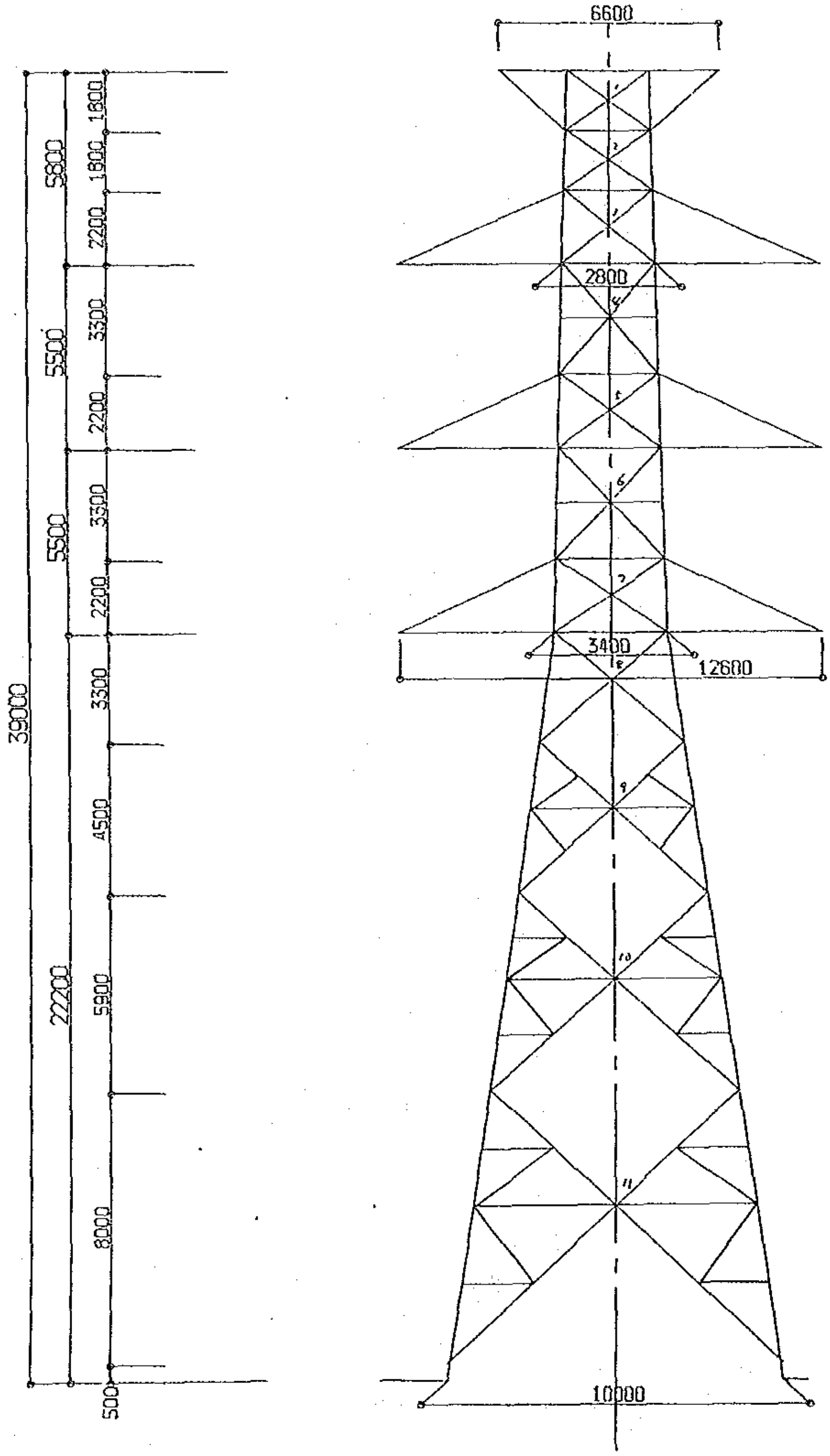
DWG.NO. TLT-03

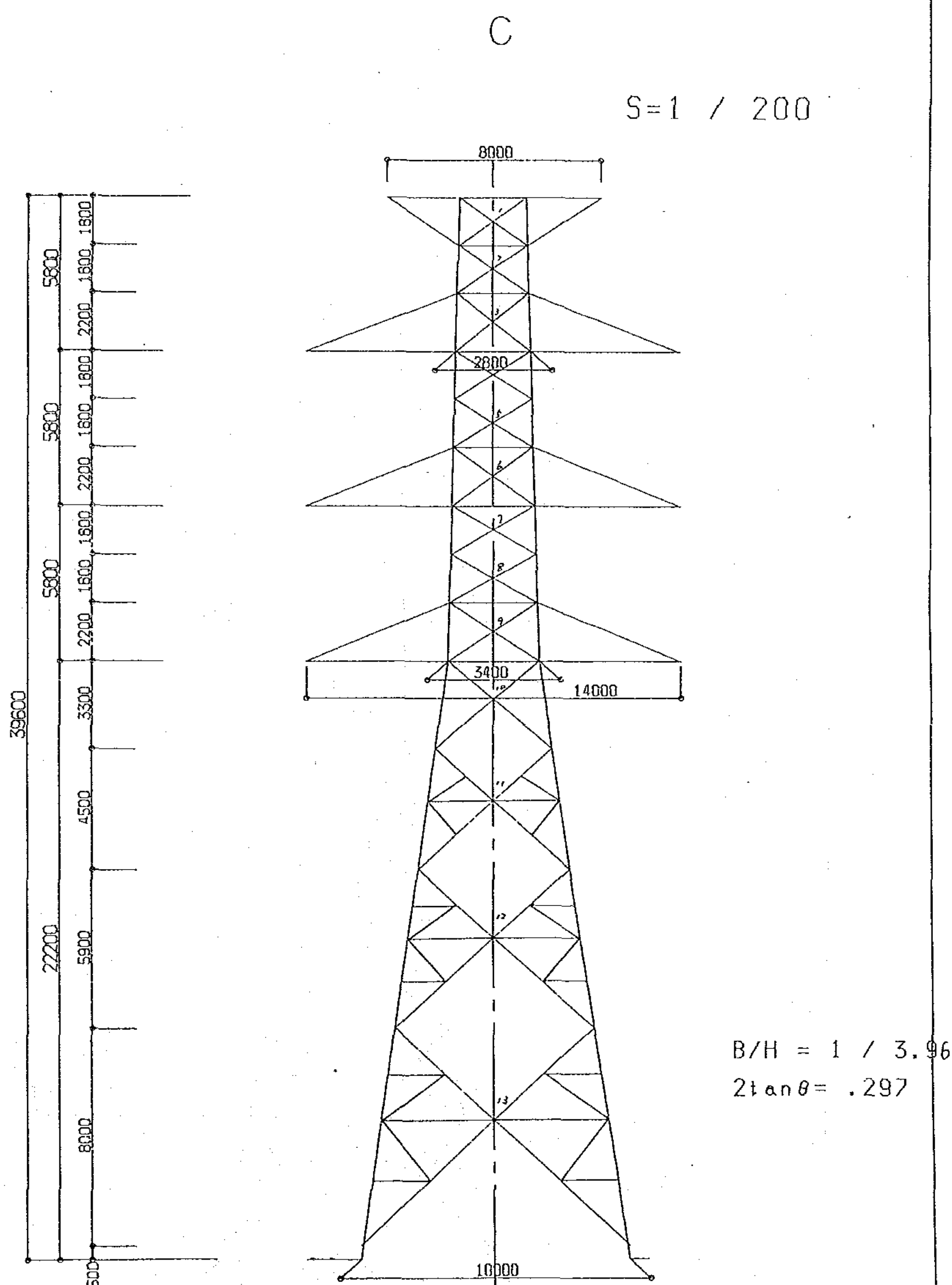
B

S=1 / 200



B/H = 1 / 3.9
$2\tan\theta = .297$

DWG.NO. TLT-04

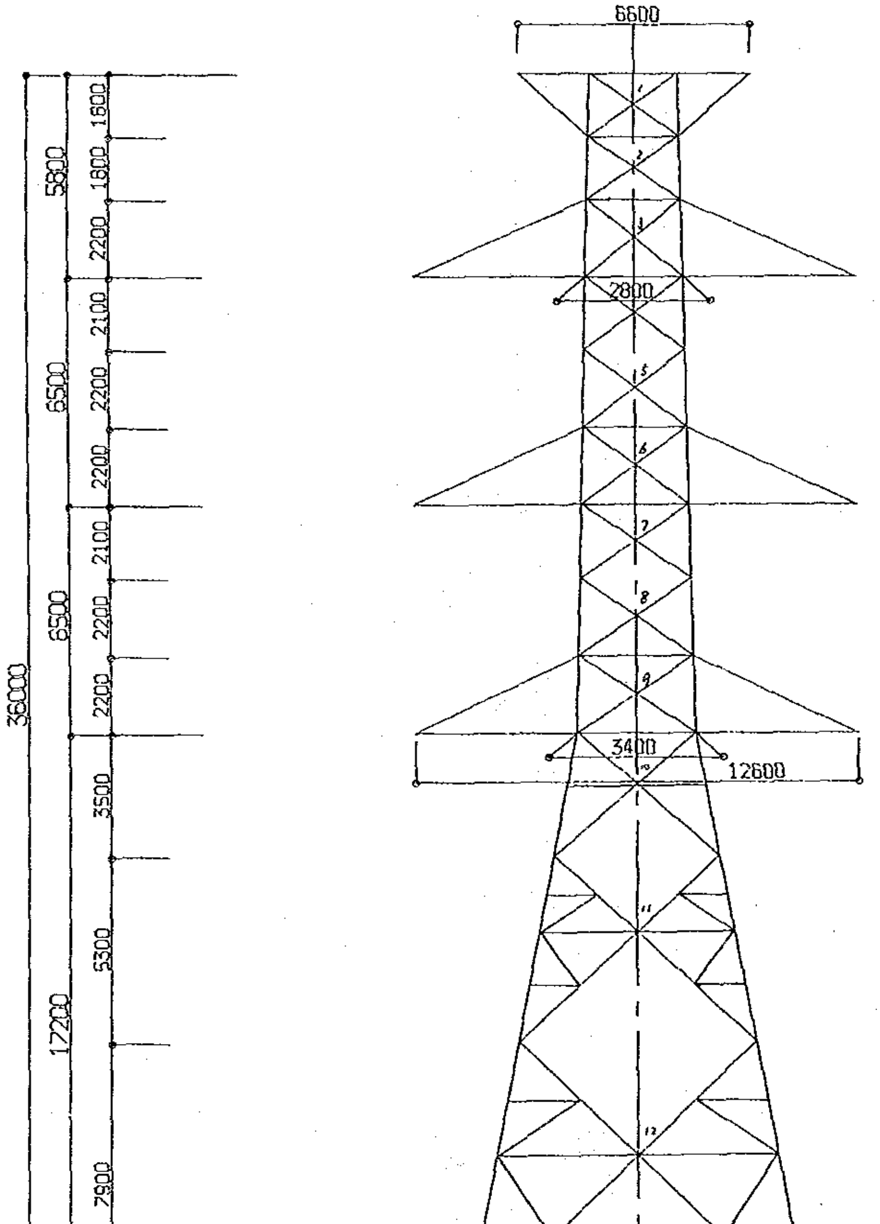


DWG.NO. TLT-05

247

D/DR

S=1 / 200

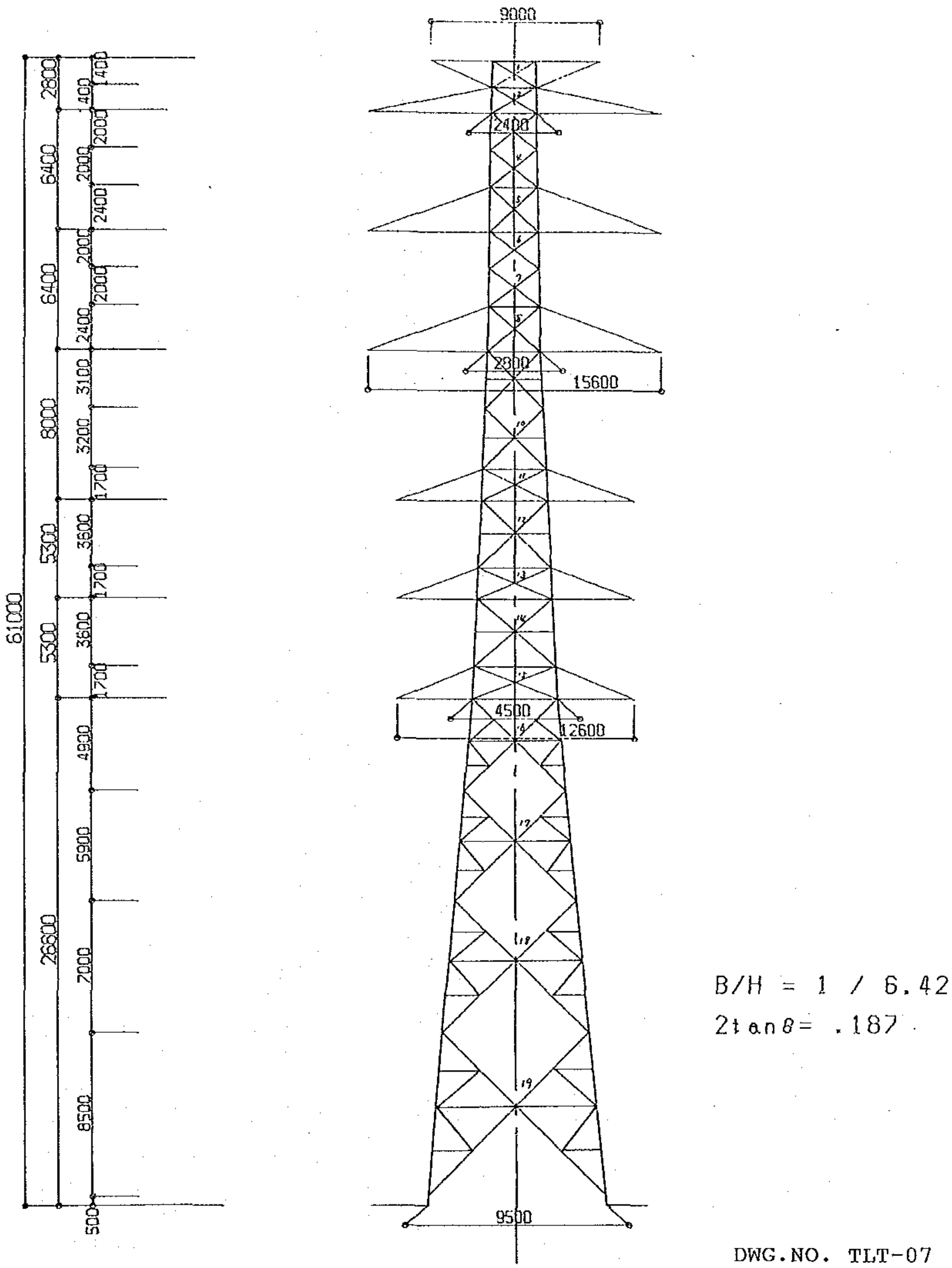


B/H = 1 / 3.8
2tanθ= .384

DWG.NO. TLT-06

A4

S=1 / 300



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D4

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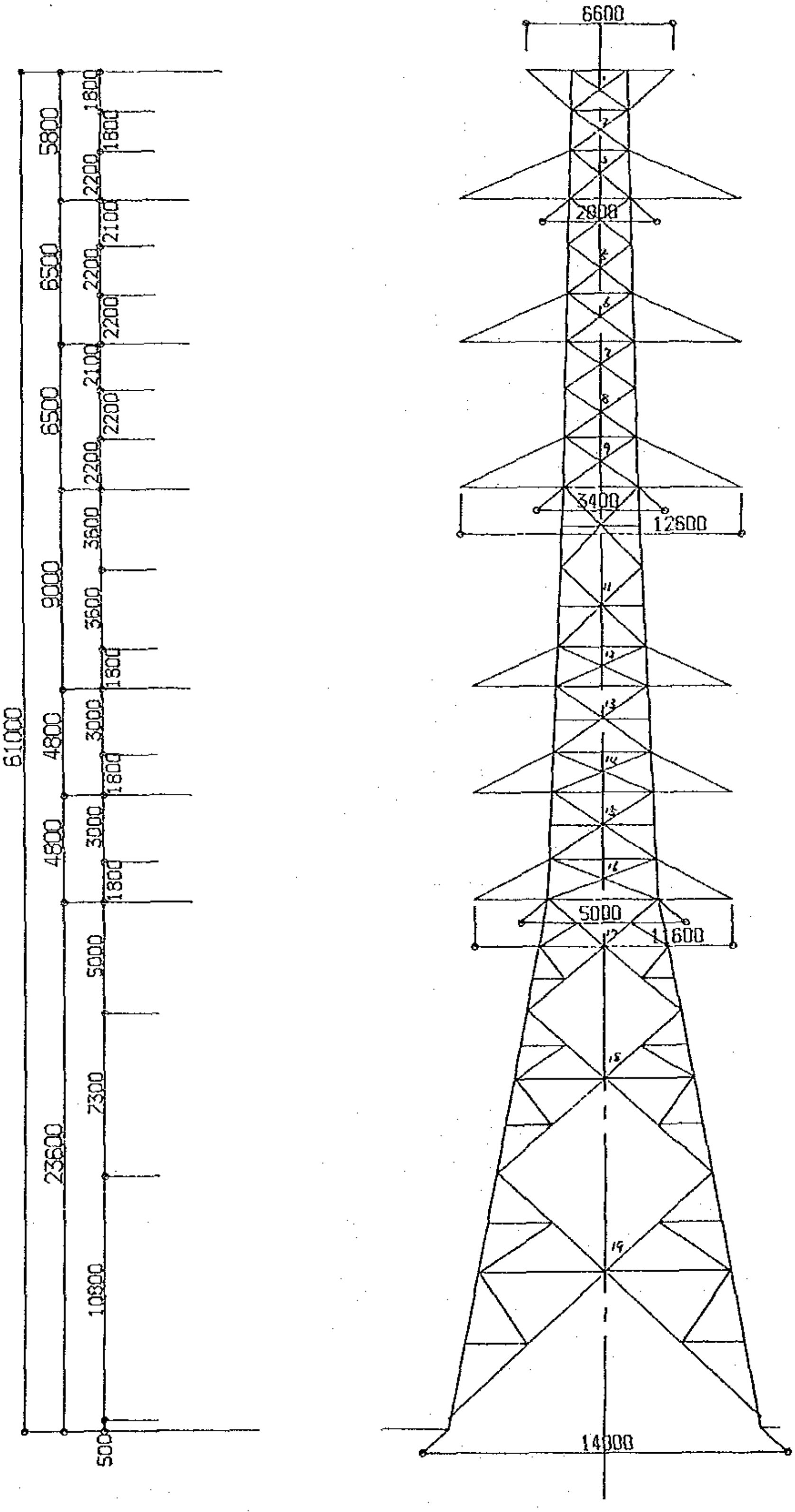


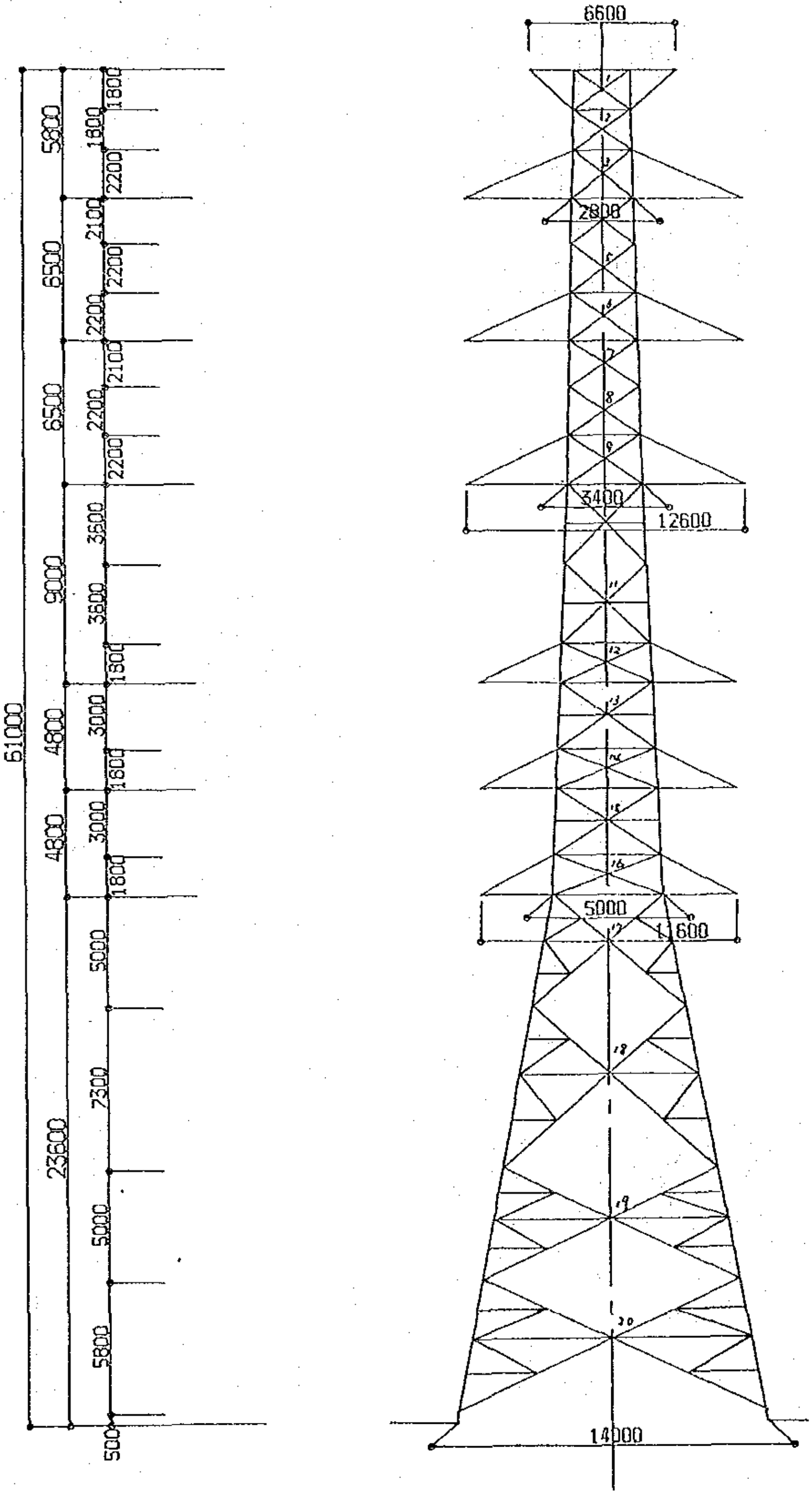
B/H = 1 / 4.36
2tanθ= .381

DWG.NO. TLT-08

252

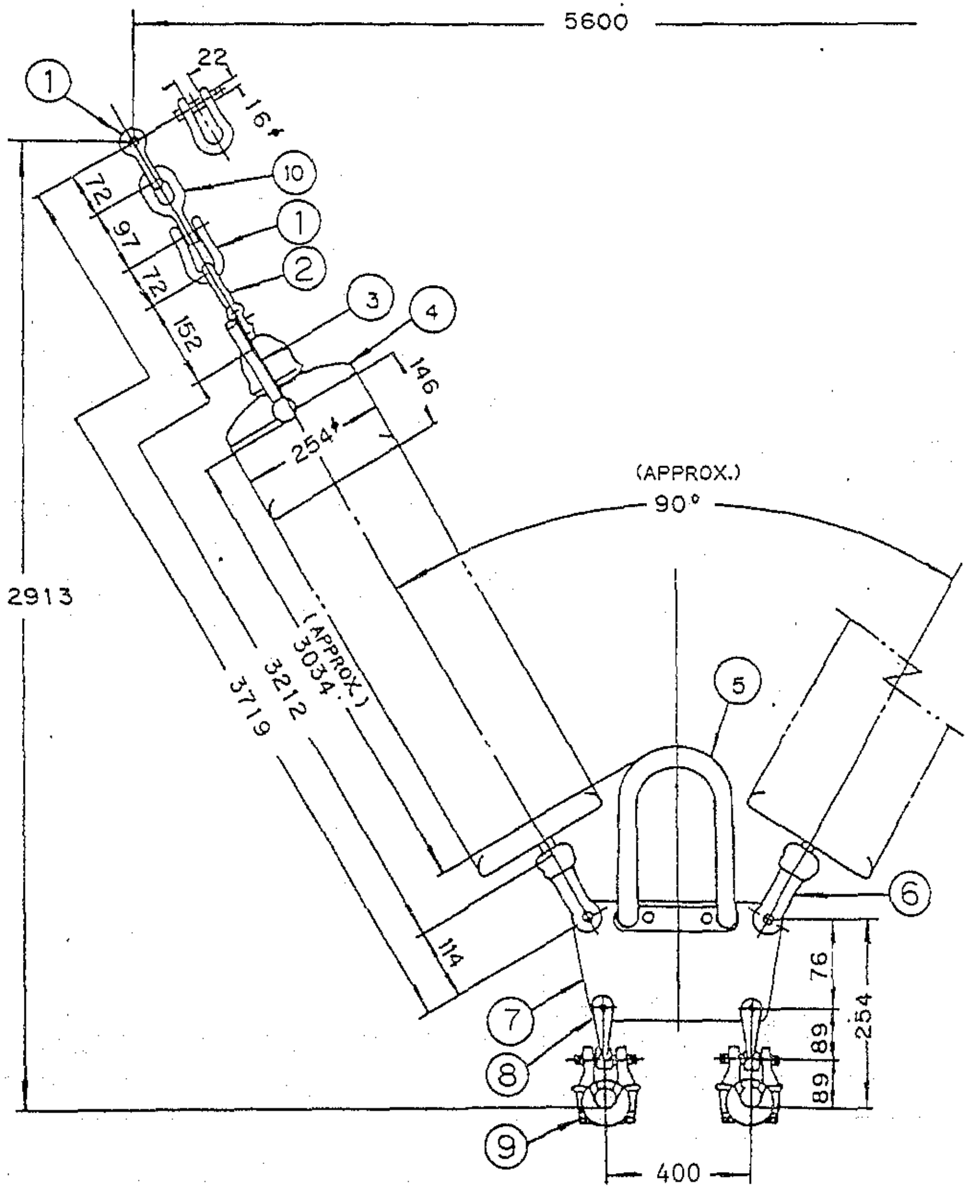
DR4

S=1 / 300



B/H = 1 / 4.36
$2\tan\theta = .381$

DWG.NO. TLT-09



ITEM	DESCRIPTION	MAIN MATERIAL	REQD.
1	ANCHOR SHACKLE	HIGH TENSION STEEL	4
2	HORN HOLDER BALL EYE	HIGH TENSION STEEL	2
3	ARCING HORN	STEEL	2
4	SUSPENSION INSULATOR	PORCELAIN	22X2
5	ARCING HORN	STEEL	1
6	SOCKET CLEVIS	DUCTILE IRON	2
7	YOKE	STEEL	1
8	CLEVIS EYE	STEEL	2
9	SUSPENSION CLAMP	ALUMINIUM ALLOY	2
10	EYE LINK	HIGH TENSION STEEL	2
MIN. BREAKING STRENGTH OF STRING		12000kg	
SUITABLE CONDUCTOR SIZE OF CLAMP		39.3ϕ~44.3ϕ	
TYPE OF BALL AND SOCKET PARTS		IEC 16mm A	

PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2

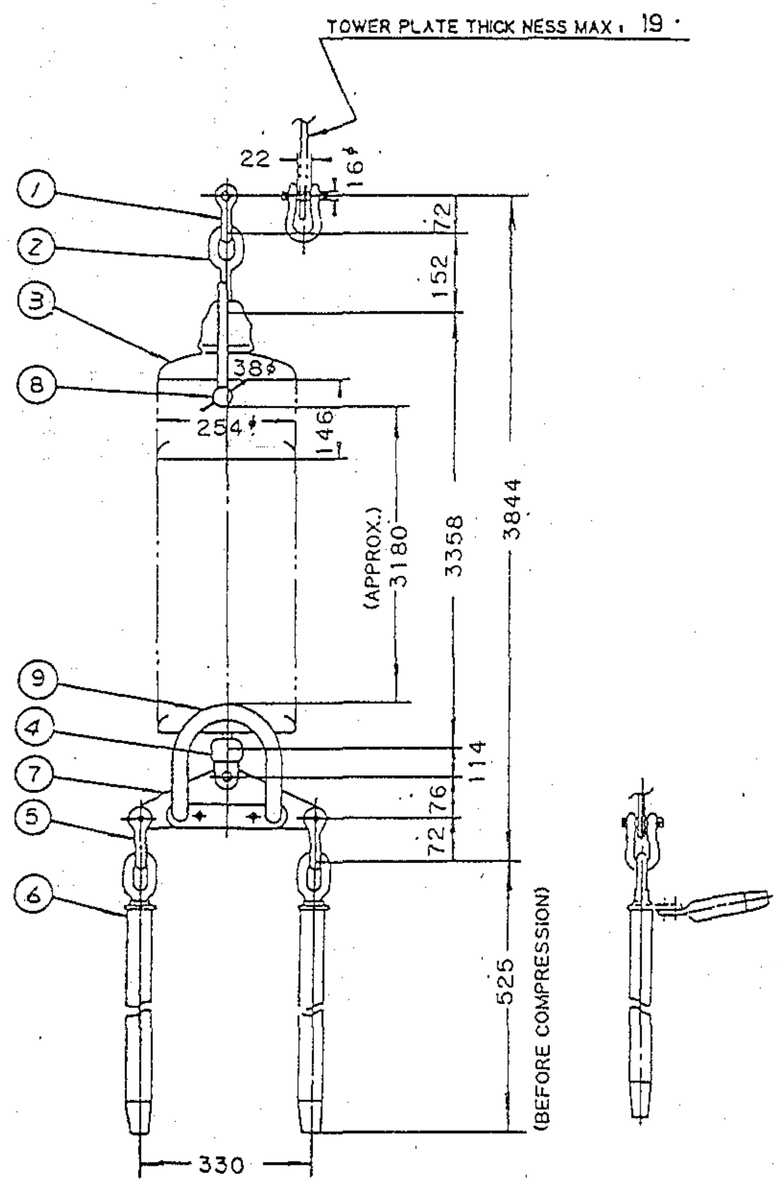
220 kV V-SUSPENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

APPROVED BY	REVIEWED BY	CHECKED BY	DRAWN BY
DRAWING NO. WLT-1201		SCALE	DATE 10TH JAN 1990

FORM 04

254



ITEM	DESCRIPTION	MAIN MATERIAL	REQD.
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	HORN HOLDER BALL EYE	HIGH TENSION STEEL	1
3	SUSPENSION INSULATOR	PORCELAIN	23
4	SOCKET CLEVIS	DUCTILE IRON	1
5	ANCHOR SHACKLE	HIGH TENSION STEEL	2
6	COMPRESSION CLAMP	ALUMINIUM	2
7	YOKE	STEEL	1
8	ARCING HORN	STEEL	1
9	ARCING HORN	STEEL	1

SUITABLE CONDUCTOR SIZE OF CLAMP	ACSR/AS 330mm²
* MIN. BREAKING STRENGTH OF STRING EXCEPT COMPRESSION CLAMP	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

220 kV SINGLE TENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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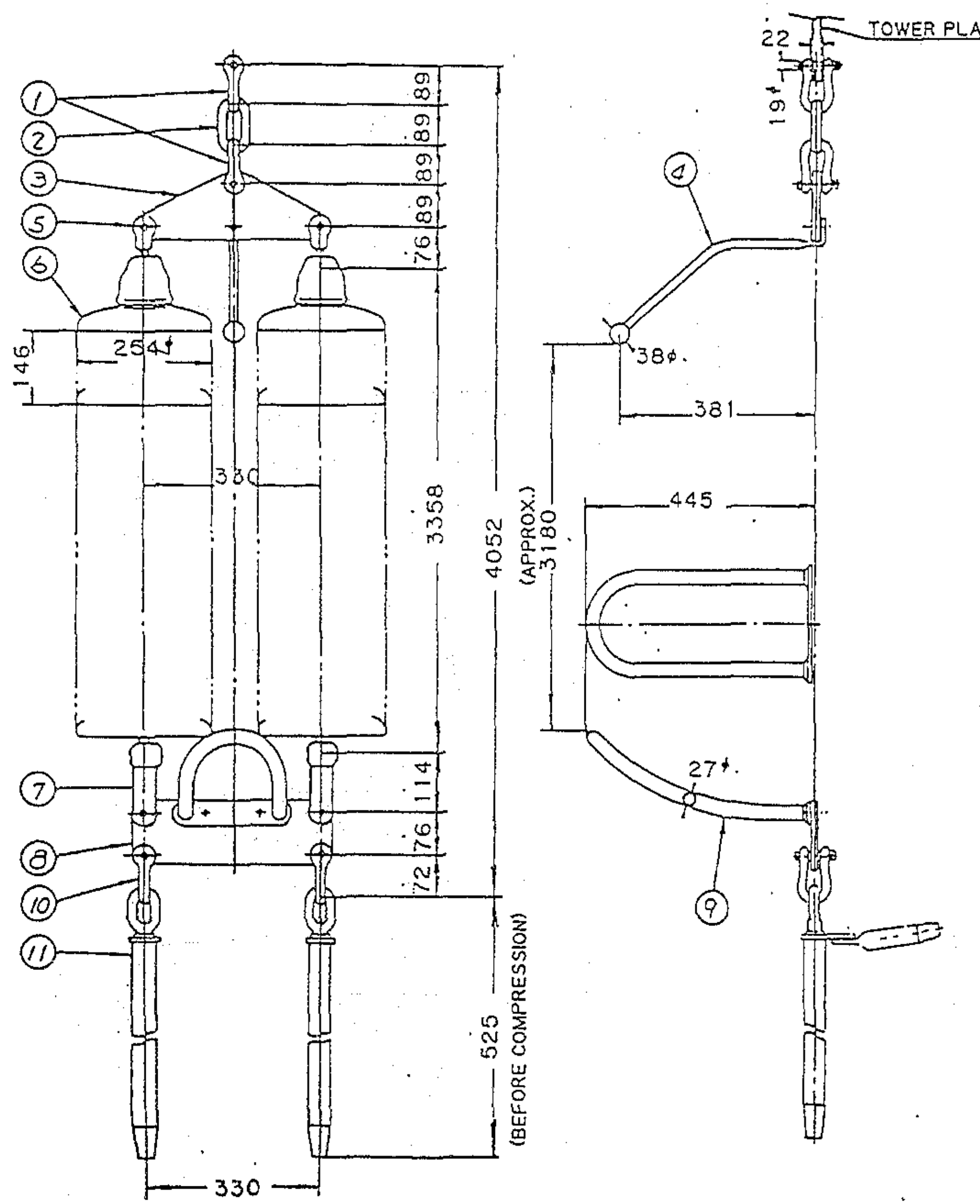
[signature]		[signature]	N. [signature]
DRAWING NO. WLT-1202		SCALE	DATE 10TH JAN 1990

FORM 04



ITEM	DESCRIPTION	MAIN MATERIAL	REQD.
1	ANCHOR SHACKLE	HIGH TENSION STEEL	2
2	CHAIN LINK	HIGH TENSION STEEL	1
3	YOKE	STEEL	1
4	ARCING HORN	STEEL	1
5	BALL-CLEVIS	HIGH TENSION STEEL	2
6	SUSPENSION INSULATOR	PORCELAIN	23×2
7	SOCKET-CLEVIS	DUCTILE IRON	2
8	YOKE	STEEL	1
9	ARCING HORN	STEEL	1
10	ANCHOR SHACKLE	HIGH TENSION STEEL	2
11	COMPRESSION CLAMP	ALUMINIUM	2

SUITABLE CONDUCTOR SIZE OF CLAMP	ACSR/AS 330mm²
* MIN. BREAKING STRENGTH OF STRING EXCEPT COMPRESSION CLAMP	24000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

220 kV DOUBLE TENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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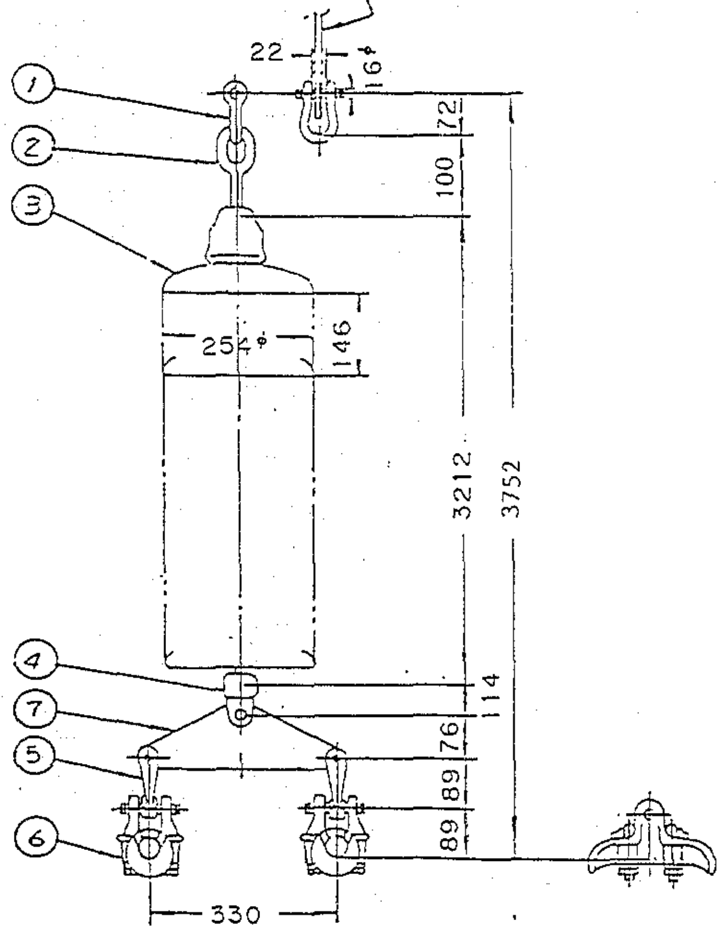
[signature]		[signature]	N. Inoue
DRAWING NO. WLT-1203		SCALE	DATE 10TH JAN 1990

FORM 04



ITEM	DESCRIPTION	MAIN MATERIAL	REQD
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	BALL EYE	HIGH TENSION STEEL	1
3	SUSPENSION INSULATOR	PORCELAIN	22
4	SOCKET CLEVIS	DUCTILE IRON	1
5	CLEVIS EYE	STEEL	2
6	SUSPENSION CLAMP	ALUMINIUM ALLOY	2
7	YOKE	STEEL	1

SUITABLE CONDUCTOR SIZE OF CLAMP	39.3φ ~44.3φ
MIN. BREAKING STRENGTH OF STRING	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

220 kV JUMPER SUPPORT INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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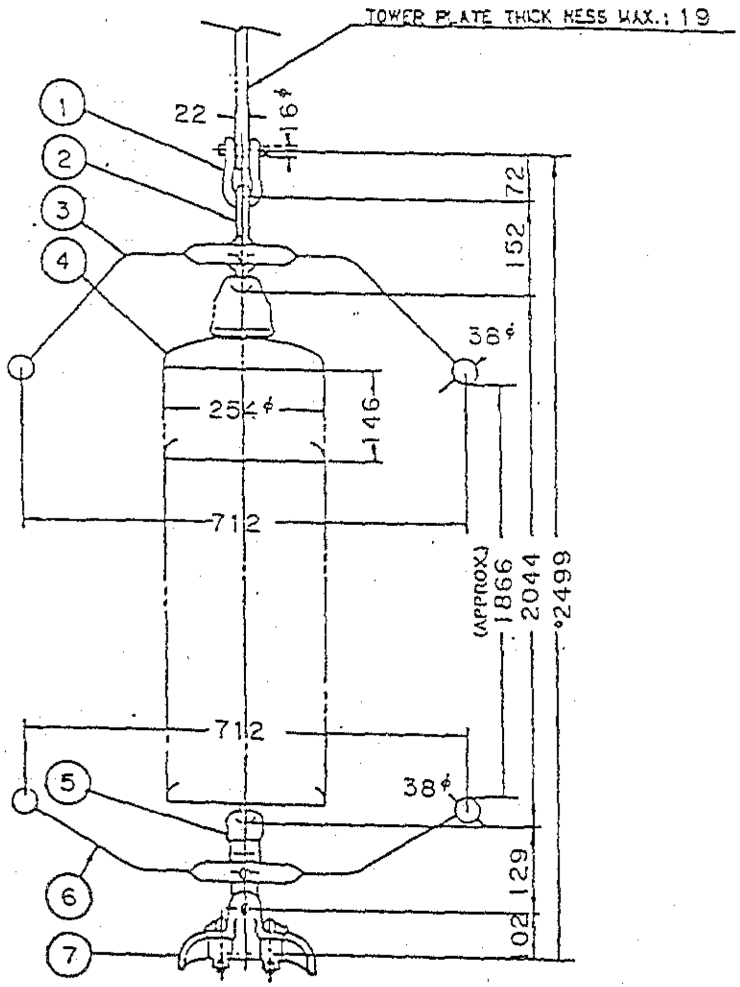
[signature]		[signature]	N. Inoue
DRAWING NO. WLT-1204		SCALE	DATE 10TH JAN 1990

FORM 04



ITEM	DESCRIPTION	MAIN MATERIAL	REQD
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	HORN HOLDER BALL EYE	HIGH TENSION STEEL	1
3	ARCING HORN	STEEL	1
4	SUSPENSION INSULATOR	PORCELAIN	14
5	HORN HOLDER SOCKET-EYE	MALLEABLE IRON OR DUCTILE IRON	1
6	ARCING HORN	STEEL	1
7	SUSPENSION CLAMP	ALUMINIUM ALLOY	1

SUITABLE CONDUCTOR SIZE OF CLAMP	43.2φ ~57.1φ
MIN. BREAKING STRENGTH OF STRING	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2

132 kV SINGLE SUSPENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

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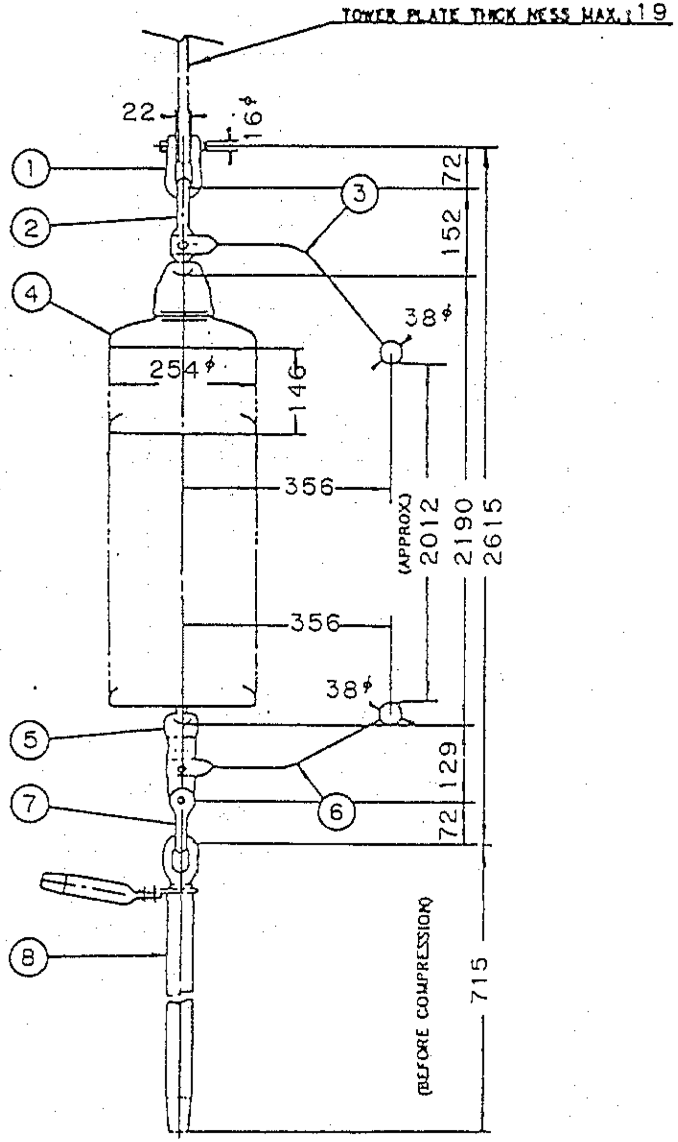
[signature]		[signature]	N. Inoue
DRAWING NO. WLT-1205		SCALE	DATE 10TH JAN 1990

FORM 04

258



ITEM	DESCRIPTION	MAIN MATERIAL	REQD
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	HORN HOLDER BALL EYE	HIGH TENSION STEEL	1
3	ARCING HORN	STEEL	1
4	SUSPENSION INSULATOR	PORCELAIN	15
5	HORN HOLDER SOCKET-EYE	MALLEABLE IRON OR DUCTILE IRON	1
6	ARCING HORN	STEEL	1
7	ANCHOR SHACKLE	HIGH TENSION STEEL	1
8	COMPRESSION CLAMP	ALUMINIUM	1

SUITABLE CONDUCTOR SIZE OF CLAMP	ACSR/AS 680mm²
※ MIN. BREAKING STRENGTH OF STRING *EXCEPT* COMPRESSION CLAMP	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

132 kV SINGLE TENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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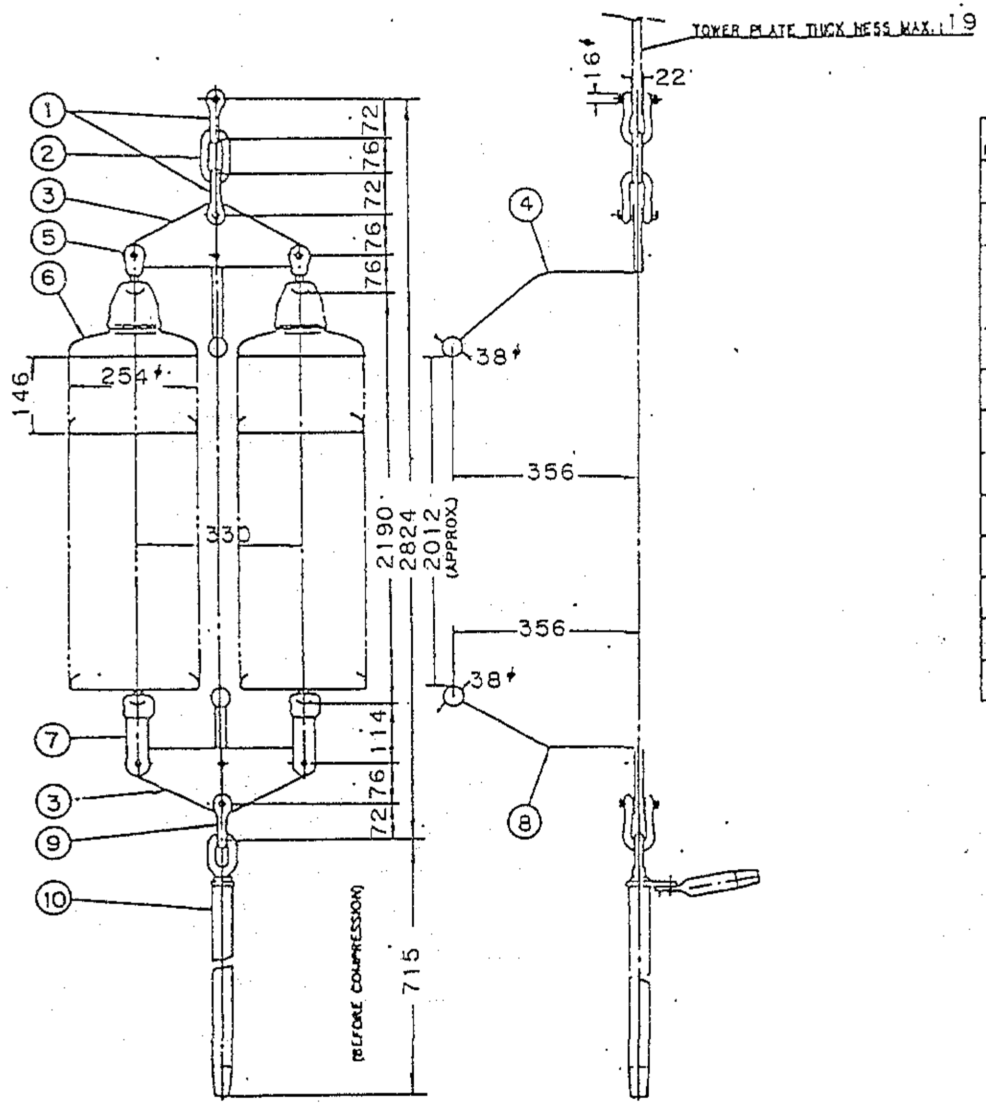
[signature]		[signature]	N. Inoue
DRAWING NO. WDT-1206		SCALE	DATE 10TH JAN 1990

FORM 04



ITEM	DESCRIPTION	MAIN MATERIAL	REQD.
1	ANCHOR SHACKLE	HIGH TENSION STEEL	2
2	CHAIN LINK	HIGH TENSION STEEL	1
3	YOKE	STEEL	2
4	ARCING HORN	STEEL	1
5	BALL-CLEVIS	HIGH TENSION STEEL	2
6	SUSPENSION INSULATOR	PORCELAIN	15×2
7	SOCKET-CLEVIS	MALLEABLE IRON OR DUCTILE IRON	2
8	ARCING HORN	STEEL	1
9	ANCHOR SHACKLE	HIGH TENSION STEEL	1
10	COMPRESSION CLAMP	ALUMINIUM	1

SUITABLE CONDUCTOR SIZE OF CLAMP	ACSR/AS 680mm²
MIN. BREAKING STRENGTH OF STRING ※ EXCEPT COMPRESSION CLAMP	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

132 kV DOUBLE TENSION INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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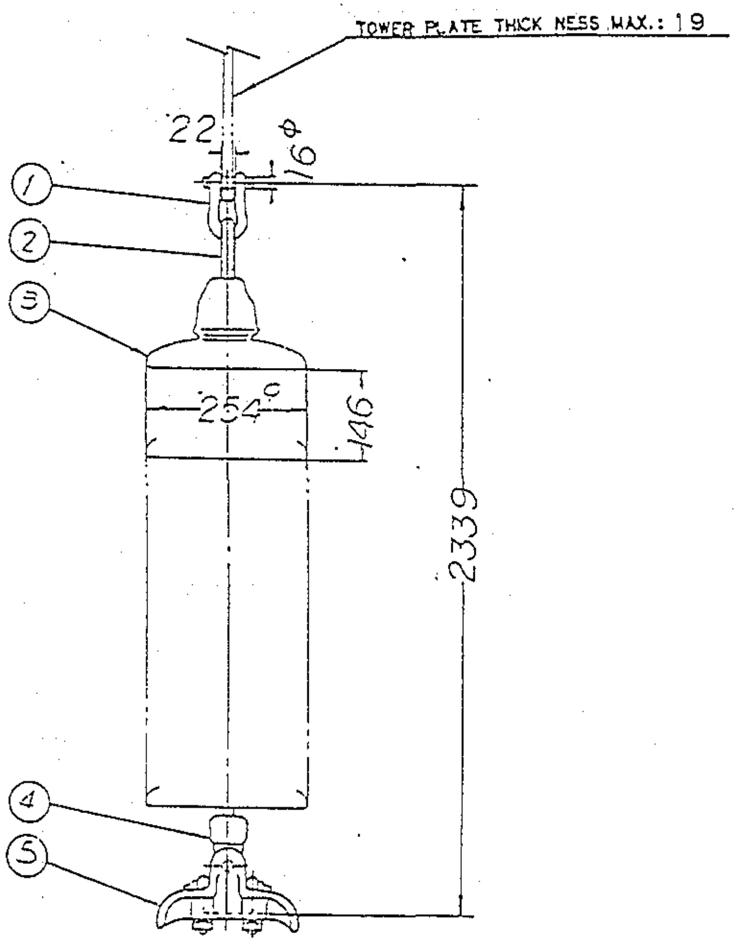
[signature]		[signature]	N. Inoue
DRAWING NO. WLT-1207		SCALE	DATE 10TH JAN 1990

FORM 04

260

19τ



ITEM	DESCRIPTION	MAIN MATERIAL	REQD
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	BALL EYE	HIGH TENSION STEEL	1
3	SUSPENSION INSULATOR	PORCELAIN	14
4	SOCKET-EYE	MALLEABLE IRON OR SPHEROIDAL GRAPHITE IRON (DUCTILE IRON)	1
5	SUSPENSION CLAMP	MALLEABLE IRON OR DUCTILE IRON	1

SUITABLE CONDUCTOR SIZE OF CLAMP	43.2φ ~57.1φ
MIN. BREAKING STRENGTH OF STRING	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

132 kV JUMPER SUPPORT INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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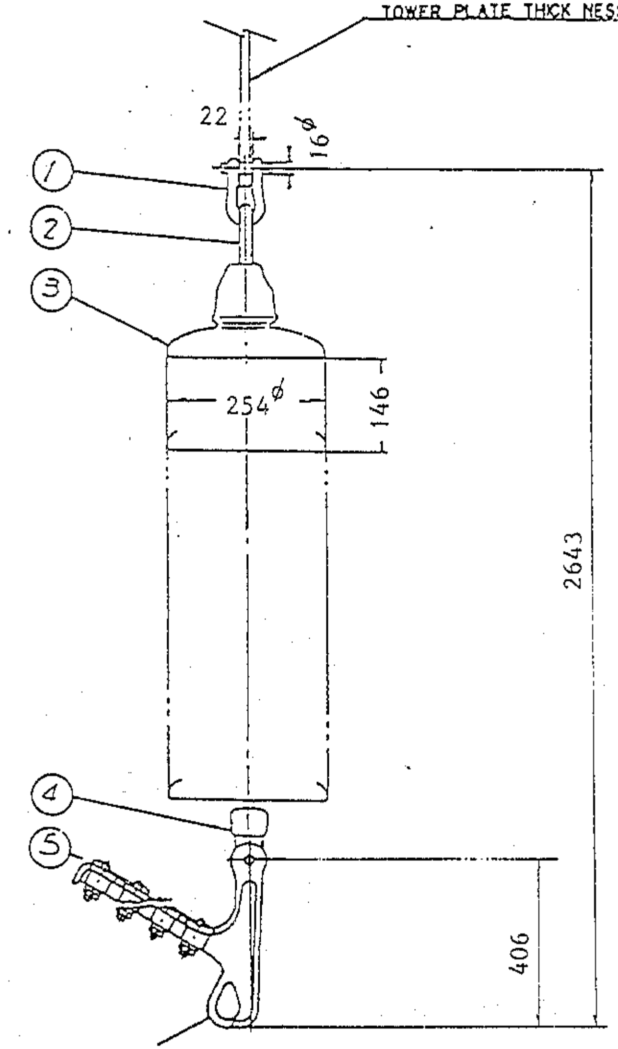
(signature)		(signature)	N. Inoue
DRAWING NO. WLE-1208		SCALE	DATE 10TH JAN 1990

FORM 04



ITEM	DESCRIPTION	MAIN MATERIAL	REQD
1	ANCHOR SHACKLE	HIGH TENSION STEEL	1
2	BALL EYE	HIGH TENSION STEEL	1
3	SUSPENSION INSULATOR	PORCELAIN	14
4	SOCKET-EYE	MALLEABLE IRON OR DUCTILE IRON	1
5	STRAIN CLAMP	ALUMINIUM ALLOY	1

SUITABLE CONDUCTOR SIZE OF CLAMP	30.5φ~43.2φ
MIN. BREAKING STRENGTH OF STRING	12000kg
TYPE OF BALL AND SOCKET PARTS	IEC 16mm A

PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2
132KV
TIE DOWN INSULATOR STRING

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

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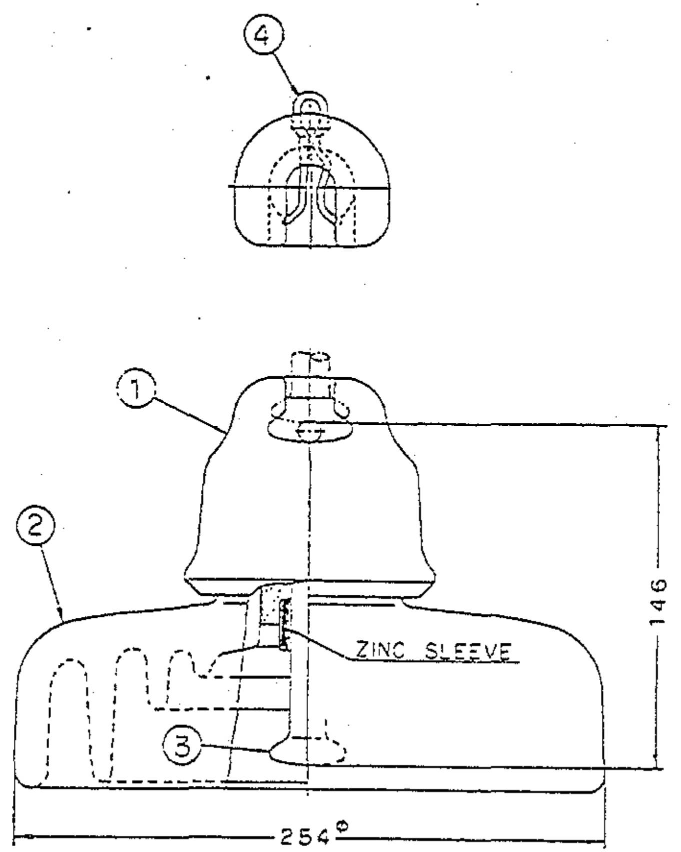
FORM 04

262

263



TECHNICAL DATA

SPECIFICATION APPLIED : IEC Pub. 383-1983

Characteristics	Rating
1. Type of ball and socket coupling	IEC 16mm A
2. Creepage distance (mm)	432
3. Electro-mechanical failing load (kN)	120
4. Dry lightning impulse withstand voltage (kV)	125
5. Wet power-frequency withstand voltage (kV)	45
6. Power-frequency puncture voltage (kV)	130

ITEM	MATERIAL
①	DUCTILE IRON
②	PORCELAIN
③	HIGH TENSION STEEL
④	STAINLESS STEEL

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WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

FOG TYPE SUSPENSION INSULATOR

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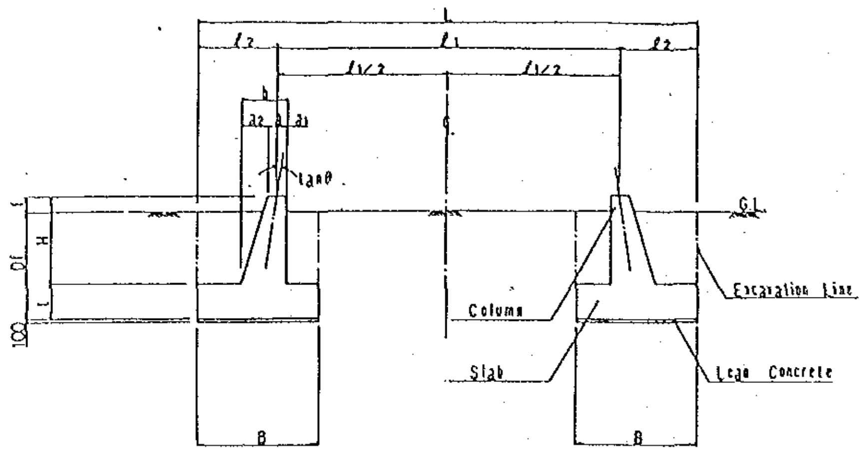
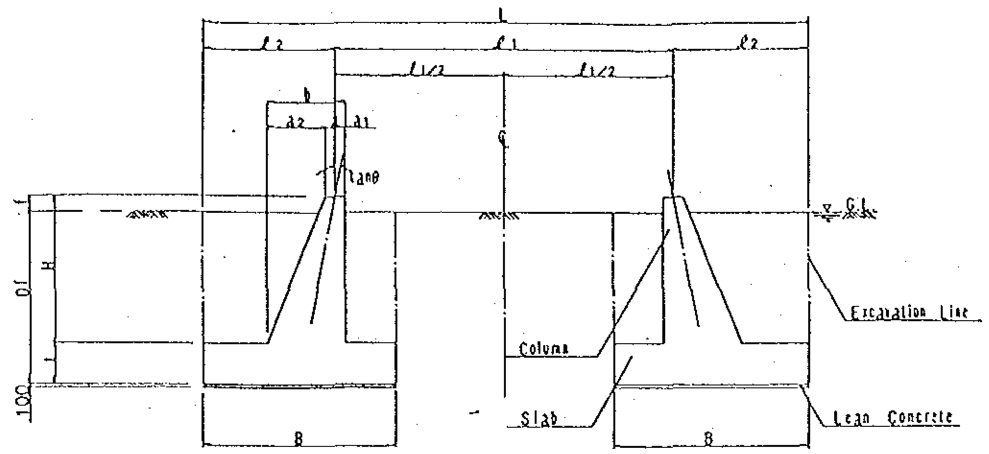
FORM 04



SECTION A - A



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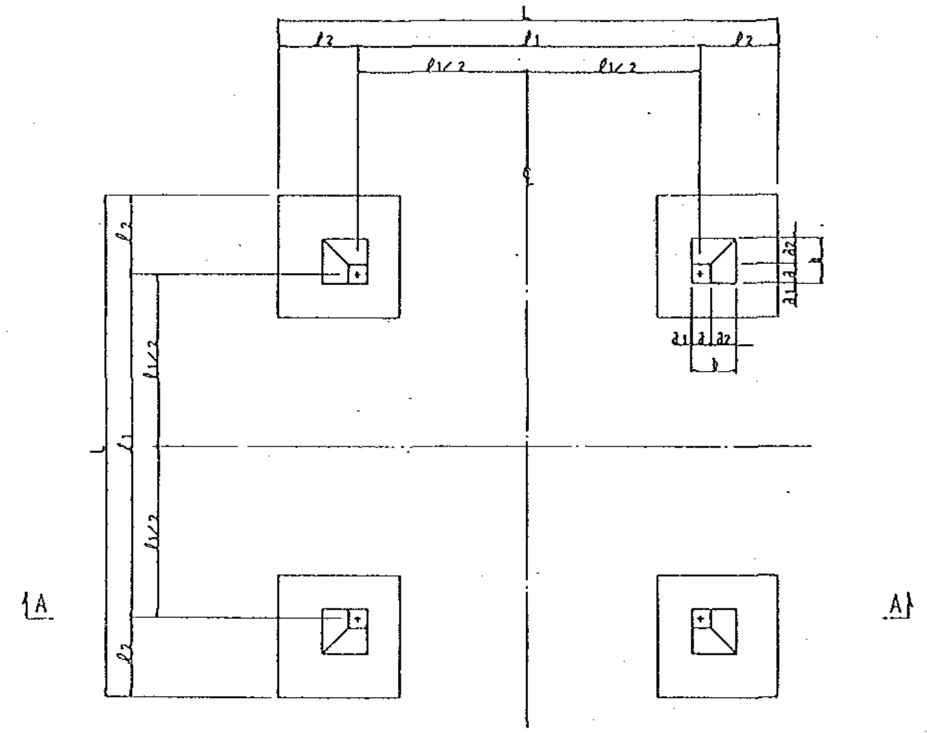
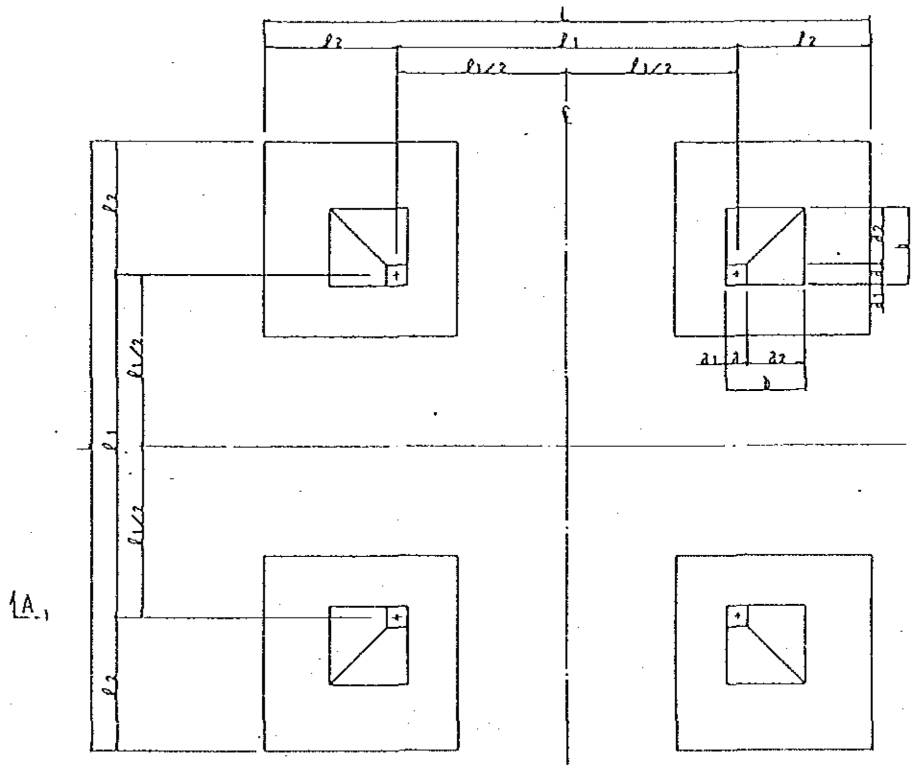


FOUNDATION PLAN



FOUNDATION PLAN

(UNIT : m)

TOWER TYPE	B	H	t	f	Df	a	a_1	a_2	b	tanθ	ℓ_1	$\ell_1/2$	ℓ_2	L	ANGLE SIZE
As-D-I	2.200	1.800	0.800	0.450	2.150	0.450	0.008	0.442	0.900	0.12069	6.891	3.4455	1.4135	9.718	L-150×12
A-D-I	2.300	2.000	0.800	0.450	2.350	0.550	0.006	0.494	1.050	0.12204	8.890	4.4450	1.4915	11.873	L-175×12
B-D-I	2.700	2.000	0.800	0.450	2.350	0.550	0.003	0.597	1.150	0.14865	9.866	4.9330	1.7660	13.398	L-175×12
C-D-I	3.400	2.400	1.000	0.450	2.950	0.600	0.015	0.935	1.150	0.14865	9.866	4.9330	2.2055	14.277	L-200×15
D-D-I	3.400	2.400	1.000	0.450	2.950	0.600	0.015	0.935	1.150	0.19186	9.827	4.9135	2.3520	14.531	L-200×20
DR-D-I	3.900	2.900	1.000	0.450	3.450	0.600	0.019	1.131	1.750	0.19186	9.827	4.9135	2.6980	15.223	L-200×25

INDIVIDUAL TYPE TOWER FOUNDATION (I - DRY)

(UNIT : m)

TOWER TYPE	B	H	t	f	Df	a	a_1	a_2	b	tanθ	ℓ_1	$\ell_1/2$	ℓ_2	L	ANGLE SIZE
As-C-I	4.000	3.000	1.000	0.450	3.550	0.450	0.013	0.737	1.200	0.12069	6.891	3.4455	2.4825	11.856	L-150×12
B-C-I	4.700	3.800	1.000	0.450	4.350	0.550	0.010	1.140	1.700	0.14865	9.866	4.9330	3.0630	15.992	L-175×12
C-C-I	5.600	4.200	1.200	0.450	4.950	0.600	0.020	1.630	2.250	0.14865	9.866	4.9330	3.6025	17.071	L-200×15
D-C-I	5.600	4.200	1.200	0.450	4.950	0.600	0.019	1.631	2.250	0.19186	9.827	4.9135	3.8360	17.499	L-200×20
DR-C-I	6.000	4.900	1.200	0.450	5.650	0.600	0.010	1.690	2.500	0.19186	9.827	4.9135	4.1700	18.167	L-200×25

INDIVIDUAL TYPE TOWER FOUNDATION (I - WET)

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KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2
INDIVIDUAL TYPE TOWER FOUNDATION (I-DRY, I-WET)

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

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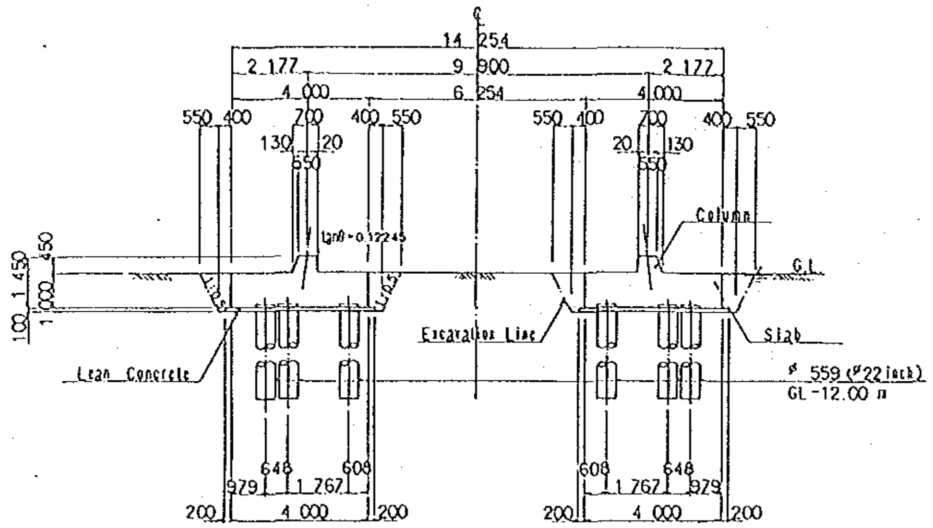
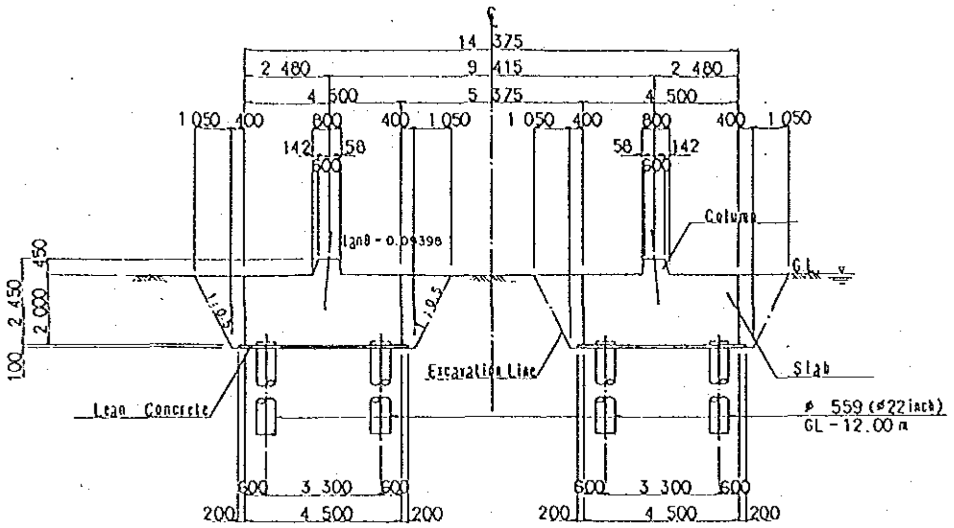


SECTION A - A



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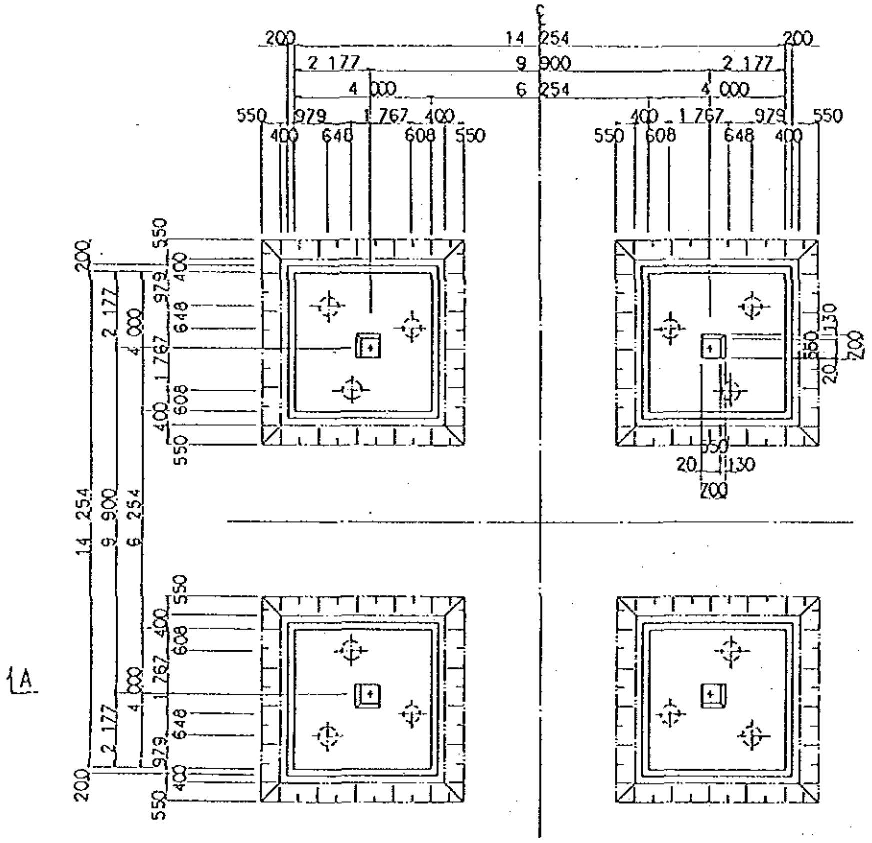
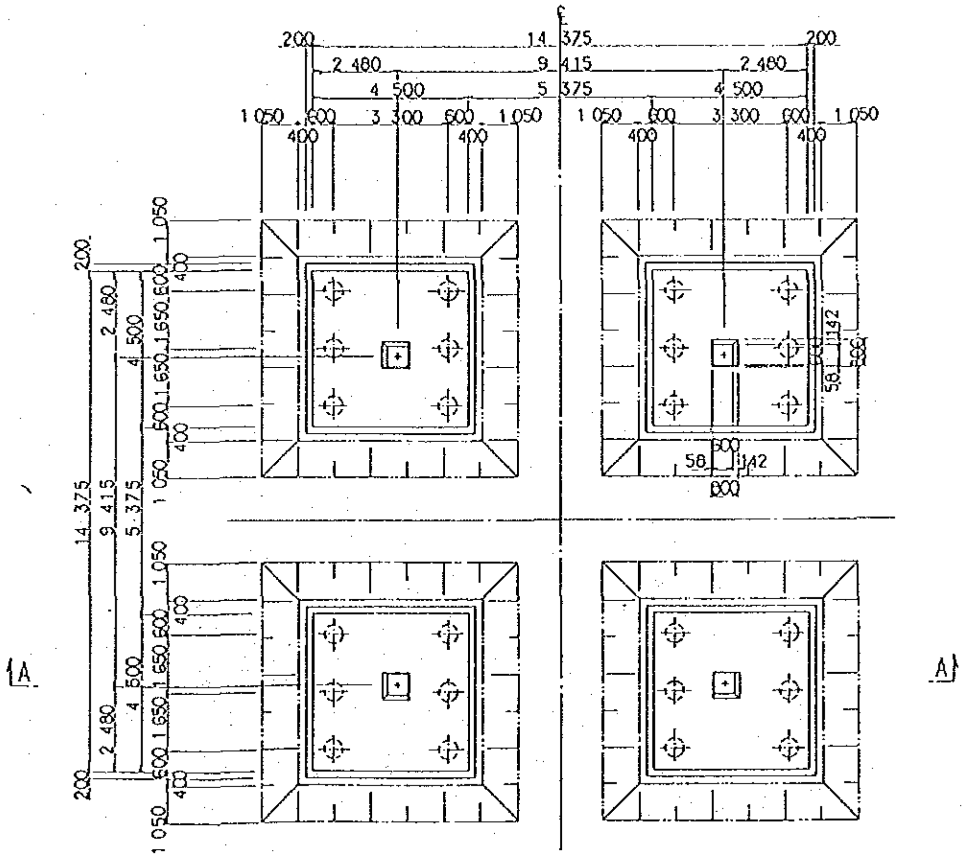


FOUNDATION PLAN
(AL - S - Ⅲ)



FOUNDATION PLAN
(A4 - S - Ⅲ)

PILE TYPE TOWER FOUNDATION (1/2)

PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO.1 AND NO.2
PILE TYPE TOWER FOUNDATION (1/2)

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TOKYO JAPAN

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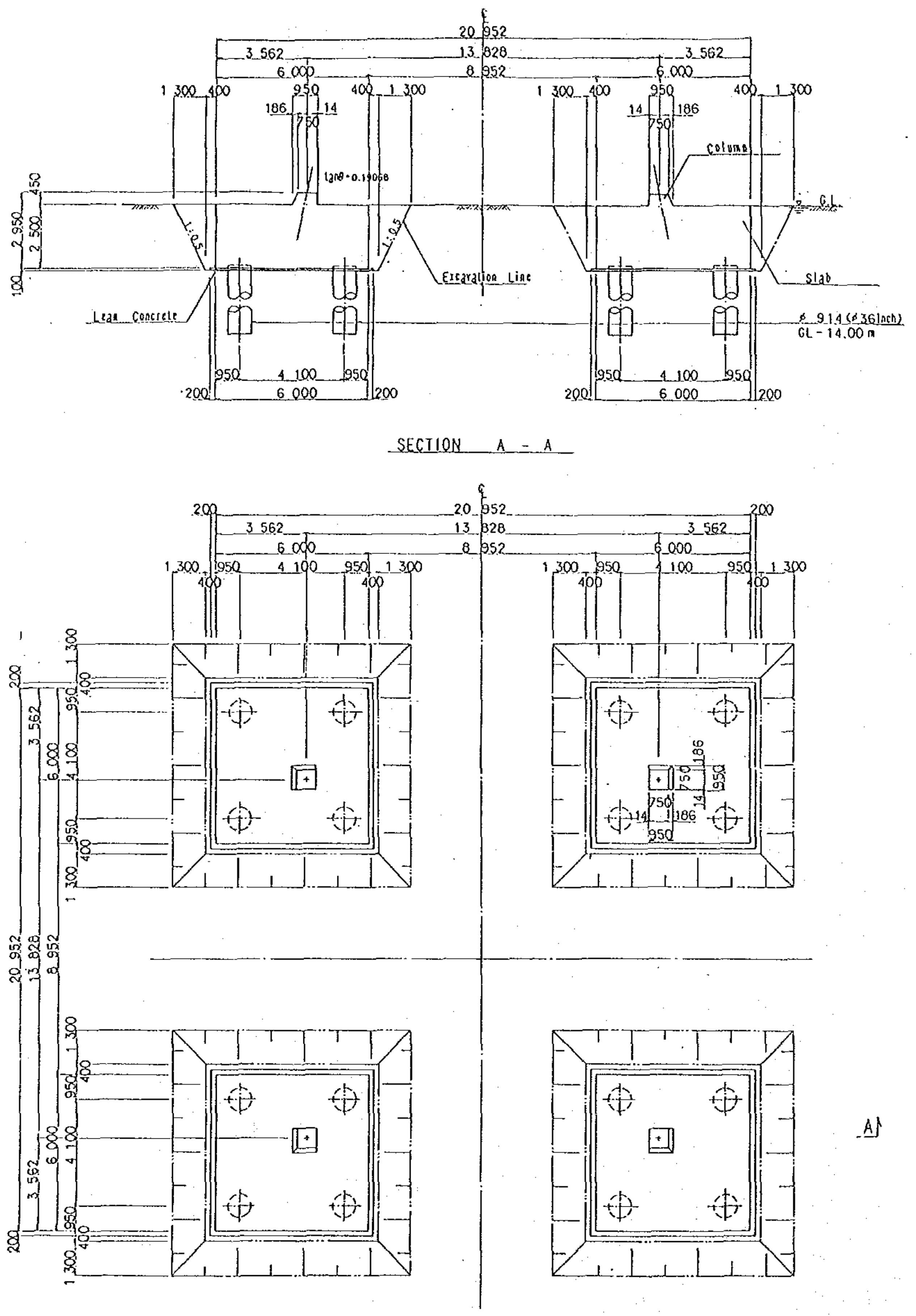

SECTION A - A

FOUNDATION PLAN
(DR4 - S - Ⅲ)
(D4 - S - Ⅲ)

PILE TYPE TOWER FOUNDATION (2/2)

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

PILE TYPE TOWER FOUNDATION (2/2)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

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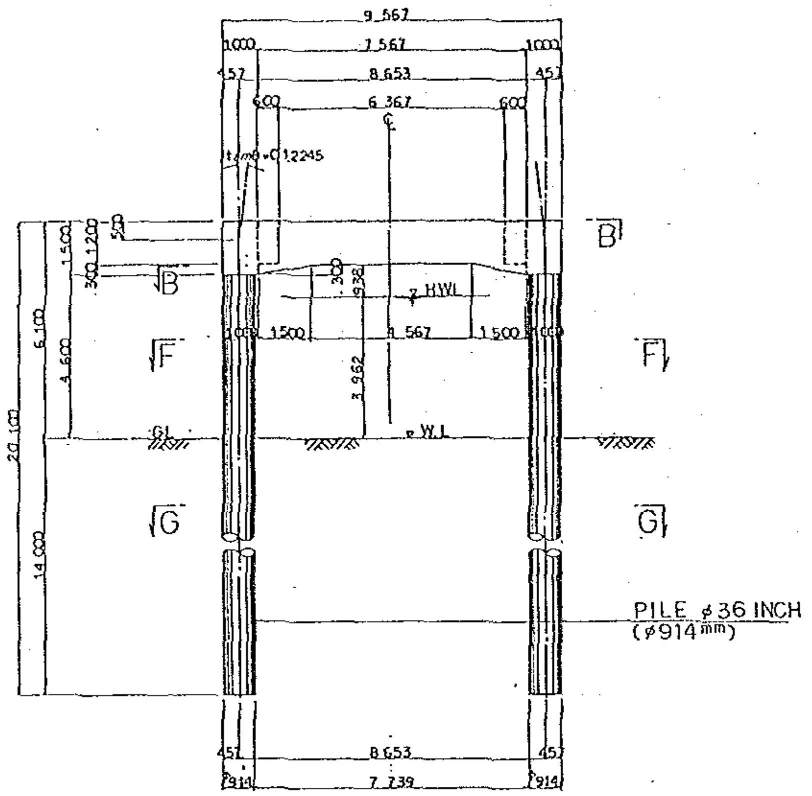
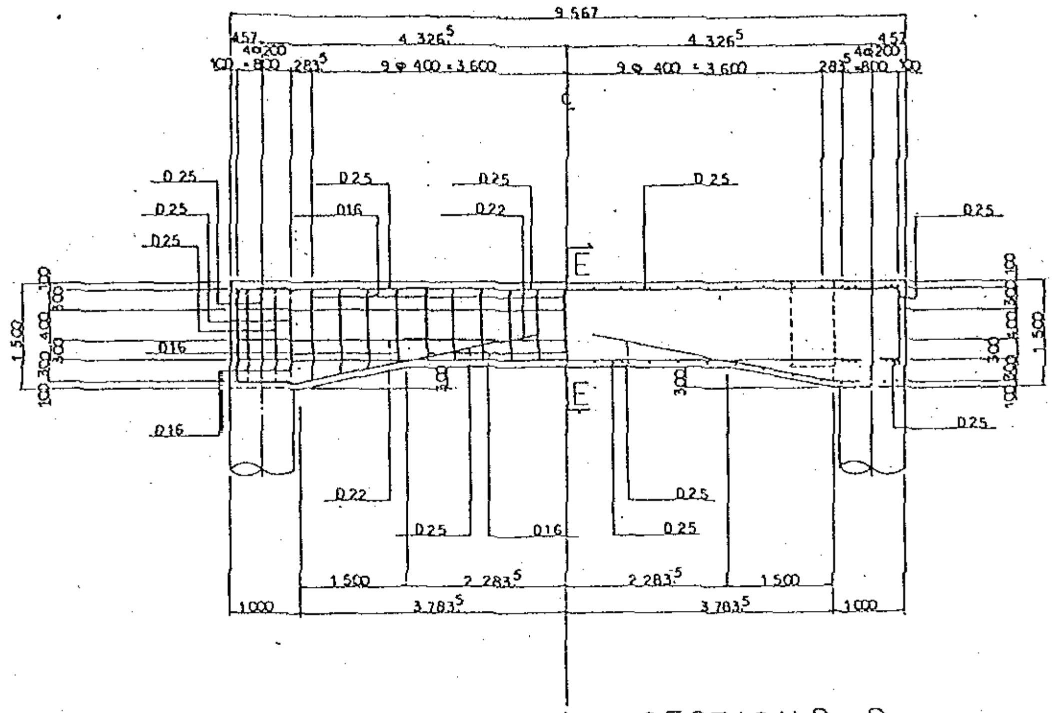
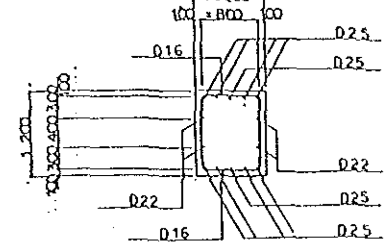


SECTION A - A s=1/100

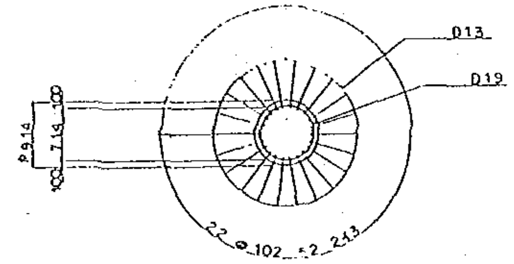


SECTION C - C s=1/50

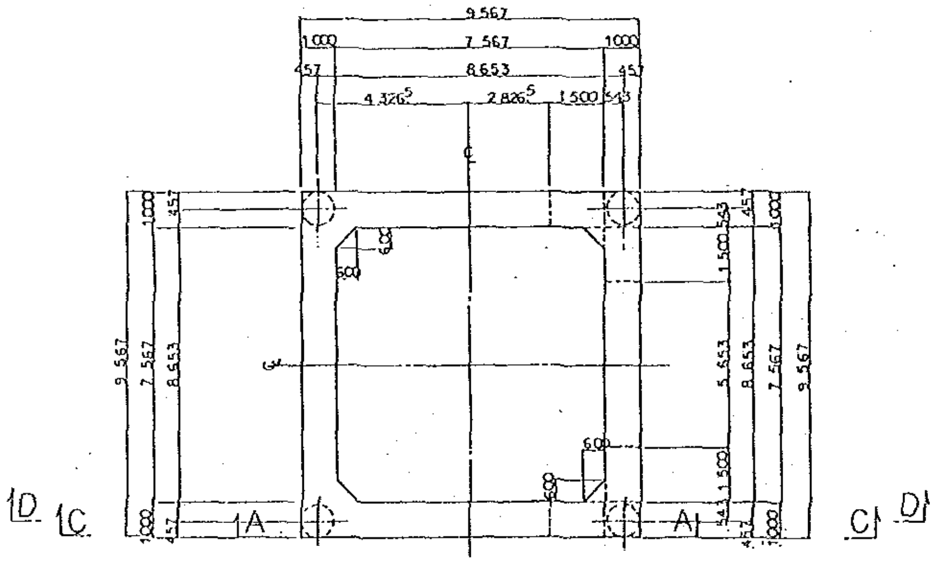
SECTION D - D s=1/50



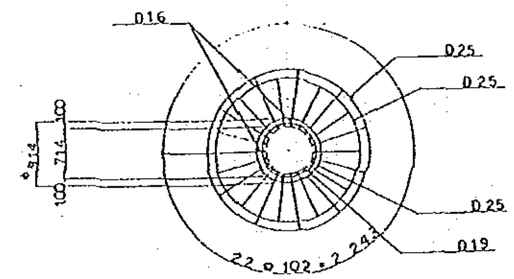
SECTION E - E s=1/50



SECTION F - F s=1/50



SECTION B - B s=1/100



SECTION G - G s=1/50

RIGID FRAME TOWER FOUNDATION (AL-R)

PAKISTAN			
KARACHI ELECTRIC SUPPLY CORPORATION			
WEST WHARF THERMAL POWER PLANT PROJECT			
UNITS NO.1 AND NO.2			
RIGID FRAME TOWER FOUNDATION (AL-R)			
JAPAN INTERNATIONAL COOPERATION AGENCY			
TOKYO JAPAN			
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DRAWING NO. .WLT-1604		SCALE	DATE 10TH JAN 1990

TLG−2 地 中 線

ＴＬＧ－２　地　中　線

目　次

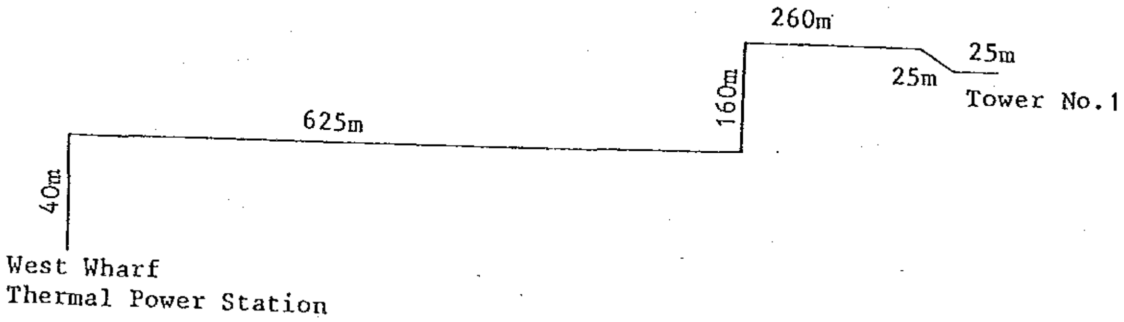
TLG－2　地　中　線

1．地中線ルート

ウエストワーフ火力発電所から鉄塔No.1までの 220kV地中線のルートは、Fig. 1に示す通りである。

全長は約 1.1kmである。

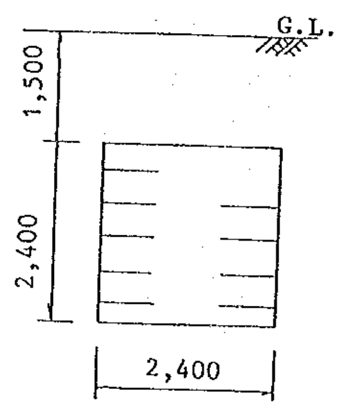
Fig. 1



2．洞道断面

地中線洞道の断面図を Fig. 2に示す。

Fig. 2



3．ケーブルサイズ

架空線のところで行なった計算結果によれば、必要電流容量は 220kVで、1200A，132kVで 720Aである。

従って、ケーブルサイズは 220kVは 1200mm²、132kVは 500mm²とする。

2/70

ケーブル概要は以下の通りである。

220kV 1200mm² OFAZV

中空６分割銅導体ケーブル	
直流抵抗（20℃）	0.0151 Ω/km
絶縁体の熱抵抗率	4.5 ℃m/W
絶縁体の最高許容温度	85 ℃
絶縁体の誘導率	ε＝3.45
絶縁体の誘電正接	tonδ＝00.023
導体内径	12.0 mm
導体外径	43.6 mm
バインダー外径	44.1 mm
導体遮蔽外径	44.7 mm
絶縁厚さ	15.2 mm
コア外径	76.8 mm
アルミシース波高さ	4.8 mm
アルミシース厚さ	2.1 mm
アルミシース外径	91.1 mm
ジャケット外径	101.1 mm
ジャケット材質	ＰＶＣ

132kV 500mm² OFAZV

自己支持銅ケーブル	
直流抵抗（20℃）	0.0366 Ω/km
絶縁体熱抵抗率	4.5 ℃m/W
絶縁体許容温度	85 ℃
絶縁体誘電率	ε＝3.45
絶縁体損失係数	Tanδ＝0.0023
導体内径	12.0 mm
導体外径	27.9 mm
導体遮蔽外径	28.5 mm
絶縁体厚さ	9.1 mm
コア外径	48.4 mm
アルミシースの波高さ	3.8 mm
アルミシースの厚さ	1.6 mm
アルミシースの外径	59.7 mm
ジャケット外径	68.7 mm
ジャケット材質	ＰＶＣ

注）許容電流は IEC 287 に従って計算し、その結果を Table. 1とTable. 2に示す。

Table 1. ALLOWABLE CURRENT OF 220KV CABLE

DESCRIPTION	VALUE
(1) Installation Conditions 220 kV 1 x 1,200 mm2 OFAZV	
(a) Max. conductor temperature	85 °C
(b) Ambient temperature	50 °C
(c) Relative permittivity of insulation material (ε)	3.45
(d) Dielectric loss factor of insulation material (tan δ)	0.0023
(2) D.C. resistance of conductor at 20 °C	0.0151×10^{-3} Ω/m
(3) A.C. resistance of conductor at 85 °C (R)	0.0197×10^{-3} Ω/m
(4) Ratio of losses in metallic sheath to total losses in conductors of cable ($\lambda 1$)	0.1768
(5) Ratio of losses in armour to total losses in conductors of cable ($\lambda 2$)	------
(6) Thermal resistance of :	
(a) Insulation (T1)	0.445 K.m/W
(b) Separation sheath (T2)	----- K.m/W
(c) Outer sheath (T3)	0.151 K.m/W
(d) Surrounding of cable in air (T4)	0.341 K.m/W
(7) Permissible conductor temperature rise above ambient ($\Delta\theta$)	35 °C
(8) Max. dielectric losses (Wd)	4.65 W/m
(9) Max capacitance (C)	399 pF/m
(10) Continuous current carrying capacity per conductor (I)	1255 Amps.

Table 2. ALLOWABLE CURRENT OF 132KV CABLE

DESCRIPTION	VALUE
(1) Installation Conditions 132 kV 1 x 500 mm^2 OFAZV	
(a) Max. conductor temperature	85 °C
(b) Ambient temperature	50 °C
(c) Relative permittivity of insulation material (ε)	3.45
(d) Dielectric loss factor of insulation material ($\tan\delta$)	0.0023
(2) D.C. resistance of conductor at 20 °C	0.0366×10^{-3} Ω/m
(3) A.C. resistance of conductor at 85 °C (R)	0.0469×10^{-3} Ω/m
(4) Ratio of losses in metallic sheath to total losses in conductors of cable ($\lambda 1$)	0.0315
(5) Ratio of losses in armour to total losses in conductors of cable ($\lambda 2$)	------
(6) Thermal resistance of :	
(a) Insulation (T1)	0.455 K.m/W
(b) Separation sheath (T2)	----- K.m/W
(c) Outer sheath (T3)	0.197 K.m/W
(d) Surrounding of cable in air (T4)	0.471 K.m/W
(7) Permissible conductor temperature rise above ambient ($\Delta\theta$)	35 °C
(8) Max. dielectric losses (Wd)	1.76 W/m
(9) Max capacitance (C)	419 pF/m
(10) Continuous current carrying capacity per conductor (I)	790 Amps.

４．洞道内換気

４．１　計算ベース

洞道内の 220kVと 132kVのケーブルによる送電電力は、ウエストワーフ火力発電所の発電容量の20%増しの 480MWとする。

計算は、220kV 1200mm² ２回線と 132kV 500mm² ７回線として行なう。

４．２　ケーブルの発生熱量と洞道内温度

洞道内温度　△T；

$$\Delta T = \sum_{i=1}^{n} W_i . R_t + T_o \quad (℃)$$

W_i　：　ケーブルの発生熱量　(W/cm)

R_T　：　洞道の熱抵抗　(℃·cm/W)

T_o　：　基底温度　(30℃)

$$W_i = I_i^2 r_{aci} (1+P_i). L_{fi} + W_{di}$$

I_i　：　電　流　(A)

r_{aci}：　導体の交流抵抗　(Ω/cm)

P_i　：　金属シースの渦電流損率

L_{fi}　：　損失率

W_{di}　：　誘電体損　(W/cm)

$$R_T = \frac{g \cdot \eta}{2\pi} \log_e \left\{ \frac{2L}{D} + \sqrt{\left(\frac{2L}{D}\right)^2 - 1} \right\} = 13.85℃\cdot cm/W$$

g　：　土壌の固有熱抵抗　(200℃·cm/W)

η　：　地下水による熱抵抗の低減率　(0.3)

L　：　洞道中心までの埋設深さ　(270cm)

D　：　洞道の等価直径

$$D = \sqrt{高さ \times 幅} = 240cm$$

(a) 通 常 時

220kVと 132kVの通電電流をそれぞれ 320Aと 200Aとすると、以下の式が成り立つ。

$$P = (220\times0.35\times2+132\times0.2\times7)\times\sqrt{3}\times0.85 = 479\ (\mathrm{MW})$$

$$W_1 = 350^2\times0.0190\times10^{-5}\ (1+0.177)\ \times1.0+4.65\times10^{-2} = 0.0739\ (\mathrm{W/cm})$$

$$W_2 = 200^2\times0.0451\times10^{-5}\ (1+0.0315)\ \times1.0+1.76\times10^{-2} = 0.0362\ (\mathrm{W/cm})$$

$$\sum_{i=1}^{q} W_i = (W_1\times2+W_2\times7)\ \times3 = 1.204\ (\mathrm{W/cm})$$

(b) 220kV 1回線と 132kV 4回線のみ通電の場合

220kVと 132kVの通電電流をそれぞれ 600Aと 370Aとすると、以下の式が成り立つ。

$$P = (220\times0.6+132\times0.37\times4)\ \times\sqrt{3}\times0.85 = 482\ (\mathrm{MW})$$

$$W_1 = 600^2\times0.0190\times10^{-5}\ (1+0.177)\ \times1.0+4.65\times10^{-2} = 0.127\ (\mathrm{W/cm})$$

$$W_2 = 370^2\times0.0451\times10^{-5}\ (1+0.0315)\ \times1.0+1.76\times10^{-2} = 0.0813\ (\mathrm{W/cm})$$

$$\sum_{i=1}^{q} W_i = (W_1+W_2\times4)\ \times3 = 1.357\ (\mathrm{W/cm})$$

洞道内温度

$$\triangle T = 1.357\times13.85+30 = 48.8 < 50\ (℃)$$

以上より、冷却システムを設置しなくても大丈夫であるが、排気塔を1つ設けて自然通風を行ない、保守員の酸欠防止を図ることとする。

5．油圧タンク

5．1　絶縁油の量

ルート全体に亘って高低差があまりないので、PT-PT システムが適切である。各部の標準油量と温度変化による油量変化を次に示す。

		標準油量	温度変化	数　量	油量変化量
ケーブル	導体＋½絶縁体	1,100 ℓ/km	60(85～25)	1.1km	58.1 ℓ
	そ　の　他	1,600 ℓ/km	50(75～25)	1.1km	70.4 ℓ
ジョイントボックス		60 ℓ/個	60(85～25)	2	5.8 ℓ
気中ケーブルヘッド		180 ℓ/km	35(60～25)	2	10.0 ℓ
油　圧　タ　ン　ク		12 ℓ/セル	20(45～25)	Nセル	0.192N ℓ

油量の全変化量は

144.3 ＋ 0.192 N ℓ

5．2　負荷遮断時の絶縁油温度

導体温度

$$Tc = \frac{I^2 R_{20} R_{th}\ n(1-20\alpha)+Te+Td'}{1-I^2 \cdot R_{20} \cdot R_{th} \cdot n}$$

$$= \frac{1200^2 \times 0.0157 \times 10^{-5} \times 70.4 \times 1 \times (1-20 \times 0.00393)+25+2.1}{1-1200^2 \times 0.0157 \times 10^{-5} \times 70.4 \times 1 \times 0.00393}$$

$= 44.6$　(℃)

シース温度

$$Ts = I^2\ R_{20}\ \{1+\alpha(Tc-20)\}\ (R_{th}-T_1)\ n+Te+Td'$$

$$= 1200^2 \times 0.0157 \times 10^{-5}\ \{1+0.00393(44.6-20)\}\ (70.4-44.5)$$

$+25+2.1 = 33.5$　(℃)

絶縁油の温度

$T_{oil}(Tc-Ts)/2 = (44.6+3.5)/2 = 39.1$　(℃)

但し、

- I　：電　流　(A)
- R_{20}　：20℃での交流抵抗　(Ω/cm)
- Rth　：合計熱抵抗 (℃·cm/W)
- n　：導体数
- α　：20℃時のケルビン当りの定質量温度係数
- Te　：大地最低温度　(℃)
- Td'　：誘電体損による温度上昇　(℃)
- T_1　：絶縁体の熱抵抗　(℃·cm/W)

5．3　オイルデマンド

$$a = ao \cdot W = ao \cdot n(I^2R + Wd)$$

$$= 24 \times 1 \times [1200^2 \times 0.0157 \times 10^{-5} \times \{1 + 0.00393(39.1 - 20)\} + 0.0465]$$

$$= 6.96 \times 10^{-5} \quad (cm^3/cm \cdot sec)$$

但し、

- ao　：　単位損失当りのオイルデマンド　(cm^3/cm·sec·W)
- W　：　遮断時の負荷損失　(W/cm)
- R　：　油温時の導体交流抵抗　(Ω/cm)
- Wd　：　誘電体損失 (W/cm)

5．4　油流抵抗

$$b = 0.815 \times \frac{\eta}{n \pi r^4} \times 10^{-4}$$

$$= 0.185 \times \frac{7.4}{1 \times \pi \times 0.6^4} \times 10^{-4} = 14.81 \times 10^{-4} \quad (g \cdot sec/cm^3)$$

但し、

- η　：　絶縁油の粘度　(Cp)
- r　：　油通路半径　(cm)
- n　：　油通路数

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５．５　油圧の過渡変化

Fig. 4 参照

$$\Delta P = \frac{1}{2} abL^2$$

$$= \frac{1}{2} \times 6.96 \times 10^{-5} \times 14.81 \times 10^{-4} \times \left(\frac{1.1 \times 10^5}{2}\right)^2 \times 10^{-3} = 0.16 \ (kg/cm^2)$$

$$P_{minB} = P_s + h_1 \rho + \Delta P$$
$$= 0.2 + (4-1) \times 0.087 + 0.16 = 0.62 \quad (kg/cm^2 \cdot G)$$
$$= 1.65 \quad (kg/cm^2 \cdot abs)$$

$$P_{minA} = P_{minB} + h_2 \rho$$
$$= 0.68 + (4-1.5) \times 0.087 = 0.9 \quad (kg/cm^2 \cdot G)$$
$$= 1.93 \quad (kg/cm^2 \cdot abs)$$

$$P_{maxA} = P_M - h_3 \rho$$
$$= 4.5 - (4-1.5) \times 0.087 = 4.28 \quad (kg/cm^2 \cdot G)$$
$$= 5.31 \quad (kg/cm^2 \cdot abs)$$

$$P_{maxB} = P_{maxA} - h_4 \rho$$
$$= 4.28 - (1.5+1) \times 0.087 = 4.06 \quad (kg/cm^2 \cdot G)$$
$$= 5.09 \quad (kg/cm^2 \cdot abs)$$

但し、

- ΔP ： 油圧の過渡変化　(kg/cm^2)
- P_{minA} ： オイルタンクＡの最低油圧
- P_{minB} ： オイルタンクＢの最低油圧
- P_{maxA} ： オイルタンクＡの最高油圧
- P_{maxB} ： オイルタンクＢの最高油圧
- L ： オイルタンク当りのケーブル長　(cm)
- P_s ： 最低油圧の余裕　$(kg/cm^2 \cdot G)$
- P_M ： 油圧タンクの最大許容圧力 $(kg/cm^2 \cdot G)$
- ρ ： 油の比重
- $h_1, h_2, h_3 h_4$ ： 高低差　(m)

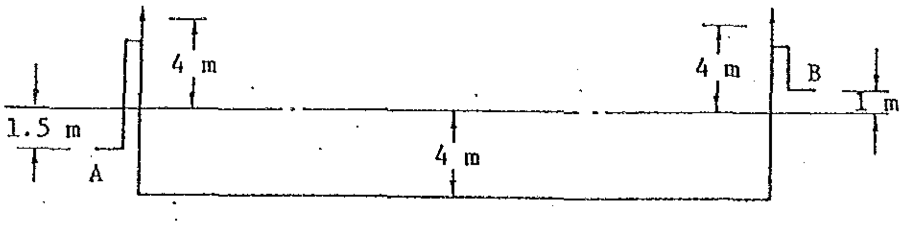


Fig. 4

5．6　必要セル数

セル１個当りの過渡油圧変化吸収量

$$Pa = Cg\left(\frac{K_{25}}{P_{min}} - \frac{K_{45}}{P_{max}}\right) - \triangle C$$

Ｃg　：与圧比 1.5のガス定数

K_{25}　：25℃の絶対温度

K_{45}　：45℃の絶対温度

△Ｃ　：セル１個当りの変化油量

$$PaA = 0.0646\left(\frac{298}{1.93} - \frac{318}{5.31}\right) - 0.192 = 5.91 \quad (\ /\text{セル})$$

$$PaB = 0.0646\left(\frac{298}{1.65} - \frac{318}{5.09}\right) - 0.192 = 7.44 \quad (\ /\text{セル})$$

$$N > \frac{167.6+100}{5.91+7.44} = 20$$

$$N = 25$$

タンク寸法を Fig. 5に示す。

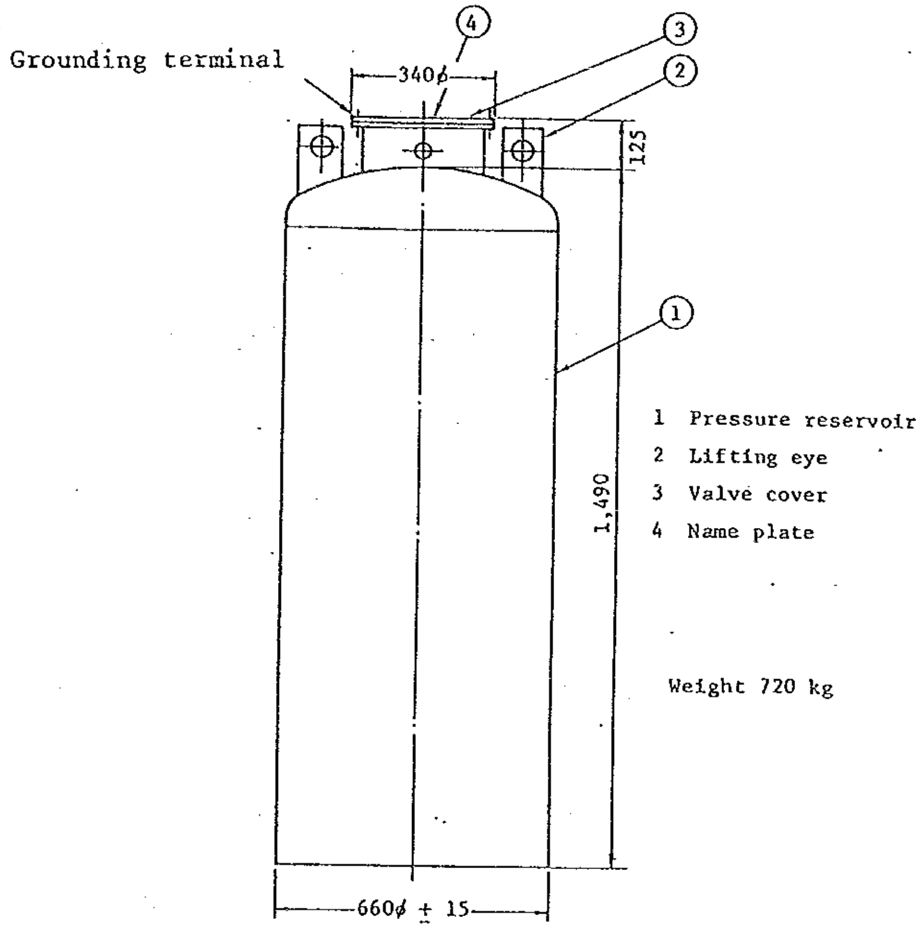


Fig. 5 Pressure Tank (Buried Type)
(Prepressure ratio 1.0 - 1.5)

TLG－3 洞道構造設計

TLG－3 洞道構造設計

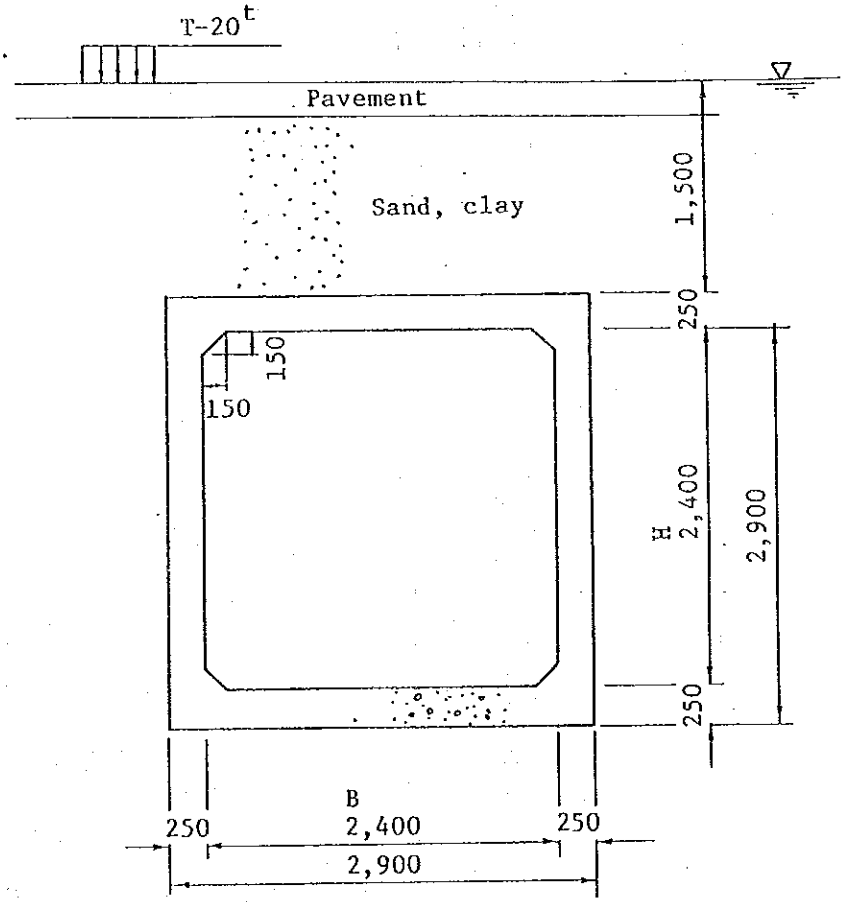
目　　次

ＴＬＧ－３　洞道構造設計

１．洞道構造設計

１．１　設計条件

- 洞道内容寸法 (B)2.4m × (H)2.4m
- ハンチ　150mm × 150mm
- 土被り(Ｄ．Ｐ)　1.5m (標準部；人孔取付部は土被り 1.5mより大)
- 許容応力度設計法準拠
- コンクリート・鉄筋許容応力度　日本土木学会準拠
- 路面交通荷重　Ｔ－20ｔ
- 舗装重量考慮
- 地下水位　　地表面とする。
- 土質は砂質土とし、土水分離にて載荷。



1．2 荷　　重

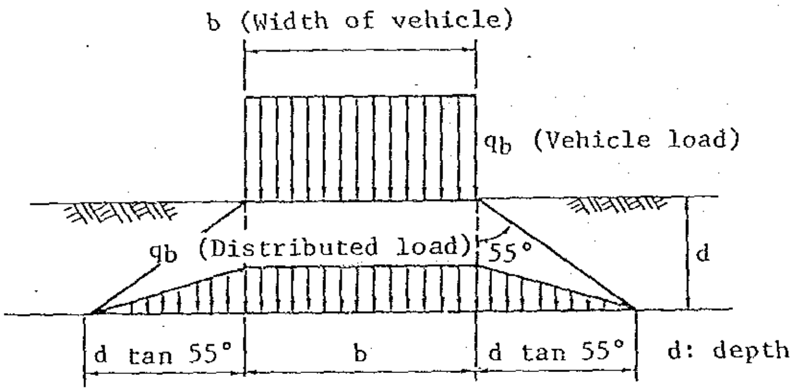
荷重としては、路面交通荷重、舗装荷重、土圧、水圧を載荷した。

路面交通荷重は、下表により 2.75t/m² とした。

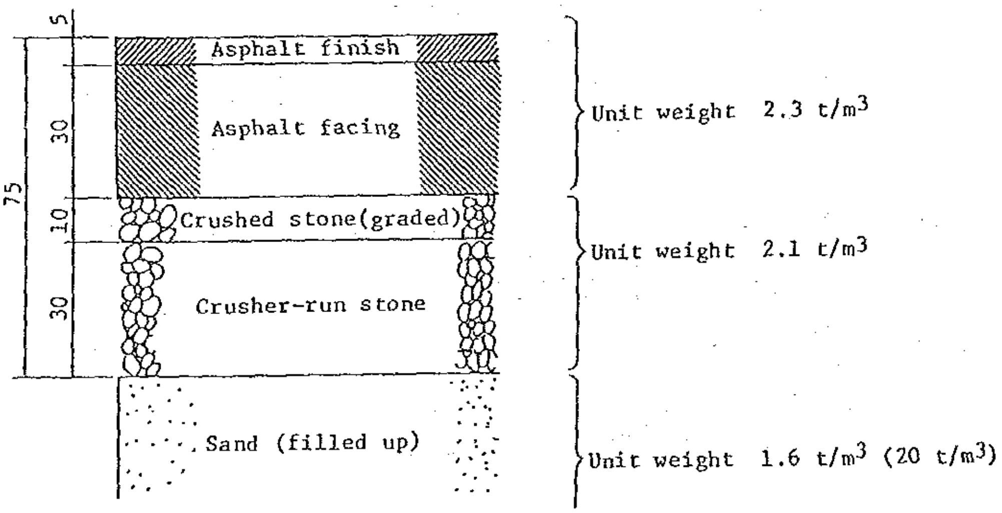
Table 1

Depth (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.5	9.0	10.0
Traffic load (ton/m^2)	4.50	2.75	2.05	1.50	1.20	1.15	1.10	1.05	0.95

Fig. 2



舗装重量は、下図の舗装形状により算出した。



土の単位体積重量は、下記のとおりである。

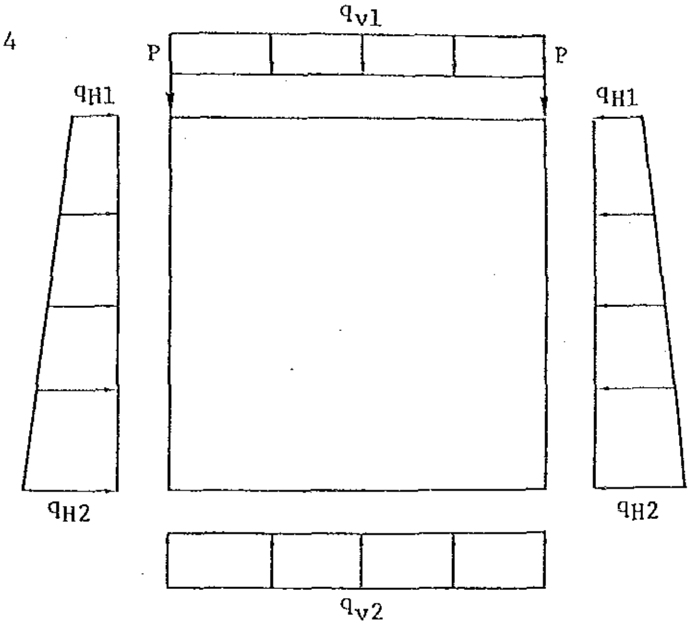
埋戻し土　　：　$r_t = 2.0\ t/m^3$

地盤(砂質土)：　$r_t = 2.0\ t/m^3$　　　$K_o = 0.5$

$r' = 1.1\ t/m^3$

以上より、構造計算に用いる荷重を以下のように算出した。

Fig. 4



鉛直土圧

$q_{ve} = 2.75+2.3\times0.35+2.1\times0.4+2.0\times0.75 = 5.895\ t/m^2$

水平土圧

$q_{He1} = 0.5\times(2.75+2.3\times0.35+2.1\times0.4+1.1\times0.875) = 2.679\ t/m^2$

$q_{He2} = 2.679+0.5\times(1.1\times2.65) = 4.137\ t/m^2$

水平水圧

$q_{HW1} = 1.0\times1.625 = 1.625\ t/m^2$

$q_{HW2} = 1.0\times4.275 = 4.275\ t/m^2$

自　重

頂版　$q_g = 2.5\times0.25 = 0.625\ t/m^2$

側壁　$P = 2.5\times0.25\times2.65 = 1.656\ t$

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底版反力

$$q_{v2} = q_{ve} + q_s + 2 \times P/2.65 = 7.770\ t/m^2$$

以上より、載荷荷重は以下のとおりである。

$$q_{v1} = q_{ve} + q_s = 6.520\ t/m^2$$

$$q_{v2} = 7.770\ t/m^2$$

$$q_{H1} = q_{He1} + q_{HW1} = 4.304\ t/m^2$$

$$q_{H2} = q_{He2} + q_{HW2} = 8.412\ t/m^2$$

$$P = 1.656\ t$$

1．3　断面力計算結果

(1) 側　壁

	M (TON-M)	Q (TON)	N (TON)		
0-	3.6200	-7.2674	-10.2950		
1-	2.7457	-6.7172	-10.2950	1	Support (face)
2-	2.5792	-6.6043	-10.2950	2	Haunch (starting point)
3-	1.7896	-6.0251	-10.2950		
4-	-0.1749	-4.0758	-10.2950		
5-	-1.6301	-0.2038	-10.2950		
6-	-0.2947	4.3486	-10.2950	3	Center
7-	1.9599	7.3267	-10.2950		
8-	2.9386	8.3370	-10.2950		
9-	3.1496	8.5420	-10.2950		
10-	4.2820	9.5813	-10.2950	4	Haunch (starting point)
				5	Support

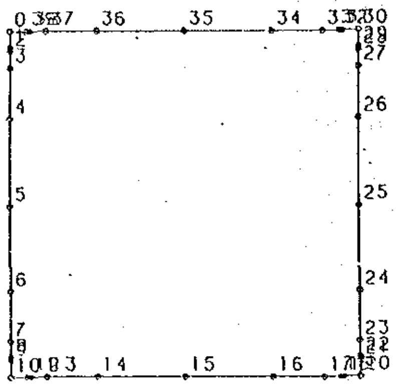
(2) 底　版

	M (TON-M)	Q (TON)	N (TON)		
10-	4.2820	-10.2953	-9.5813		
11-	3.0558	-9.3240	-9.5813	1	Support (face)
12-	2.8252	-9.1297	-9.5813	2	Haunch (starting point)
13-	1.7446	-8.1585	-9.5813		
14-	-0.8334	-5.1476	-9.5813		
15-	-2.5386	0.0000	-9.5813		
16-	-0.8334	5.1476	-9.5813	3	Center
17-	1.7446	8.1585	-9.5813		
18-	2.8252	9.1297	-9.5813		
19-	3.0558	9.3240	-9.5813		
20-	4.2820	10.2952	-9.5813		

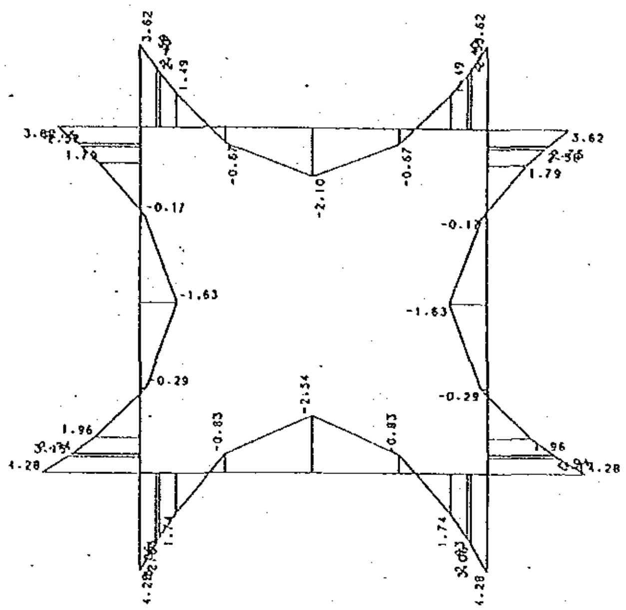
(3) 頂　版

	M (TON-M)	Q (TON)	N (TON)		
30-	3.6200	-8.6390	-7.2674		
31-	2.5911	-7.8240	-7.2674	1	Support (face)
32-	2.3975	-7.6610	-7.2674	2	Haunch (starting point)
33-	1.4908	-6.8460	-7.2674		
34-	-0.6725	-4.3195	-7.2674		
35-	-2.1033	0.0000	-7.2674		
36-	-0.6725	4.3195	-7.2674	3	Center
37-	1.4908	6.8460	-7.2674		
38-	2.3975	7.6610	-7.2674		
39-	2.5911	7.8240	-7.2674		
0-	3.6200	8.6390	-7.2674		

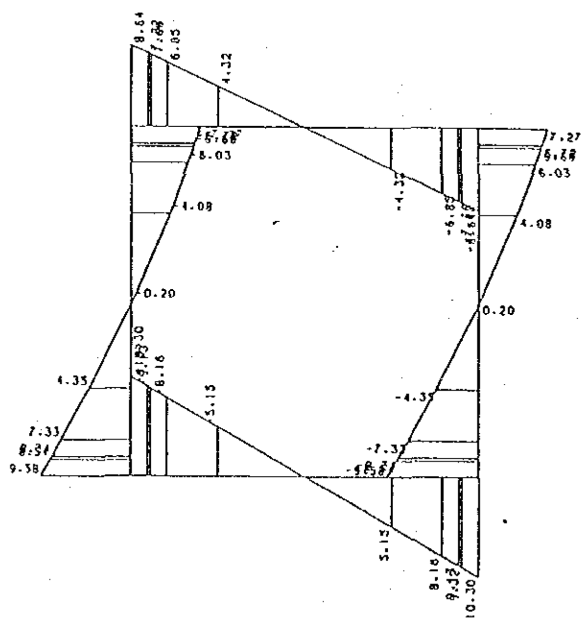
図面



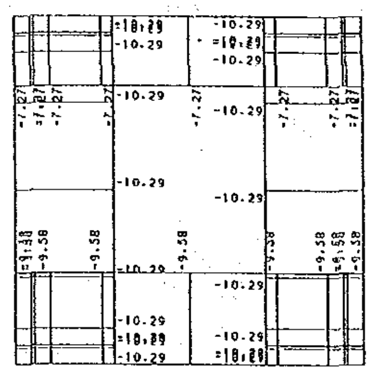
INPUT FIGURE



BENDING MOMENT



SHEARING FORCE



AXIAL FORCE

1．4　応力度計算結果

(1) 側　壁

Section No.		1-(1) Upper support (face)	1-(2) Upper haunch starting point)
M	(t.m)	3.62	2.75
N	(t)	10.30	10.30
S	(t)	6.72	6.60
b	(cm)	100.0	100.0
h	(cm)	30.0	25.0
d	(cm)	25.0	20.0
d'	(cm)	10.0	5.0
As	(cm2)	6.620	6.620
As'	(cm2)	4.223	4.223
n =	Es/Ec	15.00	15.00
P=As/(b*d)	(%)	0.265	0.331
u=d-h/2	(cm)	10.000	7.500
f=M/N+u	(cm)	45.163	34.170
f/d		1.807	1.709
d'/d		0.400	0.250
As'/As		0.638	0.638
M'=M+N*u	(t.m)	4.650	3.518
x	(cm)	8.268	7.073
C		0.000	6.137
S		0.000	11.216
Z		0.000	1.082
c	(kg/cm2)	51.7	54.0
s	(kg/cm2)	1568.6	1479.6
s'	(kg/cm2)	162.3	237.3
	(kg/cm2)	0.00	3.57
m	(kg/cm2)	2.69	3.30
ca	(kg/cm2)	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0
a	(kg/cm2)	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-) denotes tenior
m: mean shear stress

外側　D16　@ 300 = 6.62 cm^2

内側　D13　@ 300 = 4.223 cm^2

Section No.		1-(3) Center	1-(4) Bottom haunch (starting point)	1-(5) Bottom support (face)
M	(t.m)	1.70	3.15	4.28
N	(t)	10.30	10.30	10.30
S	(t)	0.00	8.34	8.54
b	(cm)	100.0	100.0	100.0
h	(cm)	25.0	25.0	30.0
d	(cm)	20.0	20.0	25.0
d'	(cm)	5.0	5.0	10.0
As	(cm2)	4.223	10.843	10.843
As'	(cm2)	6.620	4.223	4.223
n =	Es/Ec	15.00	15.00	15.00
P=As/(b*d)	(%)	0.211	0.542	0.434
u=d-h/2	(cm)	7.500	7.500	10.000
f=M/N+u	(cm)	24.013	38.094	51.593
f/d		1.201	1.905	2.064
d'/d		0.250	0.250	0.400
As'/As		1.568	0.389	0.389
M'=M+N*u	(t.m)	2.472	3.922	5.312
x	(cm)	7.310	8.138	9.424
C		5.805	5.405	0.000
S		10.077	7.878	0.000
Z		1.012	1.114	0.000
c	(kg/cm2)	35.9	53.0	51.9
s	(kg/cm2)	934.2	1158.5	1285.7
s'	(kg/cm2)	170.1	306.5	47.5
	(kg/cm2)	0.00	4.64	0.00
m	(kg/cm2)	0.00	4.17	3.42
ca	(kg/cm2)	90.0	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0	1800.0
a	(kg/cm2)	4.50	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-) denotes tension
m: mean shear stress

外側 D16, D13 交互 @ 150 = 10.834 cm^2

内側 D13 @ 300 = 4.223 cm^2

(2) 底 版

Section No.		2-(1) Support (face)	2-(2) Haunch (starting point)	2-(3) Center
M	(t.m)	4.28	3.06	2.54
N	(t)	9.58	9.58	9.58
S	(t)	9.32	9.13	0.00
b	(cm)	100.0	100.0	100.0
h	(cm)	30.0	25.0	25.0
d	(cm)	25.0	20.0	20.0
d'	(cm)	10.0	5.0	5.0
As	(cm2)	10.843	10.843	6.620
As'	(cm2)	6.620	6.620	10.843
n =	Es/Ec	15.00	15.00	15.00
P=As/(b*d)	(%)	0.434	0.542	0.331
u=d-h/2	(cm)	10.000	7.500	7.500
f=M/N+u	(cm)	54.691	39.393	33.995
f/d		2.188	1.970	1.700
d'/d		0.400	0.250	0.250
As'/As		0.611	0.611	1.638
M'=M+N*u	(t.m)	5.240	3.774	3.257
x	(cm)	9.314	7.965	6.876
C		0.000	5.361	5.923
S		0.000	8.101	11.304
Z		0.000	1.119	1.089
c	(kg/cm2)	52.0	50.6	48.2
s	(kg/cm2)	1312.5	1146.6	1380.7
s'	(kg/cm2)	57.4	282.4	197.4
	(kg/cm2)	0.00	5.11	0.00
m	(kg/cm2)	3.73	4.56	0.00
ca	(kg/cm2)	90.0	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0	1800.0
a	(kg/cm2)	4.50	4.50	4.50

外側　D16，D13 交互　@ 150 ＝ 10.843 cm^2

内側　D16　@ 300 ＝ 6.62 cm^2

※ ハンチ始点において、許容せん断応力度を上回るため、スターラップにて補強を行う。

(3) 頂 版

Section No.		3-(1) Support (face)	3-(2) Haunch (starting point)	3-(3) Center
M	(t.m)	3.62	2.59	2.10
N	(t)	7.27	7.27	7.27
S	(t)	7.82	7.66	0.00
b	(cm)	100.0	100.0	100.0
h	(cm)	30.0	25.0	25.0
d	(cm)	25.0	20.0	20.0
d'	(cm)	10.0	5.0	5.0
As	(cm2)	6.620	6.620	4.223
As'	(cm2)	4.223	4.223	6.620
n =	Es/Ec	15.00	15.00	15.00
P=As/(b*d)	(%)	0.265	0.331	0.211
u=d-h/2	(cm)	10.000	7.500	7.500
f=M/N+u	(cm)	59.812	43.154	36.442
f/d		2.392	2.158	1.822
d'/d		0.400	0.250	0.250
As'/As		0.638	0.638	1.568
M'=M+N*u	(t.m)	4.347	3.136	2.648
x	(cm)	7.660	6.572	5.811
C		0.000	6.579	7.332
S		0.000	13.442	17.903
Z		0.000	1.092	1.061
c	(kg/cm2)	52.3	51.6	48.5
s	(kg/cm2)	1776.7	1580.9	1778.0
s'	(kg/cm2)	239.7	185.1	101.6
	(kg/cm2)	0.00	4.18	0.00
m	(kg/cm2)	3.13	3.83	0.00
ca	(kg/cm2)	90.0	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0	1800.0
a	(kg/cm2)	4.50	4.50	4.50

外側 D16 @ 300 = 6.62 cm^2

内側 D13 @ 300 = 4.223 cm^2

1．5　スターラップの計算

必要なスターラップの断面積　req Av

$$Sc = 1/2 \times 4.5 \times 100 \times 0.875 \times 20 \times 10^{-3} = 3.938\ t$$

$$Sv = 9.13 - 3.938 = 5.192\ t$$

$$\text{req Av} = \frac{Sv \cdot S}{\sigma_{sa} \cdot j \cdot d} = \frac{5.192 \times 10^3 \times 15}{1800 \times 0.875 \times 20}$$

$$= 2.472\ cm^2 < D13\ @\ 300 = 4.223 cm^2$$

よって、スターラップはD13を 15cm間隔で 300ピッチで配筋する。

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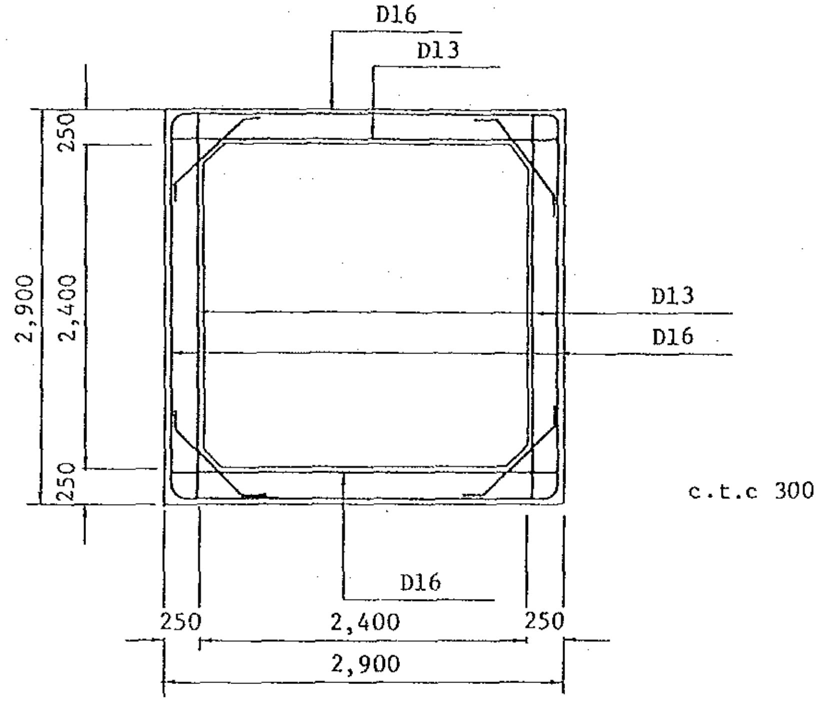
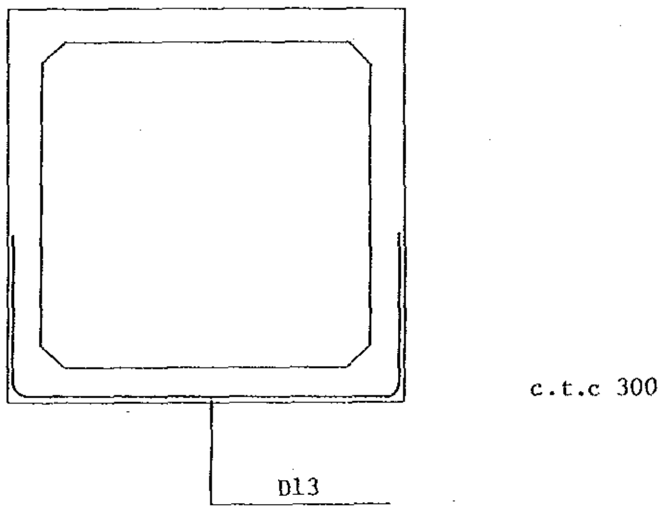
1．6 結　果

以上より決定した壁厚及び主鉄筋組合せを下に示す。



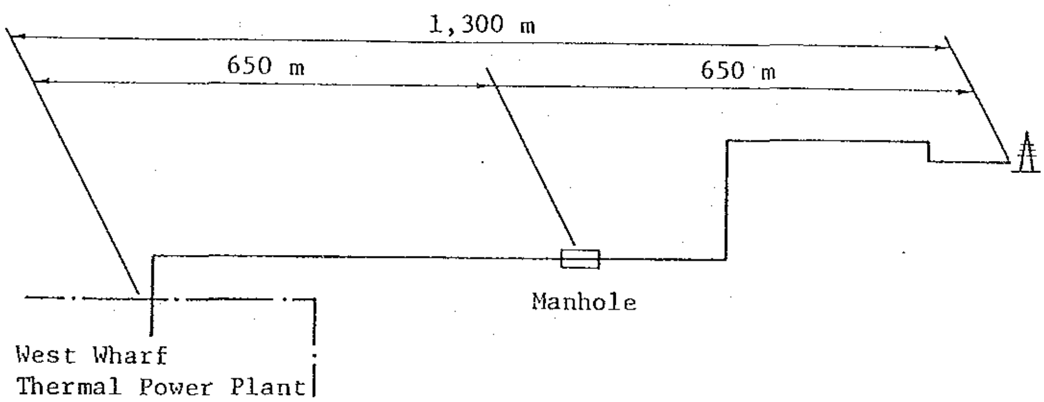


壁厚 250mmを想定して計算の結果、上記配筋にてもつため、壁厚 250mmで決定した。

２．人　孔

２．１　人孔位置

・ 人孔 ─> ケーブルジョイント部（保守要員の緊急脱出口を兼ねる）
・ 人孔位置 ─> ケーブル長・人孔設置位置の外的条件より決定
・ 1,300ｍのケーブル製造・運搬・引入れが可能であれば人孔必要なし。
・ 上記を満足しない場合 ─> ルート中間に人孔１個でＯＫ。



・ 換気計画スパンを２スパンにする場合は、人孔位置に換気口を設置する。

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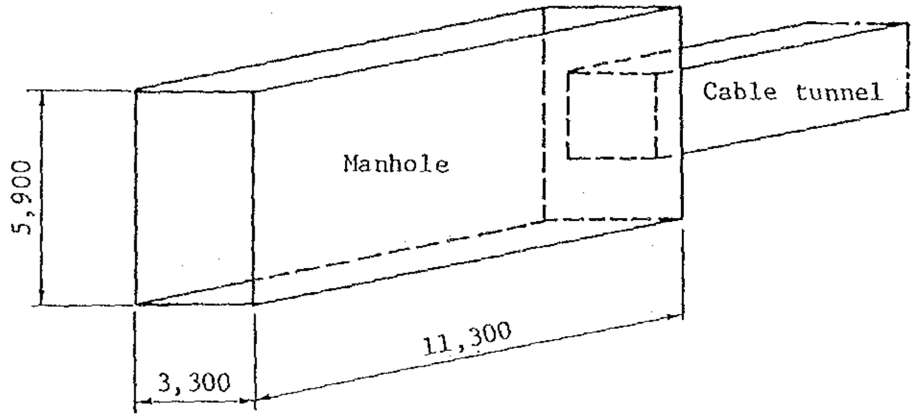
2．2　人孔規模

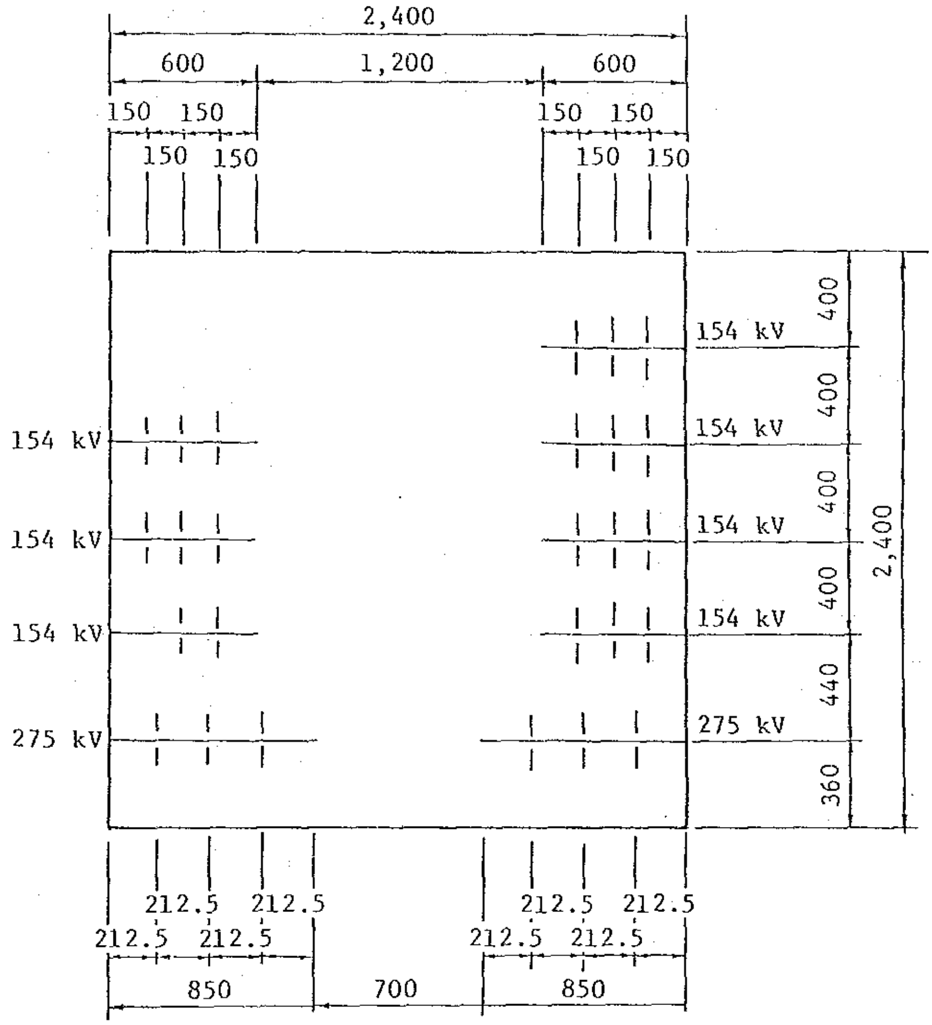
- 東電 275kV及び 154kVケーブルを参考に、躯形人孔とする場合の人孔内空寸法を検討。（別添参照）
- 人孔内空寸法　(B)3.3m × (H)5.9m × (L)11.3m
- ケーブル引入れ用の首（φ750～φ900）が必要。



- 人孔内空寸法は主にケーブルジョイント部の大きさ、およびケーブル許容湾曲半径より決まる。

洞道内ケーブル配置図

※ ケーブル電圧は 275kV, 154kVとする。



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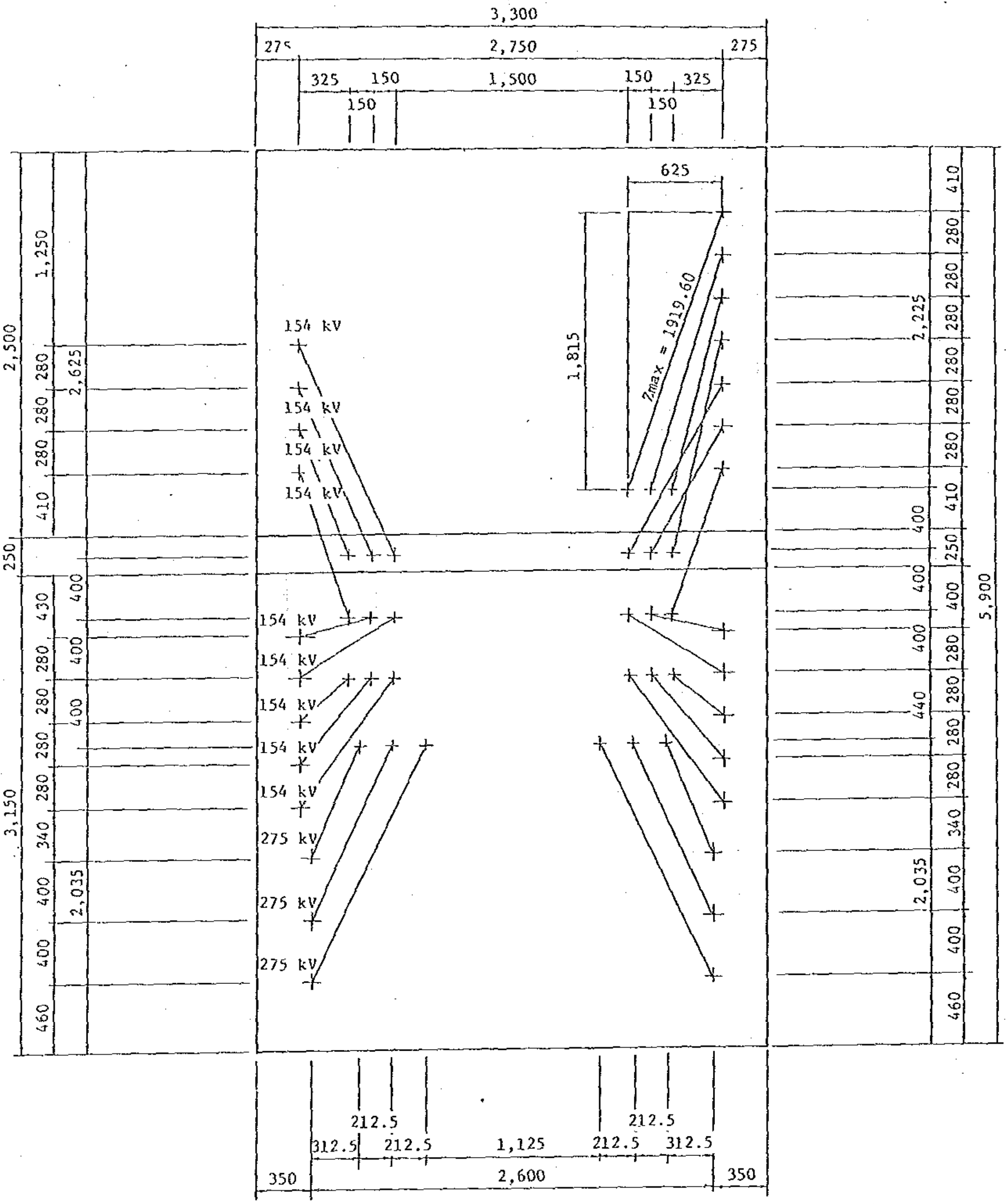
マンホール内空オフセット図



$$Z_{max} = 0.625^2 + 1.815^2 = 1.9196$$

(154 kV)

平面配置図

$$\ell_o = \sqrt{Z_{max} \cdot (4R - Z_{max})} = \sqrt{1.9196 \cdot (4 \times 1.50 - 1.9196)} = 2.80 \text{ m}$$

Manhole length $L = 2 (\ell_o + \alpha_1) + (2 \ell_1 + 0.70) + \alpha_2$

$= 2 (2.80 + 0.40) + (2 \times 2.10 + 0.70) + \alpha_2$

$= 11.30$ m

* α_2 = adjusted value = 0

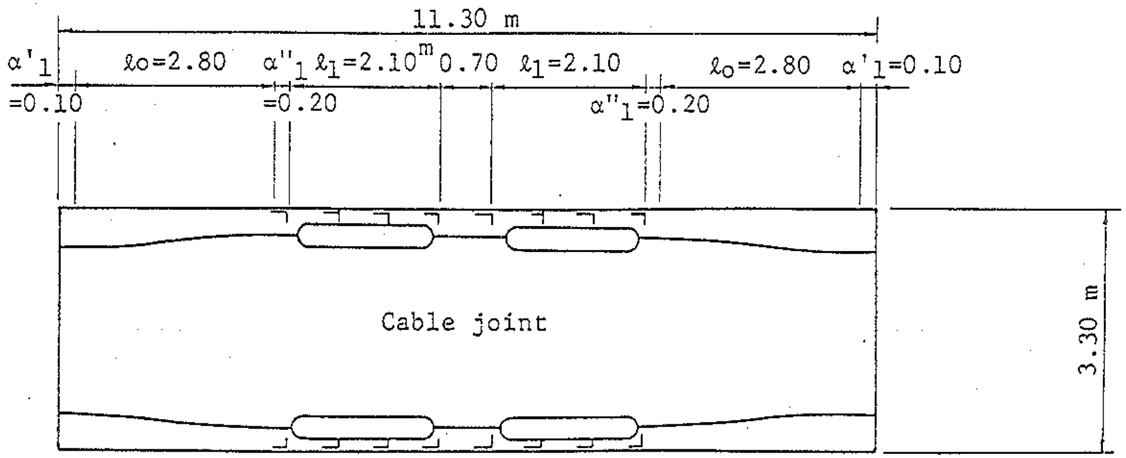
R: Design radius of curverture

154 kV ...... 1.50 m
275 kV ...... 1.80 m

α'_1 = straight line length

α''_1 = joint bonding length

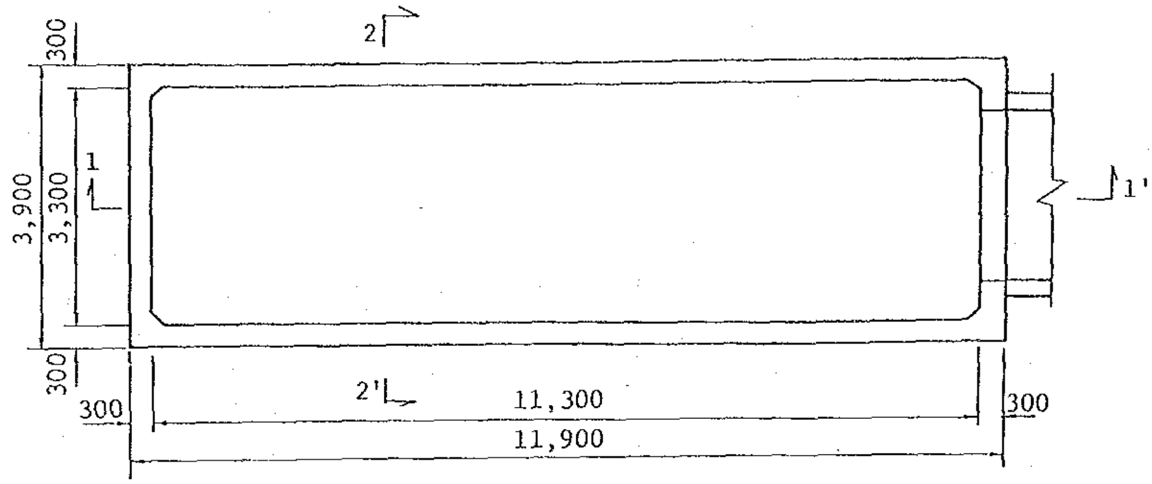
Plan Location



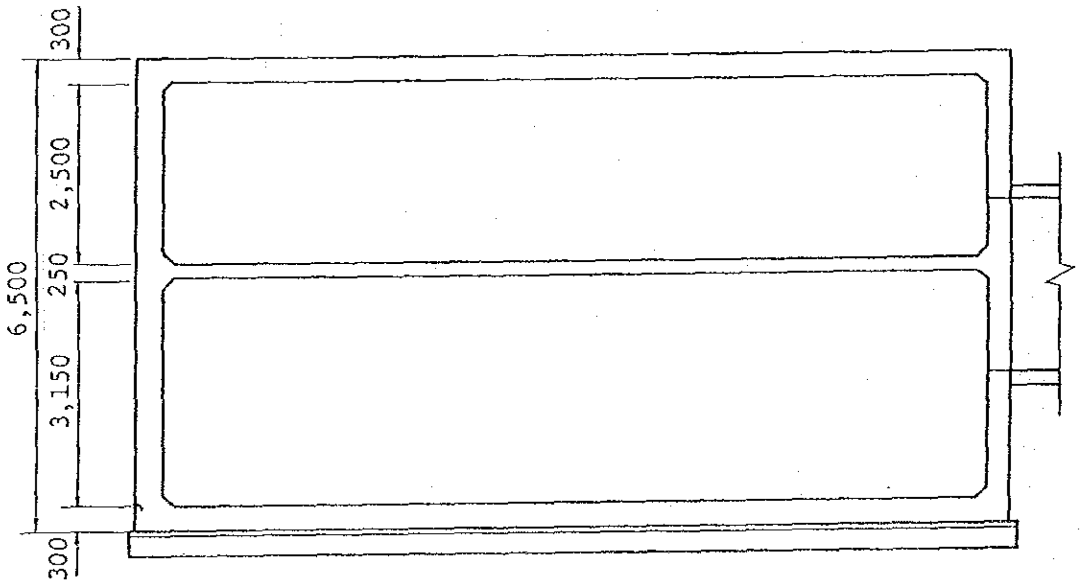
2．3　人孔構造設計

2．3．1　設計条件

設計条件は、内空寸法を除いて洞道に同じ。



1 - 1' Section



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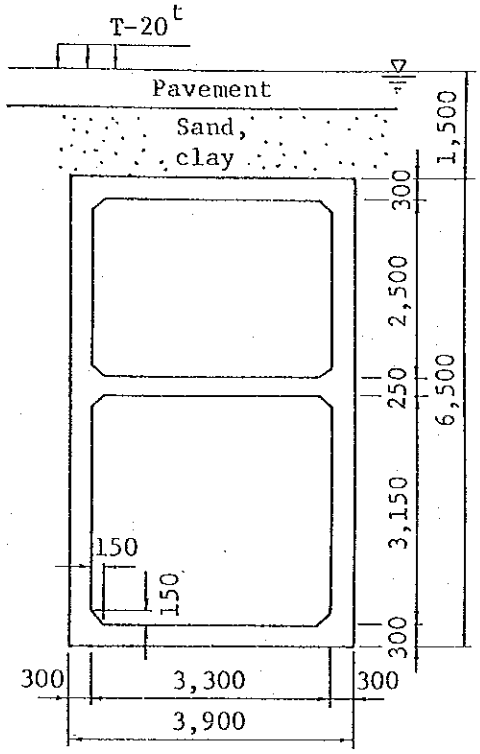
2．2' 断 面（構造設計断面）



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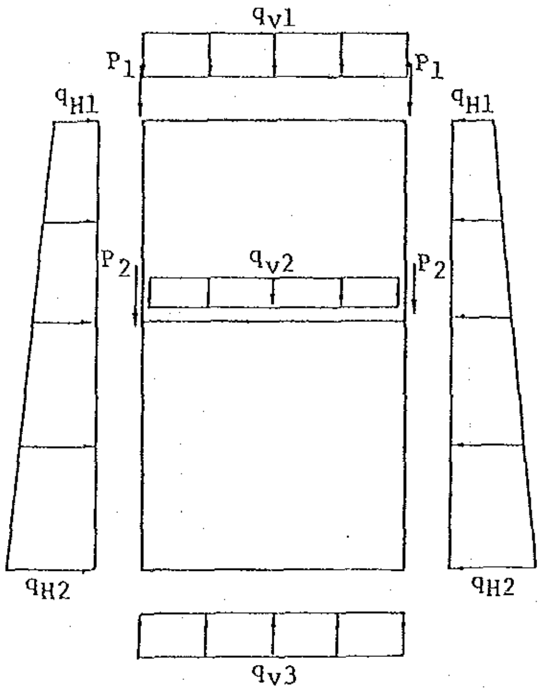
2．3．2 荷 重

洞道と同じ条件により下記のように算出した。



鉛直土圧

q_{ve} = 2.75+2.3×0.35+2.1×0.4+2.0×0.75 = 5.895 t/m^2

水平土圧

q_{He1} = 0.5×(2.75+2.3×0.35+2.1×0.4+1.1×0.9) = 2.693 t/m^2

q_{He2} = 2.693+0.5×(1.1×6.2) = 6.103 t/m^2

水平水圧

q_{Hw1} = 1.0×1.65 = 1.65 t/m^2

q_{Hw2} = 1.0×7.85 = 7.85 t/m^2

自　重

頂　版．　q_{s1} = 2.5×0.3 = 0.75 t/m^2

中床版　q_{s2} = 2.5×0.25 = 0.625 t/m^2

側壁(上)　P_1 = 2.5×0.3×2.775 = 2.081 t

側壁(下)　P_2 = 2.5×0.3×3.425 = 2.569 t

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底版反力

$$q_{v3} = q_{ve} + q_{g1} + q_{g2} + 2\times(P_1 + P_2)/3.6 = 9.853\ t/m^2$$

以上より、載荷荷重は以下のとおりである。

$q_{v1} = q_{ve} + q_{g1} = 6.645\ t/m^2$

$q_{v2} = q_{g2} = 0.625\ t/m^2$

$q_{v3} = 9.853\ t/m^2$

$q_{H1} = q_{He1} + q_{HW1} = 4.343\ t/m^2$

$q_{H2} = q_{He2} + q_{HW2} = 13.953\ t/m^2$

$P_1 = 2.081\ t$

$P_2 = 2.569\ t$

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2．3．3 断面力計算結果

(1) 側壁（上段）

	M (TON-M)	Q (TON)	N (TON)	
1-	5.7654	-7.7697	-14.0420	(1) Support (face)
2-	4.6497	-7.1008	-14.0420	(2) Haunch (starting point)
3-	3.6369	-6.3971	-14.0420	
4-	1.5065	-4.3838	-14.0420	
5-	-0.0978	-0.8141	-14.0420	
6-	-0.1446	-0.2518	-14.0420	(3) Center
7-	-0.1416	0.3223	-14.0420	
8-	1.3297	4.6261	-14.0420	
9-	3.9494	7.9315	-14.0420	
10-	5.0056	8.9709	-14.0420	
11-	5.2325	9.1817	-14.0420	(4) Haunch(starting point)
12-	6.4467	10.2501	-14.0420	(5) Support (face)

(2) 側壁（下段）

	M (TON-M)	Q (TON)	N (TON)	
12-	8.0349	-16.8229	-17.7360	(1) Support (face)
13-	6.0001	-15.7302	-17.7360	(2) Haunch (starting point)
14-	5.6096	-15.5088	-17.7360	
15-	3.7408	-14.3871	-17.7360	
16-	-3.0387	-8.8530	-17.7360	
17-	-6.7806	-0.7295	-17.7360	
18-	-6.8016	0.2532	-17.7360	(3) Center
19-	-6.7360	1.2478	-17.7360	
20-	-2.2807	10.4959	-17.7360	
21-	5.5554	17.7588	-17.7360	
22-	8.3718	19.7994	-17.7360	(4) Haunch (face)
23-	11.4970	21.8749	-17.7360	(5) Support (starting point)

M: Bending moment

Q: Shear force

N: Axial force

(3) 底　版

	M (TON-M)	Q (TON)	N (TON)		
23-	11.4970	-17.7354	-21.8749	(1)	Support (face)
24-	8.9475	-16.2574	-21.8749	(2)	Haunch (starting point)
25-	6.6197	-14.7795	-21.8749		
26-	-0.4744	-8.8677	-21.8749		
27-	-4.4649	0.0000	-21.8749	(3)	Center
28-	-0.4744	8.8677	-21.8749		
29-	6.6197	14.7795	-21.8749		
30-	8.9475	16.2575	-21.8749		
31-	11.4970	17.7354	-21.8749		

(4) 頂　版

	M (TON-M)	Q (TON)	N (TON)		
53-	5.7654	-11.9610	-7.7697	(1)	Support (face)
54-	4.0460	-10.9642	-7.7697	(2)	Haunch (starting point)
55-	2.4761	-9.9675	-7.7697		
56-	-2.3083	-5.9805	-7.7697		
57-	-4.9995	0.0000	-7.7697	(3)	Center
58-	-2.3083	5.9805	-7.7697		
59-	2.4761	9.9675	-7.7697		
60-	4.0460	10.9643	-7.7697		
1-	5.7654	11.9610	-7.7697		

(5) 中床版

	M (TON-M)	Q (TON)	N (TON)		
12-	-1.5882	1.1250	-27.0730	(1)	Support (face)
61-	-1.4264	1.0313	-27.0730	(2)	Haunch (starting point)
62-	-1.2788	0.9375	-27.0730		
63-	-0.8288	0.5625	-27.0730		
64-	-0.5757	0.0000	-27.0730		
65-	-0.8288	-0.5625	-27.0730		
66-	-1.2788	-0.9375	-27.0730		
67-	-1.4264	-1.0312	-27.0730		
42-	-1.5882	-1.1250	-27.0730		

M: Bending moment
Q: Shear force
N: Axial force

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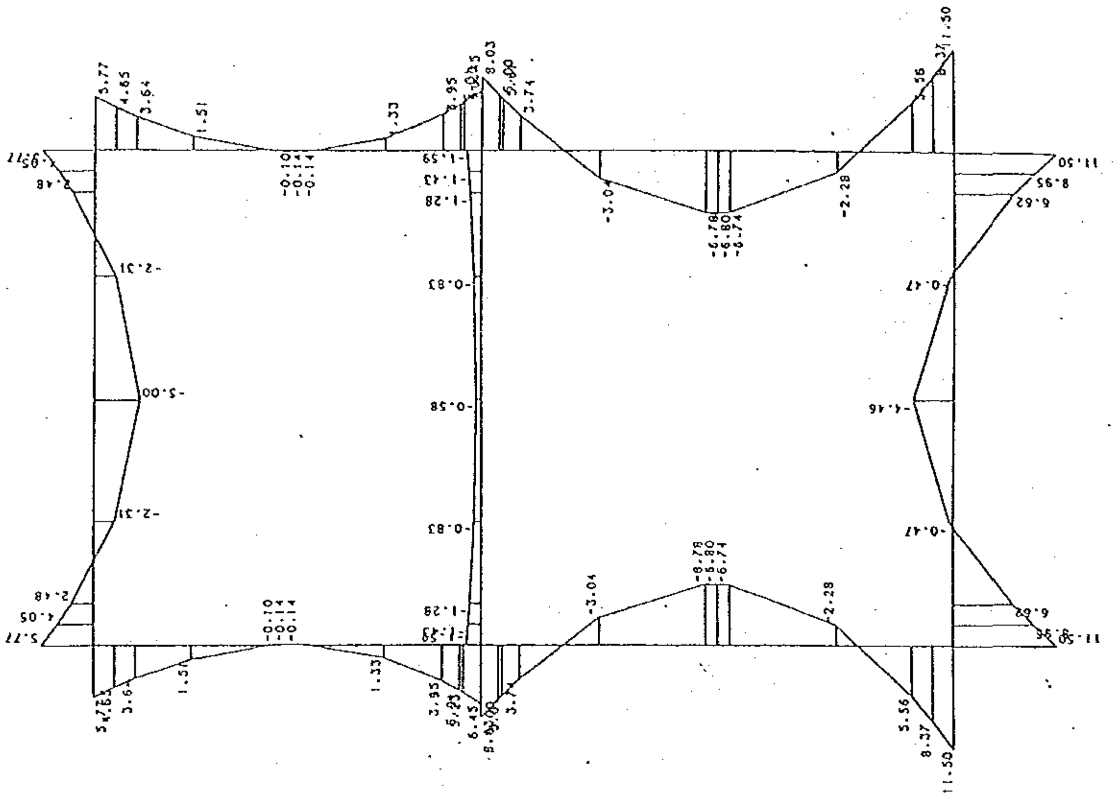
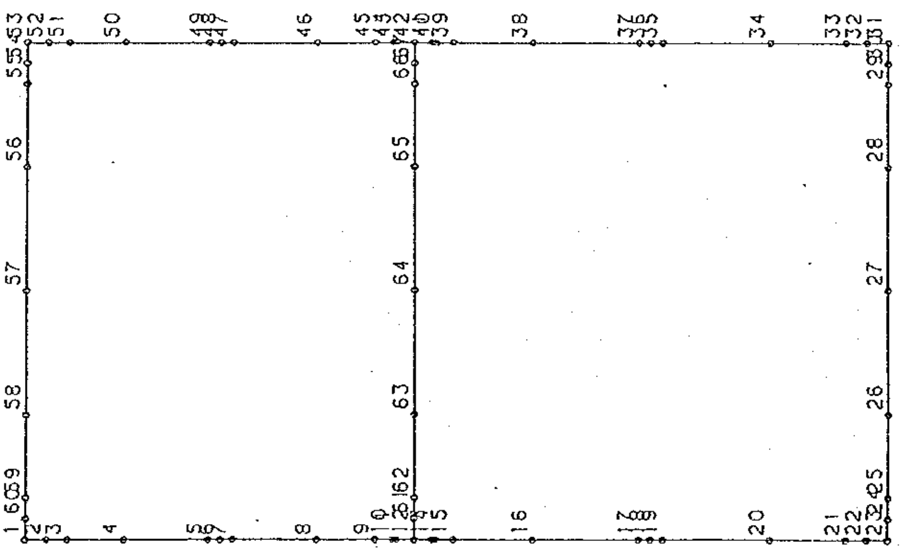
図面

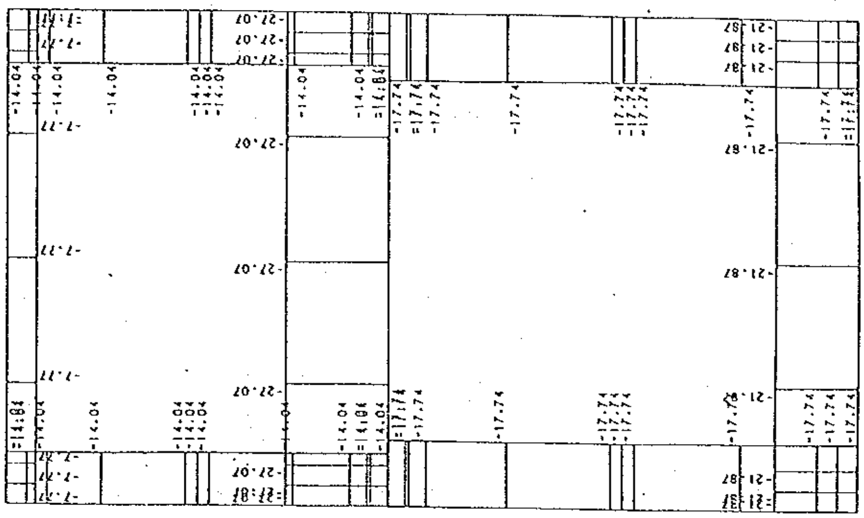


BENDING MOMENT

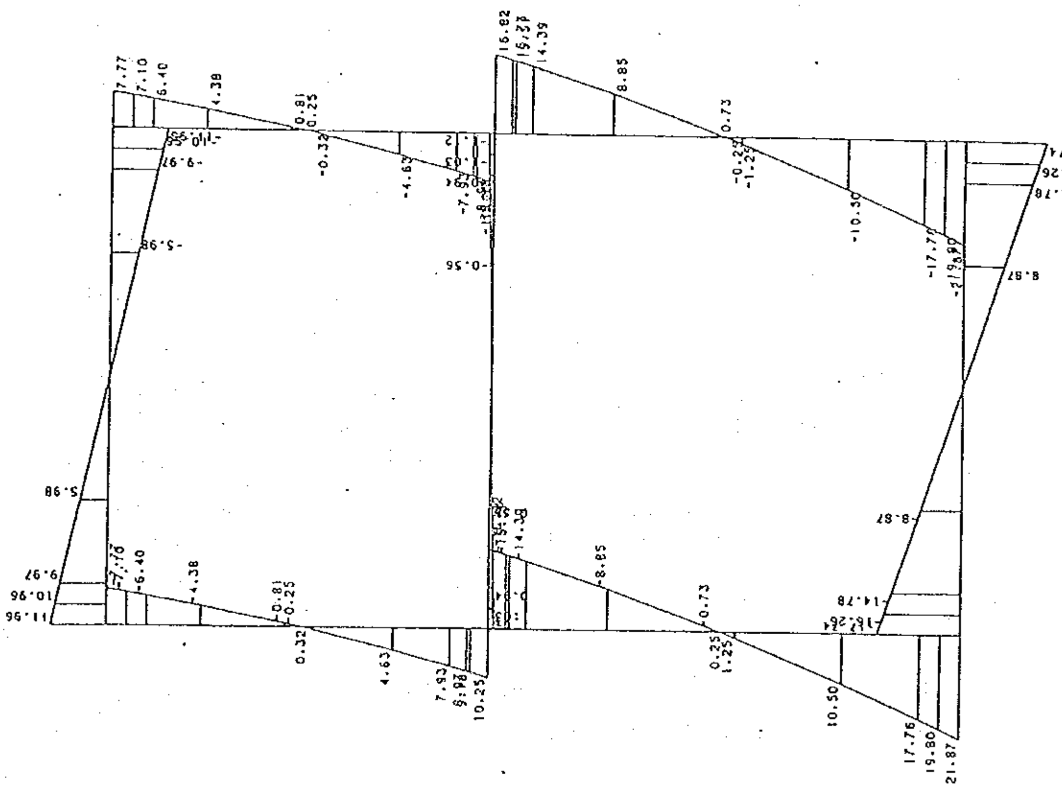


INPUT FIGURE

図面



AXIAL FORCE



SHEARING FORCE

TLG-3-25

2．3．4　応力度計算結果

(1) 側壁（上段）

Section No.	1-(1) Upper support (face)	1-(2) Upper haunch (starting point)	1-(3) Center
M (t.m)	5.77	4.65	0.15
N (t)	14.04	14.04	14.04
S (t)	7.10	6.40	0.00
b (cm)	100.0	100.0	100.0
h (cm)	35.0	30.0	30.0
d (cm)	30.0	25.0	25.0
d' (cm)	10.0	5.0	5.0
As (cm2)	10.843	10.843	4.223
As' (cm2)	4.223	4.223	10.843
n = Es/Ec	15.00	15.00	15.00
P=As/(b*d) (%)	0.361	0.434	0.169
u=d-h/2 (cm)	12.500	10.000	10.000
f=M/N+u (cm)	53.558	43.113	11.068
f/d	1.785	1.725	0.443
d'/d	0.333	0.200	0.200
As'/As	0.389	0.389	0.568
M'=M+N*u (t.m)	7.521	6.054	1.554
x (cm)	10.969	9.699	0.000
C	6.181	5.595	0.000
S	10.725	8.827	0.000
Z	1.079	1.095	0.000
c (kg/cm2)	51.7	54.2	5.0
s (kg/cm2)	1344.3	1282.4	-58.6
s' (kg/cm2)	68.4	393.9	71.6
(kg/cm2)	2.55	2.80	0.00
m (kg/cm2)	2.37	2.56	0.00
ca (kg/cm2)	90.0	90.0	90.0
sa (kg/cm2)	1800.0	1800.0	1800.0
a (kg/cm2)	4.50	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-1) denotes tension
m: mean shear stress

外側　D13，D16 交互　@ 150 ＝ 10.843 cm^2

内側　D13　@ 300 ＝ 4.223 cm^2

Section No.		1-(4) Lower haunch (starting point)	1-(5) Lower support (face)
M	(t.m)	5.23	6.45
N	(t)	14.04	14.04
S	(t)	8.97	9.18
b	(cm)	100.0	100.0
h	(cm)	30.0	35.0
d	(cm)	25.0	30.0
d'	(cm)	5.0	10.0
As	(cm2)	10.843	10.843
As'	(cm2)	4.223	4.223
n =	Es/Ec	15.00	15.00
P=As/(b*d)	(%)	0.434	0.361
u=d-h/2	(cm)	10.000	12.500
f=M/N+u	(cm)	47.263	58.410
f/d		1.891	1.947
d'/d		0.200	0.333
As'/As		0.389	0.389
M'=M+N*u	(t.m)	6.637	8.202
x	(cm)	9.403	10.671
C		5.748	6.343
S		9.533	11.490
Z		1.100	1.083
c	(kg/cm2)	61.0	57.8
s	(kg/cm2)	1518.5	1570.7
s'	(kg/cm2)	428.7	54.5
	(kg/cm2)	3.95	3.32
m	(kg/cm2)	3.59	3.06
ca	(kg/cm2)	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0
a	(kg/cm2)	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-1) denotes tension
m: mean shear stress

外側 D13, D16 交互 @ 150 = 10.843 cm^2

内側 D13 @ 300 = 4.223 cm^2

(2) 側壁（下段）

Section No.	2-(1) Upper support (face)	2-(2) Upper haunch (starting point)	2-(3) Center
M (t.m)	8.03	6.00	6.90
N (t)	17.74	17.74	17.74
S (t)	15.73	15.51	0.00
b (cm)	100.0	100.0	100.0
h (cm)	35.0	30.0	30.0
d (cm)	30.0	25.0	25.0
d' (cm)	10.0	5.0	5.0
As (cm2)	13.240	13.240	13.240
As' (cm2)	13.240	13.240	13.240
n = Es/Ec	15.00	15.00	15.00
P=As/(b*d) (%)	0.441	0.530	0.530
u=d-h/2 (cm)	12.500	10.000	10.000
f=M/N+u (cm)	57.803	43.830	48.904
f/d	1.927	1.753	1.956
d'/d	0.333	0.200	0.200
As'/As	1.000	1.000	1.000
M'=M+N*u (t.m)	10.252	7.774	8.674
x (cm)	11.359	9.895	9.560
C	5.858	4.921	5.073
S	9.614	7.512	8.193
Z	1.094	1.116	1.120
c (kg/cm2)	66.7	61.2	70.4
s (kg/cm2)	1642.7	1401.5	1705.5
s' (kg/cm2)	119.8	454.1	503.7
(kg/cm2)	5.73	6.92	0.00
m (kg/cm2)	5.24	6.20	0.00
ca (kg/cm2)	90.0	90.0	90.0
sa (kg/cm2)	1800.0	1800.0	1800.0
a (kg/cm2)	4.50	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-1) denotes tension
m: mean shear stress

外側 D16 @ 150 = 13.24 cm²

内側 D16 @ 150 = 13.24 cm²

※ 上端においては許容せん断応力を上回るため、スターラップにて補強する。

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Section No.	1-(4) Lower haunch (starting point)	1-(5) Lower support (face)
M (t.m)	8.37	11.50
N (t)	17.74	17.74
S (t)	17.76	19.80
b (cm)	100.0	100.0
h (cm)	30.0	35.0
d (cm)	25.0	30.0
d' (cm)	5.0	10.0
As (cm2)	22.453	22.453
As' (cm2)	13.240	13.240
n = Es/Ec	15.00	15.00
P=As/(b*d) (%)	0.898	0.748
u=d-h/2 (cm)	10.000	12.500
f=M/N+u (cm)	57.202	77.323
f/d	2.288	2.577
d'/d	0.200	0.333
As'/As	0.590	0.590
M'=M+N*u (t.m)	10.145	13.714
x (cm)	11.123	12.738
C	4.455	5.215
S	5.559	7.068
Z	1.151	1.144
c (kg/cm2)	72.3	79.5
s (kg/cm2)	1353.6	1615.5
s' (kg/cm2)	597.2	256.2
(kg/cm2)	8.17	7.55
m (kg/cm2)	7.10	6.60
ca (kg/cm2)	90.0	90.0
sa (kg/cm2)	1800.0	1800.0
a (kg/cm2)	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-) denotes tension
m: mean shear stress

外側 D19, D22 交互 @ 150 = 22.453 cm^2

内側 D16 @ 150 = 13.24 cm^2

※ 下端において許容せん断応力を上回るため、スターラップにて補強する。

(3) 底 版

Section No.		3-(1) Support (force)	3-(2) Haunch (original point)	3-(3) Center
M	(t.m)	11.50	8.95	4.46
N	(t)	21.87	21.87	21.87
S	(t)	16.26	14.78	0.00
b	(cm)	100.0	100.0	100.0
h	(cm)	35.0	30.0	30.0
d	(cm)	30.0	25.0	25.0
d'	(cm)	10.0	5.0	5.0
As	(cm2)	22.453	22.453	13.240
As'	(cm2)	13.240	13.240	22.453
n =	Es/Ec	15.00	15.00	15.00
P=As/(b*d)	(%)	0.748	0.898	0.530
u=d-h/2	(cm)	12.500	10.000	10.000
f=M/N+u	(cm)	65.058	50.903	30.411
f/d		2.169	2.036	1.216
d'/d		0.333	0.200	0.200
As'/As		0.590	0.590	1.696
M'=M+N*u	(t.m)	14.231	11.135	6.652
x	(cm)	13.150	11.415	11.393
C		5.058	4.362	3.941
S		6.481	5.191	4.707
Z		1.141	1.147	1.081
c	(kg/cm2)	80.0	77.7	42.0
s	(kg/cm2)	1537.2	1387.3	751.5
s'	(kg/cm2)	287.4	655.1	353.1
	(kg/cm2)	6.18	6.78	0.00
m	(kg/cm2)	5.42	5.91	0.00
ca	(kg/cm2)	90.0	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0	1800.0
a	(kg/cm2)	4.50	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-) denotes tension
m: mean rear stress

外側 D19, D22 交互 @ 150 = 22.453 cm^2

内側 D16 @ 150 = 13.24 cm^2

※ 端部においては許容せん断応力を上回るため、スターラップにて補強する。

(4) 頂 版

Section No.		4-(1) Support (force)	4-(2) Hanch (starting point)	4-(3) Center
M	(t.m)	5.77	4.05	5.00
N	(t)	7.77	7.77	7.77
S	(t)	10.96	9.97	0.00
b	(cm)	100.0	100.0	100.0
h	(cm)	35.0	30.0	30.0
d	(cm)	30.0	25.0	25.0
d'	(cm)	10.0	5.0	5.0
As	(cm2)	10.843	10.843	10.843
As'	(cm2)	10.843	10.843	10.843
n =	Es/Ec	15.00	15.00	15.00
P=As/(b*d)	(%)	0.361	0.434	0.434
u=d-h/2	(cm)	12.500	10.000	10.000
f=M/N+u	(cm)	86.704	62.074	74.346
f/d		2.890	2.483	2.974
d'/d		0.333	0.200	0.200
As'/As		1.000	1.000	1.000
M'=M+N*u	(t.m)	6.737	4.823	5.776
x	(cm)	9.789	8.471	8.196
C		3.953	5.827	6.013
S		4.754	11.372	12.327
Z		1.083	1.115	1.117
c	(kg/cm2)	51.8	45.0	55.6
s	(kg/cm2)	1602.9	1316.3	1709.0
s'	(kg/cm2)	16.7	276.4	325.1
	(kg/cm2)	0.00	4.45	0.00
m	(kg/cm2)	3.65	3.99	0.00
ca	(kg/cm2)	90.0	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0	1800.0
a	(kg/cm2)	4.50	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-) denotes tension
m: mean shear stress

外側　D13, D16 交互 @ 150 ＝ 10.843 cm^2
内側　D13, D16 交互 @ 150 ＝ 10.843 cm^2

(5) 中床版

Section No.		5-(1)	5-(2)
M	(t.m)	1.59	1.43
N	(t)	27.07	27.07
S	(t)	1.03	0.94
b	(cm)	100.0	100.0
h	(cm)	40.0	30.0
d	(cm)	30.0	25.0
d'	(cm)	10.0	5.0
As	(cm2)	4.223	4.223
As'	(cm2)	4.223	4.223
n =	Es/Ec	15.00	15.00
P=As/(b*d)	(%)	0.141	0.169
u=d-h/2	(cm)	10.000	10.000
f=M/N+u	(cm)	15.866	15.269
f/d		0.529	0.611
d'/d		0.333	0.200
As'/As		1.000	1.000
M'=M+N*u	(t.m)	4.296	4.134
x	(cm)	0.000	29.406
C		0.000	0.000
S		0.000	0.000
Z		0.000	0.000
c	(kg/cm2)	12.4	17.7
s	(kg/cm2)	-54.8	-39.7
s'	(kg/cm2)	142.0	220.0
	(kg/cm2)	0.00	0.00
m	(kg/cm2)	0.34	0.38
ca	(kg/cm2)	90.0	90.0
sa	(kg/cm2)	1800.0	1800.0
a	(kg/cm2)	4.50	4.50

Note: σs; (-) denotes compression, σs'; (-1) denotes tension
m: mean shear stress

外側 D13 @ 300 = 4.223 cm²

内側 D13 @ 300 = 4.223 cm²

2．3．5 スターラップの計算

(1) 側壁(下段)－上端部

必要なスターラップの断面積 req Av

$Sc = 1/2 \times 4.5 \times 100 \times 0.875 \times 25 \times 10^{-3} = 4.922\ t$

$Sv = 15.51 - 4.922 = 10.588\ t$

$$req\ Av = \frac{Sv \cdot S}{\sigma sa \cdot j \cdot d} = \frac{10.588 \times 10^3 \times 15}{1800 \times 0.875 \times 25}$$

$$= 4.034\ cm^2 < D13 @ 300 = 4.223\ cm^2$$

よって、スターラップはD13を 15cm間隔で 300ピッチで配筋する。

(2) 側壁(下段)－下端部

$Sc = 4.922\ t$

$Sv = 17.76 - 4.922 = 12.838\ t$

$$req\ Av = \frac{12.838 \times 10^3 \times 15}{1800 \times 0.875 \times 25} = 4.891\ cm^2 < D13 @ 150 = 8.447\ cm^2$$

よって、スターラップはD13を 15cm間隔で 150ピッチで配筋する。

(3) 底 版

$Sc = 4.922\ t$

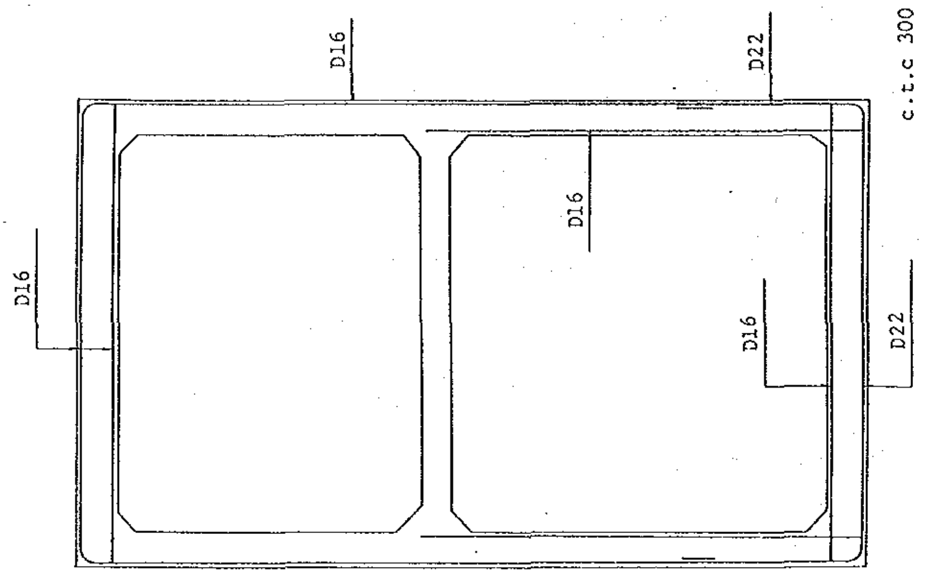
$Sv = 14.78 - 4.922 = 9.858\ t$

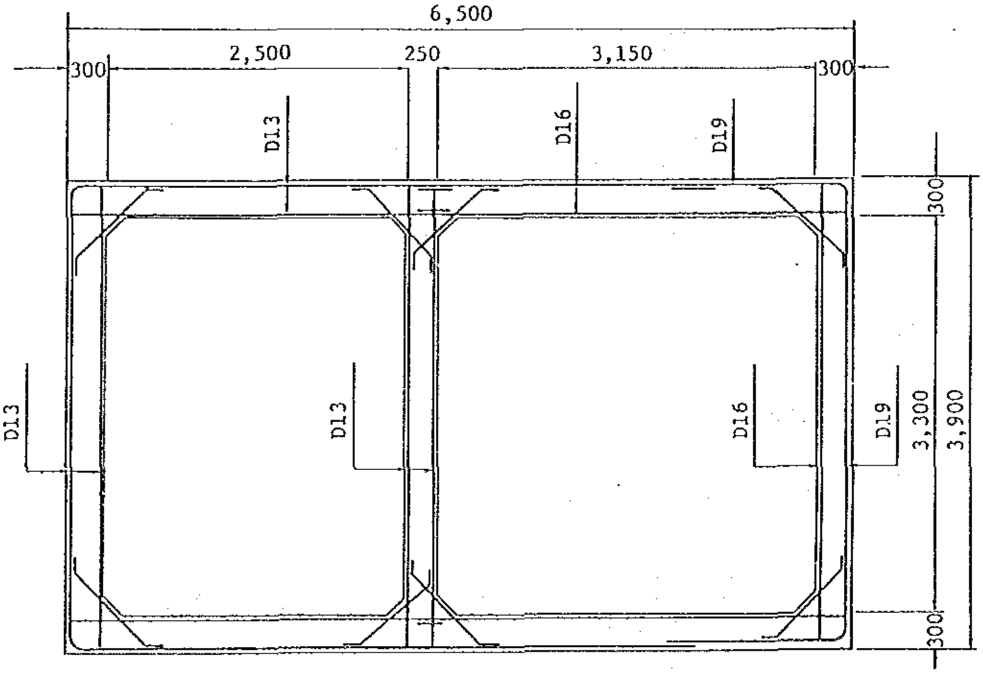
$$req\ Av = \frac{9.858 \times 10^3 \times 15}{1800 \times 0.875 \times 25} = 3.755\ cm^2 < D13 @ 300 = 4.223\ cm^2$$

よって、スターラップはD13を 15cm間隔で 300ピッチで配筋する。

2．3．6 結 果

以上より決定した壁厚及び主鉄筋組合せを下に示す。





壁厚 300mm(中床版 250mm)で計算の結果、上記配筋でもつため、300mm(中床版 250mm)に決定した。

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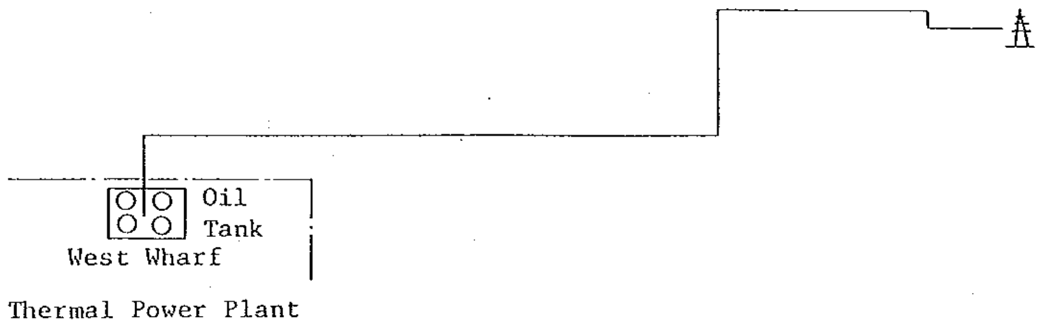
3．油　　槽

3．1　油槽設置位置

- 油槽はケーブル長にもよるが、通常ケーブル端部1ヶ所でよい。（本計画ケーブル長 1.3kmでは1ヶ所で充分）
- 保守点検の都合より、通常電源側に油槽を設置。
- 油圧は重力式により確保するのが経済的であり、よって油槽は建築物屋上に設置する。(不可の場合は架台上に設置)



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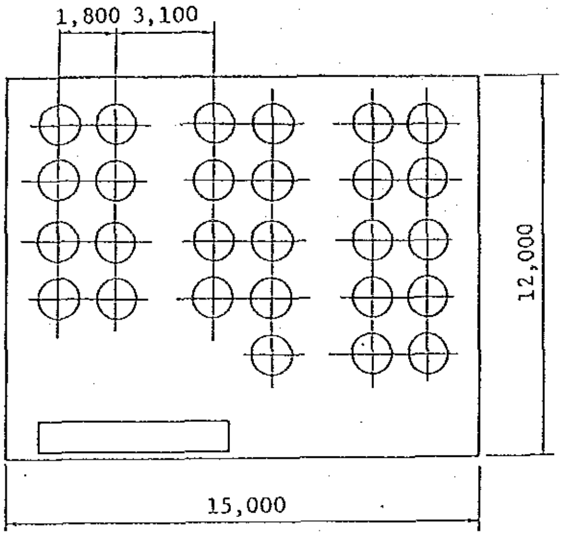
３．２　油槽ヤード面積

- 油槽はケーブル１条につき１基　―＞　本計画においては27基
- 油槽は１基 500ℓ 前後の容量で充分と考えられる。

　　└── 油槽外寸(胴径)φ1.2m×(高さ)1.7m



- 面積 A ＝ 180m² ―＞ 200m²

　※ 油槽間隔は東電に準拠

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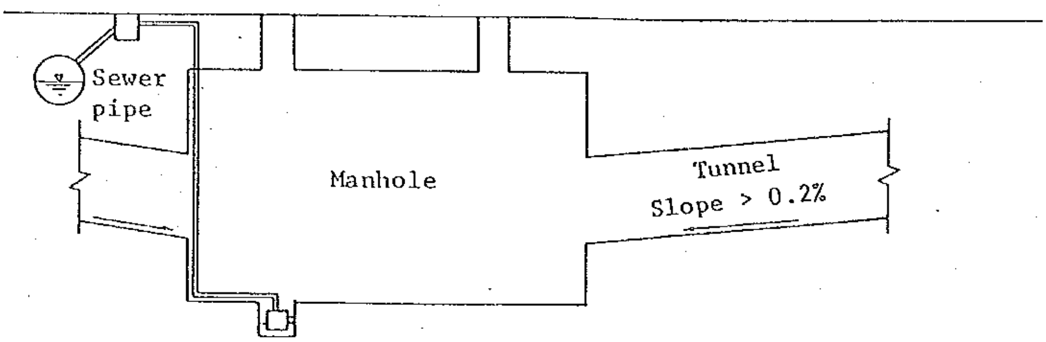
4．排　水

- 洞道内漏水は、洞道勾配により人孔部，換気口部等に集水し排水する。
- 排水のための最少勾配は 0.2%程度とする。
- 排水は、集水桝からポンプアップにより、既設下水管へ放水する。



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ＴＬＧ－４　開閉所／変電所設備

ＴＬＧ－４　開閉所／変電所設備

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ＴＬＧ－４　開閉所／変電所設備

１．一般事項

220kVバルディア変電所にウエスト・ワーフ火力発電所ユニットNo.１およびNo.２の発生電力を受電するために、220kV送電線２回線用設備を増設する。

２．基本事項

220kVバルディア変電所増設計画は、機器，設備の配置および基本使用を既設設備と将来増設について完全な調和を計る。

ウエスト・ワーフ火力発電所よりの 220KV送電線の受電設備は 400MW（1250Ａ）とする。

３．設計計画

(1)　機器使用

Type of switchgear	:	Indoor, SF6 Gas Insulated switchgear
Bus configuration	:	Double bus system
Rated voltage	:	220 kV
Highest system voltage	:	245 kV
Rated frequency	:	50 Hz
Insulation level		
Impulse withstand voltage (1.2/50 wave)	:	950 kV (peak)
Power frequency withstand voltage	:	395 kV
Max. asymmetric three-phase short-circuit withstand current	:	100 kA (peak)
Short-time current (1 sec)	:	40 kA

(2) 接地方式

(a) 150 mm^2 bare annealed copper wire shall be connected to the 220 kV equipment and steel structure.

(b) Grid (mesh) grounding wire shall be 100 mm^2 bare annealed copper wire which shall be connected to the existing grid (mesh) grounding wire.

(c) Grounding wire for control & protection panels, auxiliaries equipment and building facilities shall conform to the existing grounding wires.

(3) 制御ケーブル

(a) Since 220 kV system adopts the direct grounding method, control cables shall be PVC insulated and PVC sheathed control cables with copper tape electrostatic shielding (CVV-S).

(b) Voltage class: 600V grade

(c) Cable laying method: Racks in trench

(4) 機器架台および鉄構

Design of the steel structure and pedestals of equipment shall conform to the existing structure.

(5) 保護および制御方式

(a) Power system frequency : 50 Hz

(b) PT secondary rating : $100/\sqrt{3}$ V

(c) CT secondary rating : 1 A

(d) AC auxiliary power supply : 380 V

(e) DC auxiliary power supply : 220 V

(f) Interlock conditions

Between circuit breaker and isolators

between circuit breaker and high speed earthing switch

between isolator and working earthing switch

(g) Synchronizing switch: Transmission line and bus

(h) Protection system of transmission line

Main: Directional distance relay with transfer trip by P.L.G. system
(Single and/or three phase reclosing)

Backup: Directional distance relay and time delay nondirectional overcurrent relay

(6) 220kV開閉装置

(a) 共通仕様

- Type : Indoor, 220 kV SF6 Gas Insulated Metalclad Switchgear
- Standards : IEC
- Rated voltage : 220 kV
- Maximum system voltage : 245 kV
- Rated frequency : 50 Hz
- Rated short-circuit current: 40 KA

- Insulation medium : SF6
- Materials of enclosures : Aluminum
- Impulse withstand voltage
  - at nominal gas pressure : 950 kV (peak)
  - at minimum gas pressure : 950 kV (peak)
- Power frequency withstand voltage
  - at nominal gas pressure : 395 kV
  - at minimum gas pressure : 395 kV
- Rated short-time withstand current (1 sec): 40 kA
- Rated peak short-circuit current : 100 kA

(b) 母　線

- Rated normal current at 48°C ambient: 3,150 A
- Bus bar cross section : 3,140 mm^2
- Bus bar materials : Aluminium
- Bus bar enclosed tubing : Single-phase
- Tubing diameter : 315/305 mm
- Density of SF6 in the switchgear : 33.4 kg/m^3
- Rated pressure of SF6 insulation at 20°C: 5.5 bar
- Max. and min. admissible pressure at SF6 insulation at 20°C: 6.5/5.0 bar

(c) 遮断器

- Standards : IEC
- Rated voltage : 245 kV
- Rated current : 1,250 A
- Rated short circuit breaking current: 40 kA

- Rated short circuit making current : 100 kA
- Impulse withstand voltage (peak) : 950 kV
- Power frequency withstand voltage : 395 kV
- Total opening time at minimum supply: 50 m.sec
  voltage and specified gas pressure
- Total closing time at minimum supply: 80 m.sec
  voltage and specified gas pressure
- Driving mechanism
  . type : Motorop.spring
  . rated supply voltage : D.C. 220 V
  . rated of driving motor : 800/900 VA
- Auto-reclose : Single-phase and three-phase
- Rated operating sequence : 0-0.3sec.-CO-3min.-CO
- Number of trip coils : 2
- Arc quenching medium : SF6
- Rated arc quenching pressure of SF6 insulation: 6.5 bar
  at 20°C
- Max. and min. admissible pressure of SF6: 7.7/6.0 bar
  insulation at 20°C

(d) 断路器

- Standards : IEC
- Rated normal current at : 1,250 A
  48°C ambient
- Rated short-time withstand current : 40 kA
- Rated peak short-circuit current : 100 kA
- Impulse withstand voltage (peak) : 950 kV

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- Power frequency withstand voltage : 395 kV
- Operating mechanism : Motor drive and hand-operated
  - Motor voltage : DC 220 V
  - Rating of driving motor : 375 VA

(e) 高速度接地開閉器

- Standards : IEC
- Rated making current : 40 kA
- Rated peak short-circuit current : 100 kA
- Impulse withstand voltage (peak) : 950 kV
- Power frequency withstand voltage : 395 kV
- Operating mechanism : Motor drive and hand-operated
  - Motor voltage : DC 220 V
  - Rating of driving motor : 375 VA

(f) 接地開閉器

- Standards : IEC
- Rated making current : 40 kA
- Impulse withstand voltage (peak) : 950 kV
- Power frequency withstand voltage : 395 kV
- Operating mechanism : Handoperated

(g) 変 流 器

- Standards : IEC, BS
- Rated primary current : 700, 1,250, 3,000 A
- Rated secondary current : 1 A

. Measuring : CL 0.2

. Protection 1 : 5P 30

. Protection 2 : 5P 30

. Differential protection : CL X(BS 3938)

- Rated output

. Measuring : 20 VA

. Protection 1 : 40 VA

. Protection 2 : 40 VA

. Differential protection : CL X(BS 3938)

- Saturation factor

. Measuring : FS < 10 n

. Protection 1 : 30 n

. Protection 2 : 30 n

. Differential protection : Vknee 500 V

- Rated short-time withstand current : 100 kA

- Impulse withstand voltage (peak) : 900 kV

- Power frequency withstand voltage : 395 kV

- Insulation materials : Epoxy/SF6

(h) 電圧変成器

- Standards : IEC

- Rated primary voltage : $220/\sqrt{3}$ kV

- Rated secondary voltage : $100/\sqrt{3}$ V

- Rated tertiary voltage : $100/\sqrt{3}$ V

- Accuracy class : 1.0

- Rated output

. Secondary : 200 VA

. Tertiary : 50 VA

- Impulse withstand voltage (peak) : 900 kV

- Power frequency withstand voltage : 395 kV

(7) 220kV屋外機器

(a) ブッシング

- Standards : IEC

- Rated voltage : 245 kV

- Rated current : 1,250 A

- Impulse withstand voltage (peak) : 950 kV

- Power frequency withstand voltage : 395 kV

- Specified creepage distance : 3.5 cm/kV

- Conductor : Aluminium

(b) 避 雷 器

- Standards : IEC

- Rated voltage : 220 kV

- Maximum system voltage : 245 kV

- Rating of arrester : 198 kV

- Rated discharge current : 10 kA
- Maximum residual voltage : 649 kV

- Impulse withstand voltage (peak) : 950 kV

- Power frequency withstand voltage : 395 kV

(8) 電力線搬送

(a) コンデンサー形電圧変成器

- Type : Outdoor, CCPD

- Standards : IEC

- Rated primary voltage : $220/\sqrt{3}$ kV
- Rated secondary voltage : $100/\sqrt{3}$ V
- Rated tertiary voltage : $100/\sqrt{3}$ V
- Accuracy class : 1.0
- Rated output
  - . Secondary : 200 VA
  - . Tertiary : 50 VA
- Capacitance : 0.002 μF
- Impulse withstand voltage (peak) : 900 kV
- Power frequency withstand voltage : 395 kV

(b) ライントラップ

- Standards : IEC
- Rated current : 1,250 A
- Rated short-time current : 31.5 kA
- Rated frequency : 50 Hz
- Frequency band : 100 - 500 kHz
- Inductance : 0.2 mH
- Method of mounting : Mounting on the capacitor voltage transformer

(c) カップリングフィルター

- Nominal impedance
  - . PLC side : Z2 = 75/125 ohm (unbalance)
  - . Line side : Z1 = 240/320 ohm
- Range of coupling capacitance : 1.5 to 13 nF
- Composite loss within passband : less than 1.0 dB
- Return loss within passband : more than 12 dB
- Crossover attenuation of hybrid : more than 20 dB

- Average continuous power	:	200 W
- Nominal peak power		
. at 50 kHz	:	less than 400W
. at 100 kHz	:	less than 1,000W
- Protection devices		
. Drain coil		
. Earthing switch		
. Lightning arrester		

(d) 電力線搬送設備

- Type	:	Single-sideband with reduced carrier
- RF range	:	24 to 500 kHz
- Nominal bandwidth	:	4 kHz
- RF system impedance	:	50, 75, 125 ohm unbalanced or 150 ohm balanced
- Useful AF bandwidth	:	300 to 3,480 Hz
- Ambient conditions		
. Temperature	:	0 - 55°C
. Humidity	:	< 95%
(Transmitter data)		
. RF output power	:	20W
. AF input (Speech)	:	600 ohm balanced
. Signalling	:	External contact keys pilot oscillator at 50 baud max.
. Teleoperations	:	5 decoupled and individually adjustable input, 600 ohm balanced

(Receiver data)

. RF sensitivity

at carrier frequency 24 kHz : -38 dBm

at carrier frequency 496 kHz: -24 dBm

. Selectivity

from 4 kHz carrier band

$\geq$ 0.3 kHz	:	62 dB
$\geq$ 4 kHz	:	120 dB

Image rejection

$\leq$ 400 kHz	:	80 dB
$\geq$ 400 kHz	:	70 dB
I.F. rejection	:	$\leq$ 80 dB
. AF output (Speech)	:	600 ohm balanced
. Signalling	:	Potential-free contact

(Power supplies)

. Main	:	A.C. 220 V $\pm$ 15% 50 Hz
. Battery	:	D.C. 48 V

(e) 信号，保護装置

- Transmission time

. Blocking application	:	< 14 ms
. Permissive tripping	:	< 14 ms
. Direct tripping	:	< 16 ms
- Alarm output	:	20 VA
- Power supply	:	Stabilized voltage from PLC set - 40 $\pm$ 2.5 V
- Current consumption	:	160 - 450 mA
- Ambient temperature	:	0 to 55°C

(Transmitter data)

. Separate starting input per command input

Interface 1

Command initiated by	:	Potential-free contact
Input relay supply	:	from - 40 V
Max. contact current	:	4mA

Interface 2

Command initiated by	:	Contact + battery
Battery voltage	:	220, 125, 110, 60, 48 V
Max. input current	:	4mA

. Command frequency

1st command A	:	1,300 ± 10 Hz
2nd command B	:	1,700 ± 10 Hz
Both command (A + B)	:	1,500 ± 10 Hz

. Signal boost in PLC set : 10 to 16 dB

(Receiver data)

. Receiver input	:	Matched to PLC set 20 dB level reserve
. Command outputs		
1 main contact per command	:	either N/C or N/O
Contact rating	:	100VA, 250V D.C. 1A 10VA, 500V, 0.5A
. Auxiliary output	:	1 normally open contact per command Rating: 50VA, 250V D.C. 1A

(f) 高周波同軸ケーブル

- Type	:	Armoured coaxial cable
- Impedance	:	120 ± 5% ohm
- Capacitance	:	36 pF/m
- Resistance of conductor	:	≤ 37 ohm/km
- Attenuation		
. at 40 kHz	:	0.15 dB/100m
. at 500 kHz	:	0.38 dB/100m
- Conductor	:	Copper single core 0.8 mmϕ

4．機器台数

No.	Description		Quantity
	(220 kV SF6 Gas Insulated Switchgear)		
1.	Bus bar	220 kV, 3,150 A, Single-phase Type	1 lot
2.	Circuit Breaker	3ϕ, 220 kV, 1,250 A, 40 kA	2 sets
3.	Isolator	3ϕ, 220 kV, 1,250 A, 40 kA mechanism	8 sets
4.	High Speed Earthing Switch	3ϕ, 220 kV, 40 kA with motor operated mechanism	2 sets
5.	Working Earthing Switch	3ϕ, 220 kV, 40 kA with handoperated mechanism	4 sets
6.	Current Transformer	Bushing Type No. 1 core 700 - 1,250/1A No. 2 core 700 - 1,250/1A No. 3 core 700 - 1,250/1A No. 4 core 3,000/1A	6 sets
7.	Voltage Transformer	1ϕ, $\frac{220}{\sqrt{3}}/\frac{0.10}{\sqrt{3}}/\frac{0.10}{\sqrt{3}}$ kV 200 VA, 50 VA	6 sets
8.	Bushing	Outdoor type, 1ϕ, 245 kV 1,250 A, 40 kA	6 sets
	(220 kV Outdoor Equipment)		
9.	Lightning Arrester	1ϕ, 198 kV, 10 kA	6 sets
	(Power Line Carrier System)		
10.	Capacitor Voltage Transformer	1ϕ, $\frac{220}{\sqrt{3}}/\frac{0.10}{\sqrt{3}}/\frac{0.10}{\sqrt{3}}$ kV 200 VA, 50 VA	2 sets

No.	Description		Quantity
11.	Line Trap	1,250 A, 0.2mH mounting on the C.V.T.	2 sets
12.	Coupling Filter	75/125 ohm	2 sets
13.	Power Line Carrier Equipment	24 to 500 kHz Single-sideband with reduced carrier	2 sets
14.	Protection Signalling Equipment		2 sets
15.	Coaxial Cable for PLC		1 lot
	(Others)		
16.	Grounding System		1 lot
17.	Steel Structure and Pedestals		1 lot
18.	Control Cables		1 lot
19.	Control Panel	For two (2) circuits of 220 kV transmission line	1 lot
20.	Relay Panel	For two (2) circuits of 220 kV transmission line	1 lot