REPORT
ON
HOSPITAL FACILITIES IMPROVEMENT PROJECT
REPUBLIC OF INDONESIA

VOLUME 2

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JAPAN INTERNATIONAL COOPERATION AGENCY

VOLUME 1

VOLUME 2

4. Electrical facilities and workshop

VOLUME 3

5. Water supply facilities and others

4 ELECTRICAL FACILITIES AND WORKSHOP

4-1 Load Plan for Main Line

(a) Table of Codes for Main Line

Feeder Code	Class of Work	Description	System	
f - Lo	Existing	Existing installation	3 φ 4 W 127/220	127 1φ
f - Ln	New installation	Lighting	3 " 4 " "	220 1φ
f - p	"	Power (including cooling facilities)	3 " 4 " "	" 3φ
f - m	"	Medical equipment for out-patient clinic	3 " 4 " "	" 1φ
f - La	"	Laboratory equipment	3 " 4 " "	" 1φ
f - Lauk	"	Laundry and kitchen equipment	3 " 4 " "	" 1φ
f - Xo	Existing	X-ray apparatus	3 " 4 " 127/220 220/380	220V
f - Xn	New installation	X-ray apparatus	3 " 4 " 220/380	220V 1φ

f - Xo	To be selected from among feeding methods of 1φ 2W, 1φ 3W and and 3φ 4W
f - Xn	" " "

Indicating Method

Indicating Position Code Route No. Position No.				
Step	Feeder code	Wiring capacity	System	No. of wires
1 step	f - 20	X kvA	3 φ 4 W 127/220	OW 60 - 4
5 step	f - Xo	Y kvA	1 φ 2 W 220V	OW 60 - 2
6 step	f - Xn	Z kvA	3 φ 4 W 220/380	OW100 - 4

f - Lm = f - m
f - Lank = f - Luk

Rote : A, B, C, ...
Position: a, b, c ...

(b)

Rated circuit breaking capacity by system (Feeder MCB)	f-Lm 3φ4w Mainly external line	f-Xo 3φ4w 220-380	f-Xn 3φ4w 220-380	f-La 3φ4w 127-220	f-Lunk 3φ4w 127-220	f-P 3φ3w 220	f-Lo 3φ4w 127-220	f-Ln 3φ4w 127-220	Total
Gunung Wenang	4P AF AT 400-250	4P AF AT 225-100	4P AF AT 400-300	4P AF AT 225-100	4P (15×2) AF AT 600-600	3P AF AT 225-175	4P AF AT 600-400	4P AF AT 225-175	
Tondano	4P 225-150	4P 100- 50	4P 225-175	4P 100- 75	4P 100- 75	3P 100- 60	4P 100- 30	4P 100- 75	
Kotamobagu	4P (220) 225-100	" 100- 30	" 225-150	" 100- 50	" 100- 75	3P 100- 60	4P 100- 15	" 100- 50	Completion of Voltage rise (Kotamobagu)
Gorontalo	4P 225-150	4P 100- 30	4P 225-175	4P 100- 75	4P 100- 75	3P 225-175	4P 100- 50	4P 100- 75	
Lim Kendage	4P 100- 75	" 100- 30	" 225-175	" 100- 50	" 100- 60	3P 100- 50	4P 100- 50	" 100- 60	
Ujung Pandang	4P 400-250	4P 225-200	4P 400-300	4P 225-100	4P (15×2) 600-600	3P (22×1) 400-300	4P 400-300	4P 225-150	
Watan Pone	4P 100- 75	4P 100- 30	4P 225-175	4P 100- 50	4P 100- 60	3P 225-175	4P 100- 30	4P 225-100	
Sopping	4P 225-100	" 100- 30	" 225-175	" 100- 50	4P 100- 60	3P 225-125	4P 100- 50	" 100- 60	
Pare Pare	4P 225-150	" 100- 30	" 225-175	" 100- 75	4P 100- 60	3P 225-150	4P 225-100	" 100- 75	
Lim Rantpao	4P 225-100	" 100- 30	" 225-175	" 100- 50	4P 100- 60	3P 225-125	4P 100- 30	" 100- 60	
Palopo	4P 225-100	" 100- 30	" 225-175	" 100- 50	4P 100- 60	3P 225-125	4P 100- 30	" 100- 60	
Bantaeng	4P 225-100	" 100- 30	" 225-150	" 100- 50	4P 100- 60	3P 225-100	4P 100- 30	" 100- 60	
Medan	4P 400-300	4P 225-150	4P 400-300	4P 225-100	4P (15×2) 1000-800	3P 600-400	4P 400-300	4P 225-175	
Tartung	4P 225-125	" 100- 50	" 225-175	" 100- 75	4P 100- 75	3P 225-175	4P 225-100	" 100- 75	
Porsea	4P 100- 75	" 100- 30	" 225-150	" 100- 50	4P 100- 60	3P 225-150	4P 100- 30	4P 100- 60	
Sianter	4P 225-200	" 225-100	" 225-175	" 225-100	4P 225-100	3P 400-250	4P 225-125	" 225-100	
T.Tinggi	4P 225-100	" 100- 30	" 225-175	" 100- 50	4P 100- 60	3P 100- 75	4P 100- 50	" 100- 60	
Tanjun Bali	4P 225-100	" 100- 50	" 225-150	" 100- 50	4P 100- 60	3P 100- 60	4P 100- 50	" 100- 60	

Rated circuit breaking capacity by system (Feeder MCB)	f-m 3φ4w Mainly external	f-Xo 3φ4w 220-380	f-Xn 3φ4w 220-380	f-La 3φ4w 127-220	f-Lumk 3φ4w 127-220	f-P 3φ3w 220	f-Lo 3φ4w 127-220	f-Ln 3φ4w 127-220	Total
Kisaran	4P 225-150	4P 100- 30	4P 225-175	4P 100- 75	4P 100- 60	3P 225-150	4P 225-100	4P 100- 75	
Rantan Prapat	4P 225-100	" 100- 30	" 225-175	" 100- 50	4P 100- 60	3P 225-175	" 100- 50	" 100- 60	

4-2 Computation of Increase in Contract Power

(a) MCB tripping current decision basis

System composition	Feeder name	Computing expression
Mainly composed of low-capacitance 200V single-phase loads (connected to external cables)	f - m f - La f - Ln	$\frac{P^{KVA} \times 10^3}{\sqrt{3} \times 200} \leq T.A$
Mainly composed of 200V single-phase load of the highest capacity X-ray apparatus	f - Xo f - Xn	Output of the highest capacity X-ray apparatus $\frac{\frac{KVP}{1.4} \times mA \times 1.1}{\frac{0.8 \times 10^3}{2}} = P^{KVA}$ $\frac{P^{KVA} \times 10^3}{200} \leq T.A$
Mainly composed of 127V single-phase load of the highest capacity X-ray apparatus	f - Lo	$\frac{\frac{P^{KVA}}{3} \times 10^3}{127} \leq T.A$
Mainly composed of motors, the one with the largest load and the others, seldom operating coincidentally	f - P . Ujing Pandang . Medan	200V When Pm stands for the power for the largest-load motor, $Pm \times 4 \times K + (\Sigma P - Pm) \times 4 \leq T.A$ where the unit of power Pm.P is kw. K=2.5 11^{kw} 1.8
Mainly composed of motors, two largest ones of which may operate coincidentally.	f - Lau.K . Gunung Wenang . Ujung Pandng . Medan	When Pm_1 and Pm_2 respectively stands for the powers for the largest motors, $(Pm_1+Pm_2) \times 4 \times K + [\Sigma P - (Pm_1 + Pm_2)] \times 4 \leq T.A$ where the unit or power Pm.P is kw. K = 2.5 < 11^{kw} < 1.8

(b)

Load sum of each system	f-Lm (KVA) 1ϕ	3ϕ	t	f-Xo 1ϕ	f-Xn 1ϕ	3ϕ	t	f-Xa	f-LuK 3ϕ	f-P		f-Lo 3ϕ4w	f-Ln 3ϕ4w	Total
Gunung Wenang	64	11	75	33	65	3	68	30	117	C26.4 G 5 S8	39.4	167	52.5	582.5
Tondano	42.5		42.5	9.5	32			20	10.3	C 9.6 G 5	14.6	8.5	23.5	160.9
Kotamobagu			42.5	3	25			20	10.3	C 9.6 G 5	14.6	11.6	23.5	150.5
Gorontalo			42.5	3	32			20	10.3	C 9.6 W11.2 G 5	25.8	12.8	23.5	169.3
Lim kendage			22.3	3	32			10	8.67	C 7.2 G 5	12.2	12	18	118.17
Ujung Pandang	64	11.1	75	61	58			30	112	C26.4 W22.1 GS13	61.5	100	45	542.5
Watam Pone			22.3	3	32			10	8.67	C 7.2 W15 G 5	27.2	9.15	27.15	130
Soppeng			28.3	3	32			10	8.67	C 7.2 W 7.5 G 5	19.7	12	18	131
Pare Pare			47.5	3	32			20	8.67	C 9.6 W 7.5 G 5	22.1	33	22.5	183.7

Load sum of each system	f-Lm (KVA) 1φ	3φ	t	f-Xo 1φ	f-Xn 1φ	3φ	t	f-Xa	f-LuK 3φ	f-P		f-Lo 3φ4w	f-Ln 3φ4w	Total
Elim Rantepao			28.3	3		32		10	8.67	C 7.2 W 7.4 G 5	19.7	7	17.6	124
Palopo			28.3	3		32		10	8.67	C 7.2 W 7.4 G 5	19.7	7	17.6	126.27
Bantaeng			28.3	3		25		10	8.67	C 2.4 W 7.5 G 5	14.9	8	17.6	115.47
Medan	73.9	16.1	90	59.5	65	3	68	30	160	C28.8 W37.1 GS13	78.9	110.5	54.5	651.5
Tartung			36.5	7		32		20	10.3	C 9.6 W11.1 G 5	25.7	38	23.5	193
Porsea			22.3	5		25		10	8.67	C 2.4 W14.9 G 5	22.3	7	17.6	117.8
Sianter			65.5	18		32		30	14.8	C19.2 W22.1 G 5	46.3	42	31.1	279.7
T. Tinggi			28.3	3		32		10	8.67	C 7.2 W 0.1 G 5	12.3	11	17.6	122.8
Tanjung Balai			28.3	10		25		10	8.67	C 2.4 G - G 5	7.4	13	17.6	119.9

Load sum of each system	f-Lm (KVA) 1φ	3φ	t	f-Xo 1φ	f-Xn 1φ	3φ	t	f-Xa	f-LuK 3φ	f-P		f-Lo 3φ4w	f-Ln 3φ4w	Total
Kisaran			42.5	6		62		20	8.67	C 9.6 W 7.5 G 5	22.1	29	24	214.27
Rantau Propat			28.3	3		32		10	8.67	C 7.2 W15 G 5	27.2	15	17.6	141.77

C: Cooling facilities

G: Generator

S: Work shop

W: Water supply

(c) Computation of Increase in Contract Power

*Total calculated value of X-ray, lighting and motors. Tr commonly used
**Denotes 220-380V.
For rated value, example in Jakarta is used.

	Contract Capacity (KVA)				⑤ Existing contract capacity (KVA)	⑥ Increase in contract capacity ④-⑤ (KVA)	P.L.N. availability of reserve capacity
	①Calculated value for lighting and motors	②Rated capacity of light- and motors	③Rated value of X-ray	④Total of rated values			
Gunung Wenang	229	240	**147	387	114.5	269.5	Yes
Tondano	69	114	**105	219	4	215	"
Kotamobagu	** 76.2	**105	**105	210	6.6	204	"
Gorontalo	81.2	114	**105	219	3.8	215.2	"
Kendge	*150			135	5.7	129.3	"
Ujung Pandany	206	240	**147	387	260	127	"
Watam Pone	*150			135	3.5	131.5	No
Soppeng	*150			135	8.4	126.6	Yes No supply in daytime
Pare Pare	88.4	114	**105	219	4	215	"
Rantpao	*150			135	1.0	134	No until 1979
Palopo	*150			135	0.5	130	"
Bantaeng	*150			135	2.5	132.5	20kVA in reserve
Medan	247.1	305	**147	452	74.5	377.5	Yes
Tartung	91.4	114	**105	219	14	205	"
Porsea	*150			135	0.5	130	No
Sianter	127	135	**105	240	30	210	Yes
T.Tinggi	*150			135	3	132	"
Tanjung Bali	*150			135	1.5	131.5	"
Kisaran	87.2	114	**105	219	5	214	"
Rantan Prapat	*150			135	0	No supply until 1979	

d) Calculation Sheet for PLN Transformers and Contract Power

1. Explanation

2. Calculation Table

1. Explanation

Calculation method for capacity

A. Classification of loads

a. For general load, lighting and motor loads were totalled (loads where three phase balance is expected to be relatively available with small capacity of single phase)

b. For special load, X-ray loads were totalled (loads which require to set power capacity to its lowest limit to reduce voltage regulation)

B. Calculation of demand

For general load, demand is set on average at 80%.

C. Calculation of contract demand

With the calculated demand as the basis, the contract demand is held down as shown below.

Up to initial 6 KVA	100%
Up to next 14 KVA	90%
Up to next 30 KVA	80%
Up to next 50 KVA	70%
Up to next 100 KVA	60%
For all the rest	50%

D. The rated value closest to the value obtained above is set as transformer capacity.

E. The capacity for future demand is taken into consideration. Its value is (transformer capacity minus calculated capacity) (approximately 20 to 25%).

2. Calculation Table

*Commonly used for X-ray, lighting, and motors

Contract Capacity and Required Transformer Capacity	Lighting and Motors (KVA)			X-Ray (KVA)			Contact Capacity (KVA)		
	Planned Load	Demand Factor		Planned Load	Max. per Phase		Lighting and Motors	Transformer	X-Ray
Gunung Wenang	481.3	0.8	384	101	50		229	300	150
Tondano	118.4	"	94	41.5	30		69	100	100
Kotamobagu	122.5	"	98	28	25		76.2	100	75
Gorontalo	134.3	"	107	35	30		81.8	100	100
Kendage	83.17	"	66	35	30		53.8÷3+30=47.9		*150
Ujung Pandang	423.5	"	338	119	50		206	300	150
Watam Pone	95	"	76	35	30		60.8÷3+30=50.2		*150
Soppeng	96	"	76	35	30		60.8÷3+30=50.2		*150
Pare Pare	148.7	"	118	35	30		88.4	100	100
Rantpao	89	"	71	35	30		57.3÷3+30=49.1		*150
Palopo	91.27	"	72	35	30		57.4÷3+30=49.2		*150
Bantaeng	87.47	"	69	28	25		55.9÷3+30=48.6		*150
Medan	524	"	419	127.5	50		247.1	300	150
Tartung	154	"	123	39	30		91.4	100	100
Por Sea	87.8	"	70	30	25		56.6÷3+25=44		*150
Sianter	229.7	"	183	50	30		127	150	100
T.Tinggi	87	"	69	35	30		55.9÷3+30=48.6		*150
Tanjung Bali	84.9	"	67	35	25		54.5÷3+25=43.1		*150
Kisaran	146.27	"	116	68	30		87.2	100	100
Rantan Prapat	106.77	"	84	35	30		66.4÷3+30=52.1		*150

4-3 Calculation Sheet for Generator's Capacity

Gunung Wenang B

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② ④	③ - ④ ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
f-Lm	75	25	43	50	93	0.6	1.2	78	3φ4w	127-220	1φ 220
f-Xo	33	15	26	18	44	0.5	-	26	1φ2w	220	
f-Xn	68	50	86	18	104	0.5	-	61	1φ2w	220	
f-La	30	10	17	20	37	0.7	1.2	36	3φ4w	127-220	1φ 220
f-LnK	117				117	0.5	-	68	3φ4w	127-220	3φ 220
f-p	39.4				39	0.6	-	28	3φ3w		220
f-Lo	167	56	97	111	208	0.5	1.2	146	3φ4w	127-220	1φ 127
f-Ln	52.5	17	29	35	64	0.6	1.2	54	3φ4w	127-220	1φ 220
Total	582							497			

Uzung Pandan A

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② ④	③ - ④ ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
f-Lm	75	25	43	50	93	0.6	1.2	78	3φ4w	127-220	1φ 220
f-Xo	61	35	60	26	86	0.5	-	43	1φ2w	220	
f-Xn	58	50	86	8	94	0.5		47	1φ2w	220	
f-La	30	10	17	20	37	0.7	1.2	34	3φ4w	127-220	1φ 220
f-LnK	112				112	0.5		56	3φ4w	127-220	1φ 220
f-R	61.5				61.5	0.6		37	3φ3w		
f-Lo	100	35	57	65	122	0.5	1.2	73	3φ4w	127-220	1φ 127
f-Ln	45	15	26	30	56	0.6	1.2	40	3φ4w	127-220	1φ 220
Total	542							408			

Medan A

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② ④	③ - ④ ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
T-Lm	90	30	52	60	112	0.5	1.2	79	3φ4w	127-220	1φ 220
T-Xo	59.5	25	43	35	78	0.5	-	39	1φ2w	220	
T-Xn	68	50	86	18	104	0.5		52	1φ2w	220	
T-La	30	10	17	20	37	0.7	1.2	36	3φ4w	127-220	1φ 220
T-LnK	160				160	0.5		94	3φ4w	127-220	3φ 220
T-P	79				79	0.6		56	3φ3w		220
T-Lo	110	37	64	73	137	0.5	1.2	96	3φ4w	127-220	1φ 127
T-Ln	54	18	31	36	67	0.5	1.2	47	3φ4w	127-220	1φ 220
Total	650.5							499			

Sianter B

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② ④	③ - ④ ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
f-Lm	65.5	22	37.8	43.5	81.3	0.5	1.2	57	3φ4w	127-220	1φ 220
f-Xo	18	15	26	3	29	0.5	-	17	1φ2w	220	
f-Xn	32	30	51.9	2	53.9	0.5	-	32	1φ2w	220	
f-La	30	10	17	20	37	0.6	1.2	31	3φ4w	127-220	1φ 220
f-LnK	14.8				14.8	0.6	-	11	3φ4w	127-220	3φ 220
f-P	46.3				46.3	0.5	-	27	3φ3w		220
f-Lo	42	14	24	28	52	0.6	1.2	43	3φ4w	127-220	1φ 127
f-Ln	31.1	10	17	21.1	38.1	0.6	1.2	32	3φ4w	127-220	1φ 220
Total	279							250			

Tartung C

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② / ④	③ - ④ / ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
f#Lm	36.5	12	21	24.5	45.5	0.6	1.2	33	3φ4w	127-220	1φ 220
f#Xo	7	5	8.7	2	10.7	0.5	-	6.2	1φ2w	220	
f#Xn	32	30	51.9	2	53.9	0.5	-	31	1φ2w	220	
f#La	20	6.7	11.5	13.3	24.8	0.7	1.2	25	3φ4w	127-220	1φ 220
f#LnK	10.3				10.3	0.6		7.5	3φ4w	127-220	3φ 220
f#P	25.7				25.7	0.6		18	3φ3w		220
f#Lo	38	12.7	22	25.3	47.3	0.6	1.2	40	3φ4w	127-220	1φ 127
f#Ln	23.5	7.8	13.6	15.7	29.3	0.6	1. 2	25	3φ4w	127-220	1φ 220
Total	193							185.7			

Pare Pare C

	① Total	② 1φ Maximum	③ 3φ Conversion	① - ② ④	③ - ④ ⑤	Demand ratio ⑥	Unbalance factor ⑦	⑤×⑥×⑦ / 0.85 (KVA)	System	Voltage	Main load
f-Lm	42	14	24	28	52	0.6	1.2	44	3φ4w	127-220	1φ 220
f-Xo	3	3	5.2	-	5.2	0.5	-	3	1φ2w	220	
f-Xn	32	30	51.9	-	51.9	0.5	-	31	1φ2w	220	
f-La	20	6.7	11.5	13.3	24.8	0.7	1.2	25	3φ4w	127-220	1φ 220
f-LnK	8.7				8.7	0.6	-	6.1	3φ4w	127-220	3φ 220
f-P	22				22	0.6	-	15.5	3φ3w		220
f-Lo	33	11	19	22	41	0.6	1.2	35	3φ4w	127-220	1φ 127
f-Ln	23	7.7	13.5	15.3	28.8	0.6	1.2	24.4	3φ4w	127-220	1φ 220
Total	183.7							184			

4-4 Design Criteria Calculation for Main Line Size

The following conditions shall be used as design criteria for the calculation:

A. Location of Transformers:

1. A substation with transformers will be built in the premises of all A, B, C class hospitals.

2. A transformer will be installed on a pole or on the ground at a location within 300m from the hospital for D class hospitals including D^{+}.
   As an exception, a substation will be built for Kendage because of the existing conditions in the premises.

B. No. of transformers:

1. For each of A, B and C class hospitals, two units of transformer will be installed as follows:

   1 unit for X-ray
   1 unit for lighting and motors

2. For C class, one unit will be installed to commonly serve X-ray, lighting and motors.

C. Location of substation in premises:

1. The location shown in the attached plan of external wire installation work is selected with the X-ray room in mind. This location shall be given preference to all other alternative locations.

2. Service wires, etc. shall be installed to the generator room as shown by PLN.

D. Secondary voltage of transformer:

1. For the transformer for X-ray equipment,

   3 phase, 4 wire, 220V - 300V, 50Hz

2. For the transformer for lighting and motors,

   3 phase, 4 wire, 127V - 220V, 50Hz

3. For the common transformer for X-ray and lighting/motors,

   3 phase, 4 wire, 127V - 220V, 50Hz

E. Property and work boundary with PLN:

1. Common to each hospital, the property and work responsibility shall be demarcated with the primary side (PLN power terminal) on the distribution board in the generator room which is shown in the attached plan of external wire installation work.

Work by PLN	:	Power supply side from the above terminal
Work by the Japanese side	:	Load side including the above terminal

2. Specifications and other details of this terminal shall be as a rule discussed with the Indonesian side for adjustment.

F. No. of main lines:

1. Reliability, load sharing and voltage fluctuation shall be considered.

2. No. of lines

Existing	2 lines
Newly installed	6 lines
Total	8 lines

G. Distribution system by line

1. System

Feeder code	System	Details of Load
f - Lo	3 ϕ 4 W 127-220V	Existing loads excluding X-ray
f - Ln	" "	Lighting for building to be newly constructed
f - m	" "	Newly installed medical equipment and plug sockets
f - p	3 ϕ 3 W 220V	Power for newly installed sanitation, air-conditioning and other equipment
f - La	3 ϕ 4 W 127-220V	Newly installed laboratory equipment in laboratory
f - Lauk	" "	Newly installed kitchen and laundry boilers
f - Xo	3 ϕ 4 W 220-380	Existing X-ray
f - Xn	" "	Newly installed X-ray

Note: 1. For Kotamobagn,
read voltage of f-Lo, f-Ln, f-m and f-La as 220 - 380V.

For f-p, and f-Lauk, a transformer, 3ϕ, 4W, 220 - 380V, 127 - 220V, shall be installed, with the system as shown in the table.

2. For D^{+} and D classes, read voltage of f-Xo and f-Xn as 127 - 220V.

H. Consideration for voltage rise:

1. Single phase equipment to be installed shall be rated at 1ϕ, 220 - 220V, and 3ϕ 4W wiring shall be made to provide easy connection between external lines at the present moment (127 - 220V) and between neutral lines at the time of voltage rise (220 - 380V).

2. Three phase equipment to be installed, which are nemeruous in f-Lauk and f-P, shall be rated at 200 - 220V, and wiring shall be made at 220V between external lines at present and by installing a coupling transformer in the generator room at the time of voltage rise (220 - 380V).

3. In 2, consideration on transformers shall be made separately.

I. PLN's voltage fluctuation:

1. At the time of survey, the voltage fluctuation was 10 to 13% in hospitals which have no transformers in their vicinity. It was 5 to 9% in the case of hospitals which have transformers in their premises.

Analysis of voltage fluctuation:

2. The voltage dropped by 5 to 9% on the primary high-voltage side of the transformer. The taps were found connected at the standard location. Taps have a lead of ± 5% and the upper limit can be adjusted to 5% by selecting this lead.

J. Setting particulars for design calculation:

1. To improve the above conditions, the following particulars shall be set:

Allowable voltage drop

There was a voltage drop of 5% on the power supply side. With overall allowance set at 7% for loads in general and 9 to 10% for X-ray, the following values shall be taken as main line allowable voltage drop:

General	2%
X-ray	4%

2. For distribution voltage, the voltage obtained at the survey shall be used as the set value.

3. The design load capacity shall be set according to the table of load equipment plan in the attached material, 7 - (1).

4. Setting main line route

   a. Consideration shall be made to allow main line branching for each existing building.

   b. For erecting poles, the route shall be selected which will cause the least obstruction to traffic.

   c. Consideration shall be made to install branch lines on the building or branch poles.

   d. Air space over the projected construction site (confirmed at the survey) shall be avoided in routing.

   e. Routing shall be made in a straight lines as much as practicable to facilitate maintenance and inspection.

5. For the overall length, the following points shall be considered because the scale used is too large:

   a. With 20% of the actual length as the limit, the calculated value for drop shall be set as a corresponding value.

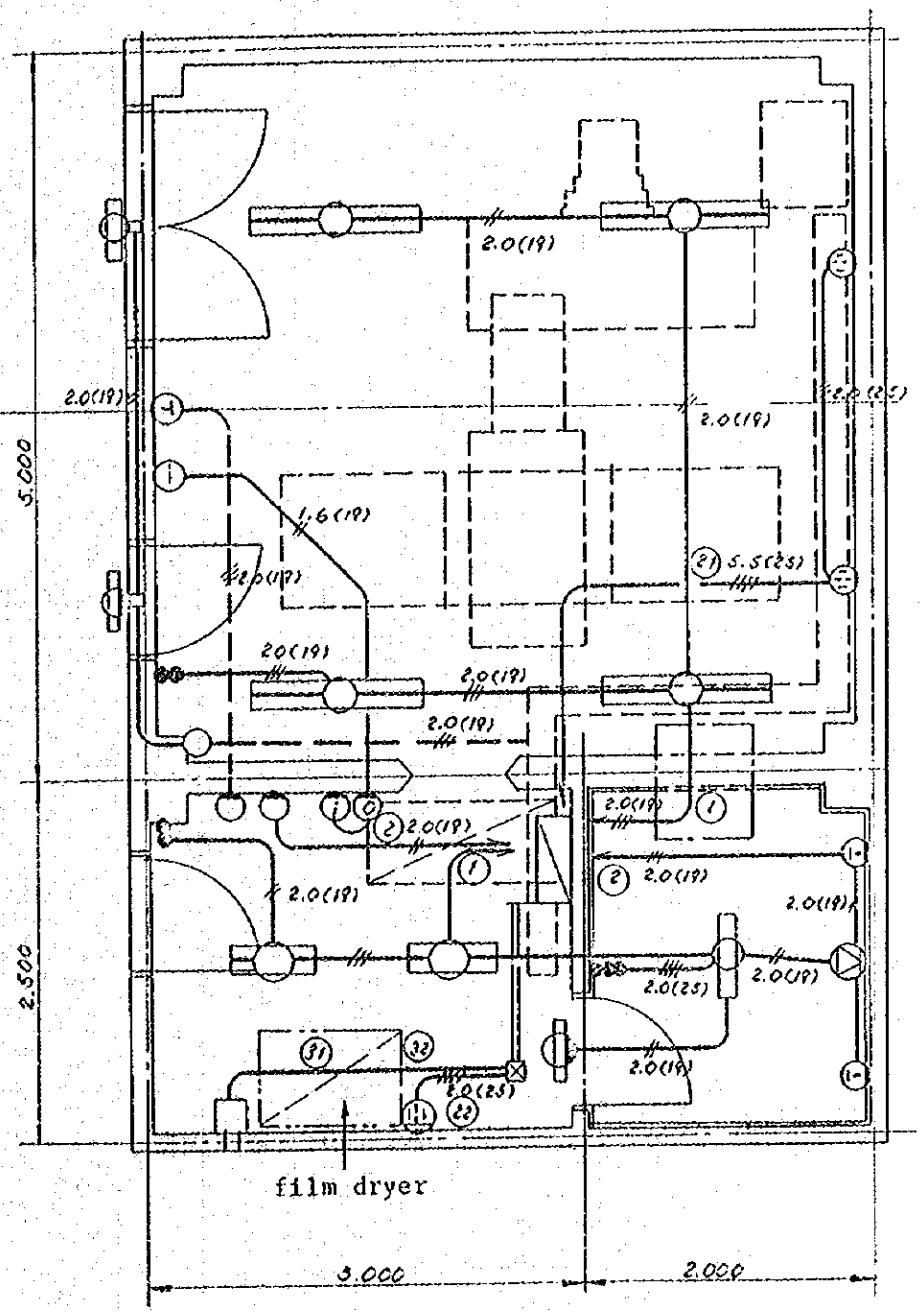
6. Because of various conditions in G and H, there are many single phase loads. Moreover, all wiring for the section from the branching point on the main line to the building and interior wiring will be all installed by the Indonesian side. Therefore, not only complete balance connection but balanced operation of loads as well cannot be expected.

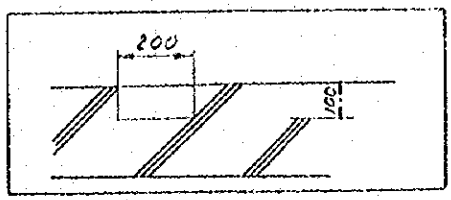
   The main line current shall be calculated, taking the foregoing into consideration.

K. Calculation formula for electric wire size:

		L=Length (m) I=Calculated current $I_1 = \frac{P \times 10^3}{3} \div 127$ $I_2 = \frac{P \times 10^3}{I_3 \cdot 200}$	e=Voltage drop e_1 = 2V e_2 = 4V e_3 = 8V $I_3 = \frac{P \times 10^3}{0.5} \div 200$
①	f-Lo	$\frac{17.8 \times L \times I_1}{1000 \times e_1}$ or $0.009 \cdot L \cdot I_1$	
②	f-Ln f-La f-Lauk f-P	$\frac{30.6 \times L \times I_2}{1000 \times e_2}$ or $0.0076 \cdot L \cdot I_2$	
③	f-Xo f-Xn	$\frac{35.6 \times L \times I_3}{1000 \times e_3}$ or $0.0045 \cdot L \cdot I_3$	

Reference Chart for X-ray





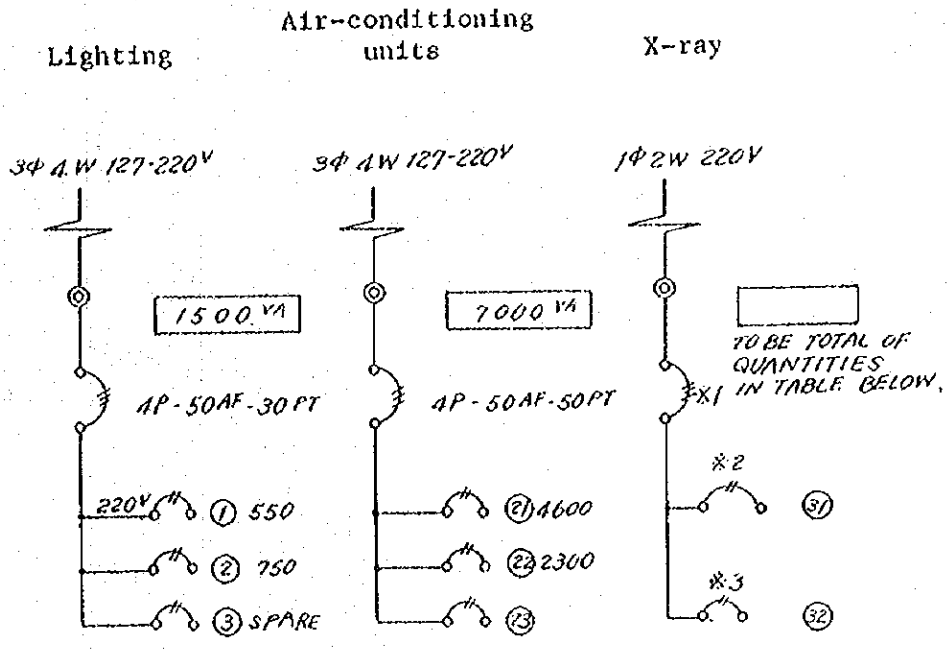
Condition	X-ray
Data	1978.6
Model	150^{nop} - 700^{mA}
Scale	1:50

LEGEND

SYMBOL	DESCRIPTION
	DISTRIBUTION BOARD
S	SWITCH BOX 600V
	4P PLUG SOCKET 600V
T	2P PLUG SOCKET 600V
	JOINT BOX WITH FLASH PLATE
	LIGHTING FIXTURE FL40-2, 250V
	" FL20-2
	LIGHTING FIXTURE WALL MOUNT BRACKET FC10-7 LETTERS: PHOTOGRAPHING"
	LAMP
	LOCAL SWITCH 250V/0A
NO	DISTRIBUTION BOARD CONNECTION SIGNAL.
	FLOOR DRIVING WIRING
	BURIED OR CONCEILED WIRING

POWER FOR INTERPHONE

	WALL-MOUNT TYPE INTERPHONE FOR SIMULTANEOUS TWO-WAY COMMUNICATION
	WALL-MOUNT TYPE INTERPHONE WITH SAME SPECIFICATION AS ABOVE



X-Ray No.	Total capacity	Total current	MCB rating	MCB rating	MCB rating	
1	50kW 1φ 200V	425A	2P 400AF 300AT	2P 225AF 200AT	2P 225AF 150AT	
2	30kW 1φ 200V	275A	2P 225AF 200AT	2P 225AF 150AT	2P 100AF 50AT	
3	"	"	"	"	"	
4	"	"	"	"	"	
5	25kW 1φ 200V	250A	2P 225AF 150AT	2P 225AF 100AT	2P 50AF 30AT	
6	3kW 1φ 200V	30A	2P 50AF 30AT	-	-	
7	Mobile type			-	-	
8	"			-	-	
9	3kW 3φ 200V 7kW 1φ 200V	10A 35A	3P 50AF 20AT 2P 50AF 50AT	-	-	

	Room Area (m^2)	Ceiling Height (n)	Height from Desktop (m)	Equipment Installation Height (m)	Frontage X	Depth Y	Room $\frac{X \cdot Y}{(X+Y)H}$	Room Index Class	Condition for Reflection Factor Ceiling	Wall	Floor
Photographing Room	25	3.5	0.8	2.7	5	5	0.92	I	50	50	10
Control Room	7.5	3.5	0.8	2.7	3	2.5	0.5	J	50	50	10
Processing Room	5	3.5	0.8	2.7	2	2.5	0.6	J	50	30	10

	Flashing Fixture Type	Flashing Fixture Installation Method	Light Flux Per Lamp (ℓm)	Flashing Factor U	Design Intensity of Illumination E	Compensation for Reduction in Light D	$\frac{A.E.D}{U.F}$	No. of Lamps Required
Photographing Room	FL40-2 V type	Direct mounting	6,600	0.4	300	1.4	$\frac{25\times300\times1.4}{0.4\times6600}$	4
Control Room	FL20-2 V type	"	2,400	0.32	150	1.4	$\frac{7.5\times150\times1.4}{0.32\times2400}$	2
Processing Room	FL20-1 V type	"	1,200	0.26	50	1.4	$\frac{5\times50\times1.4}{0.26\times1200}$	1

	①	② ∿ ④	⑤	⑥	⑦ ⑧	⑨
X-Ray and Dryer	50kVA	30kVA	25kVA	3kVA	3 ∿ 2	3φ 3kVA 1φ 7kA
Lighting and Plug Socket	1,500 VA			500	-	3,200 VA
Air-Conditioning Units 3φ 3W	7,000 VA			2300	-	14,000 VA
					-	
Room Area	37.5 m^2			10 m^2	-	80 m^2

4-5 COMMON SPECIFICATIONS FOR INDEPENDENT POWER PLANT FACILIES WORKS

I N D E X

4-5-1 Equipment

1. General matters

1.1 General specifications

(a) The equipment should be made of good quality materials and should be hardly slackened, strong and high in durability in any part. Further it should be of a structure which permits easy maintenance, inspection, repair, etc.

(b) The independent power plant of continuous rating for more than 72 hours.

(c) The independent power plant should be operated to be staited and be stopped by a push button.

(d) The time required for starting should be within 40 seconds from the time of pushing a button till the voltage is established.

(e) The finishing color of the equipment should be the standard color of manufacturer unless specified otherwise.

2. AC Generator

2.1 Structure

(a) The AC generator should be a horizontal synchronous generator.

(b) The outside cover should be of protected type.

(c) The kind of insulation should be of B grade or higher.

(d) The structure should not cause harmful vibration even when directly connected to the engine.

(e) All the specifications except those mentioned above should be according to JIS C 4004 "Rules of revolving electric machinery" and JES 114 "Synchronous machine".

2.2 Rating

(a) The net output which can be actually supplied to the load is to be regarded as the rated output and is indicated by "KVA".

(b) The rated power-factor should be in principle 80% lag.

(c) The kind of rating should be the continuous rating.

2.3 Performance

(a) The efficiency should be indicated by the unified efficiency and should be the rated power-factor and the rated output. It should be as shown in the table of 1.2.1.

Table 1.2.1 Efficiency of Generator

Rated output KVA)	100	125	150-200	250	300-375	500-625	750-1000
Unified efficiency (more than %)	86	87	88	89	90	91	92

(b) The overload yield strength should remain normal mechanically during operation for 30 minutes under 110% load of the rated frequency, rated power-factor and rated output.

(c) The overspeed yield strength should remain normal mechanically during operation for one minute under 120% speed of rated rpm with no load and with no excitation.

(d) The limit of temperature rise at 40°C of ambient temperature during the rated operation time should be according to JEC 114 "Synchronous machinery".

(e) The wave form at the time of no load, rated voltage and rated frequency should be near the sine wave and the wave form deviation rate should be less than 10%.
However this limit is not applied to the output of less than 100 KVA.

(f) The voltage variation rate should be according to the followings.

(1) The gradual voltage variation rate is regarded to be the voltage variation rate in case the load is varied under the rated power factor between the no load and the full load and the variation rate should be plus or minus 3.5%.

However, in this instance the speed variation rate should be within 5% and contain characteristics of the exciting equipment.

(2) The instantaneous voltage variation rate should be the voltage variation rate at the time when to the generator is suddenly exerted a load equivalent to 100% (less than the power-factor 0.4) of the rated current by the rated voltage during the no-load operation with the rated frequency and should cone within -20% and return to be within -3% of the final rated voltage in 2 seconds. However, in this instance, the speed variation rate of the prime mover is not put into consideration and the characteristics of the exciting equipment is not included.

(g) The withstand voltage should be normal at the rated frequency when the voltage of the value shown in Table 1.2.2 is given.

Table 1.2.2 Withstand Voltage Test Voltage

Place to test	Test voltage
Between windings at each phase of armature and earth	2E + 1000 V (Lowest 1500V)
Between field windings and earth	10E (Lowest 1500V Highest 3500V) In case of self-excitation system, 10 times as high as the DC exciting voltage (Lowest 1500V Highest 3500V)

(Remarks) In the table, E represents the rated voltage of generator and Ex, the rated voltage of the field windings.

(h) The insulation resistance between the widings and the steel frame should be according to the Table 1.2.3.

Table 1.2.3 Insulation Resistance

Place to test	Measuring instrument	Insulation resistance value
Armature widings	500V insulation resistance meter	5M Ω or more
Field windings	500V insulation resistance meter	5M Ω or more

2.4 Marking

The generator should be marked for the followings.

(a) Name

(b) Model

(c) Rating: Number of phase, rated output, rated voltage, rated current, rated power-factor, rated frequency and rated r.p.m.

(d) Number of Pole

(e) Kind of insulation

(f) Name of manufacturer

(g) Year of manufacture and Manufacture No.

3. Prime Mover

3.1 Conditions of installation

The conditions of installation should be as mentioned below.

(1) The ambient temperature should be the room temperature and should be 5°C at lowest and 40°C at highest.

(2) The ambient temperature should be 90RH at highest.

3.2 Structure

The prime mover should be a single-moving 4 cycle diesel engine and should be of astructure which permits easy manual operation, stop, etc. on the side of machine.

3.3 Performance

The performance should be as mentioned below.

(a) The fuel consumption rate should under the machine's individual operation and rated operation be less than the values shown in the table 1.3.1.

Table 1.3.1 Fuel consumption rate (unit: g/ps. h)

Rated output of generator	Over 40 KVA below 200KVA	Over 200KVA Below 375KVA	Over 375KVA Below 625KVA	Over 625KVA Below 1000KVA
	220	200	180	170

(Remarks) (1) The standard atomospheric conditions should be according to the followings.

Atomospheric pressure: 760 mmHg (1013 mbar)

Temperature: 20°C (293°K)

Humidity: 65%

(b) The speed characteristics should be as mentioned below.

(1) The speed variation in case of breaking the rated load should be in the transient state within 1.0% and in the normal state within 5% and should return to the speed of plus 5% of the final normal revolving speed in 8 seconds.

(2) The speed variation rate in case of closing the next load should be in the transient state within 10% and in the normal constant state should return to the speed of plus or minus 0.4% of the normal constant revolving speed in 8 seconds.

(i) The prime mover to be combined with a generator of 100KVA to 300KVA should be with the load of 70% of the generator's rated output.

(ii) The prime mover to be combined with a generator of over 300KVA should be with the load of 50% of the generator's rated output.

(3) The speed variation rate at an optional load between 25% load and the full load of the generator's rated output should not deviate by 1% of the rated speed from a direct line connecting the speed at the time of 25% load with the same at the time of full load.

(c) The starting performance should in the state of being directly connected with a generator be as mentioned below.
In case of pneumatic starting, the frequency to permit starting by one air tank should be more than 5 times.

(d) The overspeed yield strength should, in the state of being directly connected with a generator, remain normal even in case of operation for 30 minutes at 110% of the rated output.

(e) The overload output should in case of being directly connected with a generator remain normal in case of operation for 30 minutes at 110% of the rated output.

(f) The vibration should be at the time of rated operation less than the values in the Table 1.3.2.
Further, the vibration should not cause any trouble due to the increase in vibration at the time of passing the resonance point at the time of starting and stopping operation.

Table 1.3.2 Vibration (Unit mm)

Place to measure	Common bed FLOOR			Foundation and its neighboring place
Vibration	In case of 1, 2, 3 cylinder	In case of 4, 5, 7 cylinder	In case of 6, 8 cylinder	5/1000
	8/10	4/10	5/20	

(Remarks) The vibration means the amplitude measured by a cibrometer on the common bed floor, in the horizontal direction of the vibration proof plank and the foundation in its neighborhood and in the horizontal direction making a right angle with the axis and axial direction, in the state of rated operation.

(g) The maximum temperature should be less than the values shown in Table 1.3.3., during the rated operation for 2 hours at the lubricating oil temperature and on the surface of all parts.

Table 1.3.3 Maximum temperature (Unit °C)

R.P.M.	Cooling system	Place to measure	Main Bearing	Crank Bearing	Piston Pin Bearing	Lubricating oil
Less than 1200 rpm	Radiator system		100	105	110	90
More than 1200 rpm	"	"	150	150	150	110

3.4 Speed governer

The speed governer should be of mechanical or hydraulic system (including a model combined with the electric system) and the range set up for the revolving speed by the speed governer should be more than plus or minus 5% of the rated revolving speed at the time of non-load.

3.5 Measuring instruments

The following measuring instruments should be provided.

(1) Tachometer

(2) Lubricating oil pressure gauge

(3) Lubricating oil thermometer

(4) Cylinder thermometer

(5) Suction pressure gauge (engine with a supercharger of of over 360PS)

(6) Thermometer for measuring temperature of exhaust (Engine of over 360PS)

3.6 Parts

(a) The cooling water system should be as mentioned below.

(1) The engine of rediator cooling system should be provided with a level gauge or a gauge cock at the radiator.

(2) The cooling water pump should be of such a system as is driven by the crank shaft.

(3) The cooling water system should of a structure which permit the water in the engine to be exhausted.

(b) The lubricating oil system should be as mentioned below.

(1) The system should be provided with an inspection bar etc. to check the volume of oil in the engine crank box.

(2) The piping of the lubricating system should be provided with a filter.

(3) In case the priming is required, one of the following methods suitable to the engine should be employed.

(i) Periodical priming

The priming pump should be operated more than 3 minutes every 12 hours.

(ii) Priming before the operation start.

(c) In case the fuel reservoir is in a higher position than the fuel tank, an electromagnetic valve should be provided to prevent the overflow. Further, near the fuel oil reservoir be provided a device to shut the fuel by a remote operation from the generator room.

(d) The exhaust aggrege pipe should be of s system which is covered by insulating materials, heat shields, etc.

.7 Starting and Stopping device

(a) Starting system

The pneumatic starting system should be connected to the pipings inside of the engine from the air tank through the stop valve for starting (starting operation valve) and should be of a system which starts the engine by flowing the compressed air into the cylinder or the air motor. Further the air pipe should be provided with an electro-magnetic valve.

(b) The stopping system should be of an automatic fuel shutting system or a suction air shutting system and should be of a system which is driven by an instruction of the protection device or the switchboard.

.8 Common bed floor

The common bed floor should be provided with a vibration prevention device by use of rubber or metal spring.

3.9 Marking

The prime mover should be marked for the following matters.

(1) Name of engine

(2) Rated output

(3) R. P. M.

(4) Name of manufacturer

(5) Year of manufacture and Manufacture No.

4. Switchboard

4.1 Structure

(a) The switchboard should be made of good quality materials, hardly slackened, strong and high in durability in all parts and should of a structure which permits easy maintenance, inspection, repair, etc.

(b) The switchboard should be provided with a plate showing the use and name of the switchboard at its front. The name plate should be made of metal (with letters engraved).

(c) In case an outlet type circuit breaker, switch, etc. are used, a guard rail or stopper for the outlet should be provided.

(d) The inlet and outlet of the enclosed switchboard should in principle be of a structure to which cables or bus ducts can be connected and should be marked for each phase.

(e) The terminal bed for control should have allowance to accomodate more than 5 terminals in each face of the switchboard and should be separate from each other in enough interval according to different voltages.

(f) The earth terminal to connect the earth wire should be as mentioned below.

(1) The earth terminal should be fitted to copper made or brass made terminal and should involve no trouble of soldering.

(2) For earthing of No. 1 kind (excluding arrester), No. 2 kind, No. 3 kind, Special No. 3 kind and the arrestor, in each earthing the wiring should be done upto the earth terminal inside of the switchboard.

(3) No. 2 kind earth terminal should be provided in insulation against the metal box and should be of a structure which permits easy measuring of leakage current by use of a leakage current meter while the door, etc. are opened.

(4) The arrester earth terminal to accomodate should be insulated against the metal box and should be isolated from terminals to connect the earth wire of other appliance.

(5) The screw to fit each earth terminal should be with a grooved hexagonal head and should be colored in green in such way as the color hardly disappears.

(g) The main equipments of switchboard should be fitted to the fitting panel or the fitting frame shown in Table 1.4.1 and should be wired.
Further, the fitting panel which is less than 0.1 m^2 in dimension and fitting metals (auxiliary fitting frame, auxiliary place, , etc.) may not be according to Table 1.4.1.

Table 1.4.1 Fitting panel or fitting frame

Fitting panel or fitting frame		Thickness of material (more than mm)	
		Dimension of panel, within 0.4 m^2	Dimension of panel, Over 0.4 m^2
		2.3 (1.6)	3.2 (2.3)
Fitting frame	Light weight shape steel	2.3	
	Flat steel Angle steel	3	

(Remarks) The figures in ( ) are applied to the fitting panel or fitting frame which is specially processed for reinforcement (including reinforcement by bending-up, press-ribbing and by use of steel products).

4.2 Outer box

(a) The switchboard should be made by using steel plates thicker than shown in Table 1.4.2. It should be reinforced by bending-up and press-ribbing or by use of steel products when it is necessary and its metal parts should be electrically connected with other in assembled state.

Table 1.4.2 Thickness of Plate

Item	Thickness of steel plate (mm)
Side plate	1.6
Bottom plate	1.6
Roof plate	1.6
Dash board	1.6
Door and front plate	2.3
Shield plate (Punching metal, etc.	0.8

(Remarks) The dash board here means what is used in the unit enclosed type switchboard for the partition wall.

(b) The indoor type switchboard should be as mentioned below.

(1) The door should be constructed to be locked.

(2) The hinge should be in principle not seen from the front of door.

(3) The closed type switchboard should be provided with a board plate, which could be removed when it is necessary.

(c) The steel plates forming the switchboard should be given the foundation treatment such as the phosphate film treatment and the visible portion on the surface should be finished according to JEM 1135 "Colors of Switchboard, and control panel and their fitting tools".

4.3 Insulation class, etc.

(a) The voltage of control circuit should be according to Table 1.4.3.

Table 1.4.3 Voltage of Control Circuit

AC (V)	6	12	24	--	100	200
DC (V)	6	12	24	48	100	--

4.4 Conduction Part

(a) The main circuit should have enough current capacity to the load current and should have mechanical strength and thermal strength to the broken current of the circuit breaker.

(b) In case a bare copper belt or bar is used for the conductor of the main circuit, it should be more than 96% in its conductivity and should be covered or lacquer-coated for insulation. In this instance, any particular color is not specified.

(c) The main circuit conductor should be laid out according to Table 1.4.4 and its edge or a part of it should be colored for identification. However, this is not applied in case of a layout and color-classified insulation wire which is to be used for necessity of work.

Table 1.4.4 Layout and Color-classification of Conductor

King of voltage	Wiring system	Right & left, up & down or near & far	Red	White or grey	Black	Blue	White or grey
Low voltage	3-phase 3-line system	In case of right & left, from left	1st phase	2nd phase on earth side	-	3rd phase	-
	3-phase 4-line system	In case of up & down, from up	1st phase	-	2nd phase	3rd phase	Neutral phase
	Single phase 2-line system	In case of far & near, from near	1st phase	2nd phase on earth side	-	-	-
	Single phase 3-line system		1st phase	Natural phase	2nd phase	-	-

DC	In case of right & left, from left.				
	In case of up & down, from up	Positive pole (P)	-	-	Negative pole (N)
	In case of far & near, from near				

(Remarks) (1) The 3-phase circuit of low voltage or the single-phase 3-line system circuit branching from the single-phase 3-line system circuit should be according to the color classification before branching.

(2) The 1st phase of the single-phase 2-line system may be colored black.

(3) The phase of 3-phase AC should rotate in the order of 1st phase, 2nd phase and 3rd phase.

(4) "Left and right" and "Far and near" mean the location seen from the front.

(d) In case the insulation wire of less than 600V is used for wiring of the switchboard, the wiring and its method should be in accordance with JEM 1153 "Closed switchboard" and JEM 1265 "Low voltage closed switchboard" and should be as mentioned below.

(1) The color classification of wire covering should be according to Table 1.4.5

Table 1,4.5 Color classification of Wire covering

Kind of circuit	Dolor of covering
General (including low voltage and main circuit)	Yellow (1)
Earth line (2)	Green (3)

(Remarks) (1) In case a special insulation wire is used for the main circuit, it may be colored black.

(2) The earth line here means a wire to be used for earthing of the circuit or appliance.

(3) In case it is compelled to use green color, the green color classification should be dome at the edge.

(2) The edge of wiring should be connected without soldering and should be provided with a mark band for showing the wiring number or a mark band showing the sign of terminal. The mark band should in principle be insulated.

(3) The parts of the control circuit wiring, etc. which require castability should be given consideration to prevent them from being damaged at the time of opening or closing the door, pulling out or pushing in the appliance provided in the box, etc.

(e) The connection inbetween the conduction parts or the connection with the appliance terminal should be electrically and mechanically complete by employing one of methods suitable to the terminal structure, which are screw-tightening (combined use with the spring washer), bolt-tightening, connection by use of joint fittings, branch fittings, tight terminal, etc.

4.5 Main circuit wiring

(a) The separation distance between the conductors of low voltage and between the conductor and non-charging metal body should be over 10mm in the space as well as by the surface. However, the separation distance in a place where the voltage between lines of more than 300V is exerted should be more than 15mm.

(b) The current density to the rated current of copper conductor used for the low voltage main circuit should be according to Table 1.4.6 in principle. Further, in case the ambient temperature, the method of surface tratment at the connection part, the conditions of use, etc. are clear, it is allowed not to be according to Table 1.4.6.

Table 1.4.6 Current density of low voltage circuit copper conductor

Rated current (A)	Current density (less than A/mm^2)
Below 400	2.5
401 to 800	2.0
801 to 1200	1.7
1201 to 2000	1.5

(Remarks) The allowance of plus 5% of the current density is admitted for beveling and molding.

(d) The thickeness of the insulation wire in case it is used for the main circuit of switchboard should be according to Table 1.4.7.

Table 1.4.7 Minimum thickness of Insulation Wire

Rated current (A)	Twisted wire (mm^2)	Single wire (mm)
Below 30	5.5	2.6
31 to 40	8	3.2
41 to 50	14	4
51 to 75	22	-
76 to 100	38	-
101 to 125	50	-
126 to 150	60	-
151 to 175	80	-
176 to 200	100	-
201 to 250	125	-

(c) The neutral bus line of low voltage circuit should be as mentioned below.

(1) The rated current of neutral bus line should be same as the rated current of other bus lines.

(2) The neutral bus line of multi-line system electric wiring should be provided with an overcurrent circuit breaker. However, this is not applied to a bus line of the multi-line system electric wiring, all poles of which are broken at the same time when the overcurrent circuit breaker have worked.

(3) The neutral bus line should be provided with an individual switch gear, etc. which can be easily operated and bar blocks other than a screw clamp.

4.6 Charging part

(a) The closed type switch board should not expose any charging part when it is with the door closed.

(b) The seperation distance between the charging parts of the main circuit and the same between the charging part and the non-charging part should be according to 1.4.5 (a).

(c) The seperation distance between the charging part of low voltage control circuit and the non-charging metal body should be according to JEM1103 "Insulation distance of control appliance".

(d) For the terminal part of the low voltage main circuit to connect the outside wiring a terminal lug shitable to the thickness of wire and, in case there is no insulated partition wall in between, in principle each terminal should be fitted by more than 2 screws or it should be provided with a steady rest. In case the situation does not permit the above, the distance between the terminal lug and the non-charging metal body and the same between the different pole terminal lugs should be over 10mm even in case each terminal lug title 30°. However, this is not applied when the insulation treatment has been done.

4.7 Implements in the switchboard

(a) The switch, etc. should be as mentioned below.

(1) The neutral pole of the multi-pole switch to be built in the bus line should be closed earlier and be opened later than other poles. However, this is not applied to the circuit breaker for wiring, etc., all the ples of which are opened and closed at the same time.

(2) The circuit breaker for wiring should be in accordance with JIC C 8370 "Circuit Breaker for Wiring" and the broken current should be over 15000A. Further, the dimension and rating should be according to JEM 1292 "Dimension and Rating of Circuit Breaker for the unified type wiring for the electric lamp distribution board.

(3) The circuit breaker for protection of motor should be in accordance with JIS C 4504 "Rules of the line start switch of induction motor" and shall be as mentioned below.

(i) The circuit breaker should be marked to indicate that it is a circuit breaker for protection of motors.

(ii) Each pole should be provided with an electric pulling-out element.

(iii) The application of the unit equipment of 3-phase induction motor should be as mentioned in Table 1.4.8.

Table 1.4.8 Application of Circuit Breaker for Wiring

Kind of load	Starting time of motor (sec.)	Circuit breaker for wiring	
		Starter used	Line start
Pump, fan *	below 3	MMCB, MCB1	MMCB, MCB1
Pump (big in starting current	below 5	MCB1	MCB2
Fan	3 to 10	MCB1	MCB2
Blower	10 to 20	MCB2	MCB3
Those, long in starting time	20 to 30	MCB2	MCB3
Those, specially large in starting current and time	30 to 45	MCB2	MCB4

(Remarks) * : The fans meant here are limitted to those such as ventilating fans, which are short in starting time.

(4) The aerial circuit breaker shall be according to JEC 160 "Aerial Circuit Breaker".

(5) The AC electromagnetic switch and AC electromagnetic contactor should be in accordance with JIS C 8325 "AC electromagnetic switch" and JEM 1038 "AC electromagnetic contactor" and shall be in accordance with the following specifications.

Classification by close-circuit and broken current capacity -------- AC3

Classification by Number according to frequency -------- Higher than No. 5

Classification by kind according to life -------- Higher than Kind 3

(6) The terminal plate (terminal bed) shall be a terminal fitted to an insulated body. For the terminal plate to which the output and input terminal of the distribution board are to be fitted, an insulation plate made of molded phenol resin or an insulator similar to or better than it.

(b) The low voltage fuse should be as mentioned below.

The fuse used for the control circuit should be in accordance with JIS C 9314 "Cylinder shape fuse and holder for wiring", JIS C 8319 "Plug, fuse and holder for wiring" and JEM 1293 "Current limiting fuse".

(c) The transformer for measuring instruments should be as mentioned below.

(1)

(i) The transformer should be of widing type for indoor use and shall be epoxy or synthetic rubber molded and polyester molded.

(ii) The class of transformer should be Class 1.0.

(iii) The number of phase should in principle be single.

(iv) The rated secondary load should be more than 15va.

(2) The transformer for earth type measuring instruments should be epoxy or synthetic rubber molded.

(3) The current transformer shall be as mentioned below.

(i) The transformer should be for indoor use and shall be in accordance with (i) of (1).

(ii) The class of current transformer should be Class 1.0. However, in case the overcurrent strength is especially large, its class may be Class 3.0 upon approval of an officer in charge.

(iii) The rated secondary load shall in principle be more than 5 va.

(iv) The transformer should have enough rated overcurrent strength.

(d) The indicating instruments should be those with JIS mark (excluding the frequency meter of transducer system and power-factor meter) and shall be in accordance with JIS C 1102 "Indicating electric instruments" and JIS C 1103 "Dimension of electric indicating instruments". Further they should be as mentioned below.

(1) The indicating instruments should be square-shaped with a round barrel and with a buried type wide-angle scale.

(2) The class of indicating instruments should be Class 1.5 (excluding the frequency meter, phase meter, power-factor meter and reactive factor meter).

(3) The class of frequency meter shall be Class 1.0.

(4) The tolerance of phase meter, power-factor meter and reactive factor meter shall be plus or minus 4% in the phase angle.

(e) The integrating meter shall be in accordance with JIS C 1210 "Rules of Electric energy meter", JIS C 1211 "Ordinary electric energy meter (III model single element individual meter and III model multi-element individual meter)", JIS C 1215 "Ordinary electric energy meter (II model Multi-element individual meter)", JIS C 1216 "Ordinary electric energy meter (meter with transformer)", JIS C 1263 "Reactive electric energy meter", JIS C 1261 "Weather-proof structure of electric energy meters, etc." and JIS C 1283 "Puzzle device of electric energy meters, etc." and shall be as mentioned below.

(1) The integrating meter should be for indoor use and of buried type.

(2) The integrating meter should be in principle an inspected product.

(f) The protective relay should be in accordance with JEC 174 "Protective relay for electric energy" and shall be as mentioned below.

The protective relay should be square shaped and should be of buried type and, in principle, of pulling-out type.

(g) The auxiliary relay should be as mentioned below.
The control relay of magnetic type used as an auxiliary relay should be in accordance with JIS C 4503 "Switch for operating the AC electromagnetic switch", JIS C 8325 "AC electromagnetic switch", JEM 1138 "AC electromagnetic contactor" and JEM 1230 "Electromagnetic relay for control" and shall be as mentioned below.

Classification by close-
circuit and broken current .-------- JEM 1230 Table 3 and 4

Kind according to frequency of
opening and closing -------- Higher than No. 4

Kind according to life ------ Higher than Kind No. 2

(h) The switch for control should be in accordance with JEM 1137 "Shape for the screw-driver type switch for distribution board" and JEM 1237 "Operational switch for Control" and shall be as mentioned below.

(1) The screw-driver type switch for control should be as mentioned below.

(i) The automatic return system control switch should in principle be in structure to prevent erroneous motion and the handle return should be automatic by use of a spring.

(ii) The stop system control switch should be in structure without pulling nor return of handle.

(2) The push button should be as mentioned below.
The control switch should be in accordance with JIS C 4520 "Rules of Control switch", JIS C 0601 "Marking of operation and state for electric equipment" and JIS C 8326 "Box switch (for low voltage circuit)" and should be as mentioned below.

Further, the ordinary type push button switch should in principle be of automatic return system which does not project the surface of push button by a tightening ring. The control switch with an indicating lamp should in structure be operated by push with a lamp inside and should permit easy replacement of lamp from the front.

(i) Circuit breaker and close-circuit current capacity
----- Table 11 of JIS C 4520

(ii) Classification by number according to frequency of opening and closing -- Higher than No. 4

(iii) Kind according to life .---------- Higher than Kind No. 2

(i) The indicating lamp should be as mentioned below.

(1) The indicating lamp should be in accordance with JIS C 7516 "Electric bulb for distribution board" or JEM 1248 "Indicating Lamp". However, this is not applied in case of electric bulbs or discharge lamp of small energy circuit.

(2) As for the replacement of lamp, the structure should permit easy replacement from the front. The type of glove should be round or square and shall be made of synthetic resin or glass which is hard to change in color.

(3) The indicating lamp should in principle be of 2 lamp system (GL and RL).

(j) The indicator should be as mentioned below.

(1) The trouble indicator should be as mentioned below.

(i) The lamp illumination system trouble indicator should be with the surface made of acrylic resign or material of same quality and engraved with the indicating symbols or letters of the motion of the protective relay, etc. to indicate the illumination.

(ii) The target system trouble indicator should be comprise the motion coil indicating plate, return element, push button, etc.

(2) The motion indicator should be of lamp system and should be in accordance with (i) of (J).

(k) The indoor supporting insulator should be in accordance with SIS C 3814 "Indoor supporting insulator", JIS C 4620 "Cubicle system high voltage incoming equipment" and JIS C 3851 "Indoor use epoxy resin supporting insulator" and should be as mentioned below. Further, in case the indoor supporting insulator is used for the semi-closed type and closed type distribution board, its flexing load resistance (1 minute) should be in accordance with the current of the distribution board for a short time.

(1) The class of insulation of the indoor supporting insulator for high voltage should be No. 6 A.

(2) The surface of the insulator should be free from harmful bubbles, scars, cracks, uneveness, etc.

(3) The supporting fittings should be prepared to support the conductor with no need of finishing on the part of conductor. The copper belt supporting fittings should be firmly fixed to the supporting insulator.

(l) The branch fittings and joint fittings should be as mentioned below.

(1) Regarding the branch fittings and joint fittings of the copper belt, the copper belts should be put one upon another and fstened by a bolt without boring holes on the belt to fit in the connecting screw, etc. A square fitting should be used for jointing the belts and a triangle fitting should be used for the branching. Further, one side of the fittings should be made of non-magnetic materials.

(2) Regarding the branching fittings and joint fittings of the copper bars, a straight-line connector fastened by a bolt should be used for jointing and the Y-shape connector should be used for branching.

Further, the fitting should be made of non-magnetic materials and the bolts, nuts and spring washer should be made of zinc-plated steel.

(m) The terminal bed should be made of phenol resin or a material of same or better quality.

(n) As for the test terminal, in principle the pulling-out type test terminal should be provided on the secondary side of the current transformer and transformer for meters of the low voltage circuit and should be with a plate showing the name of circuit.
Further, the test terminal should be a pulling-out type test terminal which permits all terminals in a group to couple with or seperate from the outside circuit by setting or removing the connecting plug and should be with a plug for test.

(o) Inside of the closed type distribution board at its front and back in principle each one fluorescent lamp of single phase 100V and 10 (Total 2 lamps) or more should be provided and the lamps should in principle be on and off by opening and closing the door. Further, for the inspection the plug socket of 2P 220V 15A should be provided.

(p) The mark band indicating the number of implement should be as mentioned below.

(1) The implements to be fitted to the distribution board should in a visible place at their back be marked with the number of implement according to JEM 1099 "Automatic control implement number and JEM 1093 "Number of automatic control implement for AC substation". However, in case the above marking is impossible, a place other than the front of implement may be marked.

(2) The terminal of wiring should be with the mark band of the wiring. Further, the mark band should in principle be made of insulated materials.

4.8 Marking

The closed type distribution board should show the following matters by a metal plate at the back of its front door or the inner side of the board.

(a) Name

(b) Model

(c) Phase, system of line and nominal voltage

(d) Class of insulation

(e) Name of manufacturer

(f) Year of manufacture and manufacture number

4.9 Measuring instruments and relay

(a) The generator should be provided with following measuring instruments and relay.

(1) AC voltmeter, AC ammeter, Frequency meter and 3-phase wattmeter

(2) Integrating time meter

(3) Voltage relay, time limit relay, speed relay (in case the speed detector is of electric system) and other necessary relays.

4.10 Protective Equipment

(a) The indicating system of motion indicator should be of lamp system and shall be provided with a motion indicator of the indicating matters of Table 1.4.9.

Table 1.4.9 Indication of Motion

Item	Indicating Lamp	Matters
Control power source	White	Lighted when normal
Power source for commercial use	White	Lighted when normal
During transmission	Red	Lighted by closing circuit breaker
Operation of engine	White	Lighted by establishing voltage
Suspension of engine operation	White	Lighted during suspension of operation

(b) The protective equipment should perform automatic suspension of engine operation, automatic breaking of the main circuit and trouble indication and alarm by the motion of the equipment during the operation of engine.
The kind, marking, alarm, etc. should be according to Table 1.4.10.

Table 1.4.10 Protective Equipment

Kind	Item	Suspension of engine operation	Breaking of main circuit	Indication	Alarm	Detector	Remarks
Serious trouble	Delay in starting	o	o	Red	Bell	Relay detecting relay	
	Decrease in hydraulic pressure of lubricant	o	o	Red		Hydraulic pressure relay	
	Rise in cooling water temperature	o	o	Red		Water temperature relay	
	Overvoltage	o	o	Red		Overvoltage relay	
	Overvoltage	-	o	Red		Overcurrent relay	
Miner trouble	Decrease in air pressure	-	-	White	Buzzer	Pressure relay	
	Decrease of surface of fuel oil	-	-	White		Oil surface detector	
	Decrease of liquid surface of battery	-	-	White		Liquid decrease alarm	

(Remarks) The actions marked with o is to be taken.

(c) The set-up scope of the protective equipment should be according to Table 1.4.11.

Table 1.4.11 Set-up scope of protective equipment

Relay etc.	Set-up scole		
Hydrulic pressure relay	Value coming in accordance with the engine in a scope of 0.5 to 3.5kgs/cm^2 in the pressure of lubricant inside of engine		
Water-temperature relay	Value coming in accordance with engine in a set-up scope of 60°C to 105°C in the temperature of cooling water in engine		
Overcurrent relay	Value coming in accordance with generator in a scope of 110 to 125% in the rated current		
Overspeed detecting switch	Motion at a speed of 110% to 116% of the rated r.p.m.		
Pressure relay	For operation	For high voltage	On at 22 - 23kg/cm^2 Off at 29 - 30kg/cm^2
		For low voltage	On at 7-7.5kg/cm^2 off at 8.5-9Kg/cm^2
	For alarm	For high voltage	On at 15 to 21kg/cm^2
		For low voltage	On at 5-6 kg/cm^2

(Remarks) The error of meters is omitted

Accessory equipment of auxiliary machinery

5.1 Air compressor and air tank

(a) The air compressor should be as mentioned below.

(1) The cooling system of the air compressor should be of air-cooling system.

(2) The rated pressure of air compressor should be 30 kg/cm^2 at high pressure and 9 kg/cm^2, at low pressure. Further, the air compressor should be capable of charging the consumption air upto the rated pressure in one hour by manual operation in 5 times.

(3) The starting system should be automatic or manual by use of an operation switch.

(b) The air tank should be as mentioned below.

(1) The air tank should comprise 2 tanks of same capacity and the capacity of each should be in accordance with 1.3.3.(c).

(2) Each air tank should be provided with a safety valve, air charging valve, exhaust valve, drain valve and pressure gauge.

(3) The pressure relay should be provided for the automatic operation of air compressor and for alarm indication at the time of decrease in air pressure.

5.2 Battery charger and battery

(a) The charging method should be based on a method to perform recovery charging automatically when the input power source returns and automatically move to floating charging after the charging is completed.

(b) The battery charger should be as mentioned below.

(1) The battery charger should be with an automatic constant-voltage equipment and should be of full wave rectification and self-ventilated system and communication rating.

(2) The variation of the charger's DC output voltage should be within plus or minus 3% of the set-up value in case of output power source voltage of plus or minus 10% and load current variation of 0 to 50%.

(3) The capacity should be big enough to charge in 24 hours the battery consumption power after driving the internal combustion engine for repeating 5 times continuously operation of driving the internal cobustion engine for 5 seconds and then suspending it for 5 seconds and shall be over C/50 (A) when combined with the closed type lead battery and over C/20 (A) when combined with the alkali battery. However, C here means the nominal capacity (AH) of the battery to be combined with.

(4) The surface of the battery charger should in a place easy to see and bandle be provided with an automatic return type inspection switch to check the voltmeter and ammeter on the side of output, the indicating device during charging and the charging conditions of battery.

(5) The battery charger should be provided with a circuit breaker for wiring on the side of input and output.

(c) The battery should be as mentioned below.

(1) The capacity of battery should be big enough to drive the internal combustion by starting it 5 times continuously. However, the time for driving and suspending it at one time should be 5 seconds each.

(2) The battery of a type other than the seal type should be provided with a liquid decrease alarm. The volume of the bell, buzzer, etc. of the alarm should be ever 90 phones (A scale) at a position 1 meter from the front of the charging equipment, etc.

(3) Matters which are not mentioned above should be in accordance with the high-efficiency discharging use Bast type stationery lead batter specified in JIS C 8704 "Stationery Lead Battery", SBA 5005 "Bent type Alkali battery" and SBA 5006 "Seal type stationery alkali battery".

5.3 Accessory control panel of auxiliary machinery

The control panel of motor of 3-phase and over 200V should be as mentioned below.

(1) Each motor should be provided with a protective relay (in principle relay to prevent overload and single phase operation) and ammeter.

(2) Each motor should perform the indication of operation and suspension.

(3) The matters which are not mentioned above should be in accordance with Chapter 4 Distribution Board.

5.4 Fuel Reservoir

(a) The fuel reservoir should be as mentioned below.

(1) The fuel reservoir should be made of steel plate and should be in dimensions in accordance with Table 1.5.1.

Table 1.5.1 Dimension of Fuel Reservoir (mm)

Capacity (l)	Length	Width	Height	Inspection aperture	Plate thickness (over)		
					Bottom	Side	Upper
490	940	700	850	250	3.2	3.2	2.6
600	1000	800	1000	250	3.2	3.2	2.6
1000	1200	900	1250	250	4.5	3.2	3.2

(Remarks) The slight deviation from the above dimension is permitted.

(2) The oil surface detector should be provided.

The oil surface detector should be a float switch, etc. and should in structure of explosion-proof or sealed. Further, it is not necessary to use in combination the float switch for alarm.

(3) The fuel reservoir should be provided with the followings.

(i) Oil gauge

(ii) Ventilating pipe (more than 20mm in inner dia.) or ventilator.

(iii) Inspection hole or lid

(iv) Steel ladder

(4) The oiling pipe, oil conveying pipe, overflow pipe, drain pipe, ventilating pipe, etc. should be provided with a necessary pipe connecting opening.

(b) The underground oil storage tank should be as mentioned below.

(1) The underground oil storage tank should be made of steel plate, the thickness of which is more than 6mm, and should be in details according to the drawing.

(2) The underground oil storage tank should be built by welding the steel plates and should be provided with connecting openings and necessary fitting seats for the oiling pipe, oil absorbing pipe or oil conveying pipe, oil returing pipe, ventilating pipe, drain pipe, etc. and with following accessories.

(i)	Oiling opening (with pipe)	1 pair
(ii)	Oil absorbing non-return valve	1 "
(iii)	Measuring opening (with measuring scale)	1 pair
(iv)	Leakage inspection pipe	1 set
(v)	Oil storage tank lid	1 pair
(vi)	Lid for inspection (for leakage inspection pipe and drain opening)	1 set
(vii)	Ventilating fitting	1 pc.
(viii)	Protective cylinder, fixing band and other necessary accessories	1 set

5.5 Inflation Tank

The inflation tank should be made of copper plate and should be as mentioned below. However, as for the pressure-reducing tank mounted in case of the simple type generator, it should be constructed to permit the water-discharge system or circulating system by providing the feed water port and drain port and should be according to the standards of manufacturer.

(1) The dimension should in principle be according to Table 1.5.2. Further, the inflation tank should be built by welding. The outside of tank should be coated according to the specification of officer in charge and the inside of tank should be coated with epoxy resin or sprayed with molten zinc.

Table 1.5.2 Dimension of Inflation Tank (mm)

Capacity (l)	Length	Width	Height	Thickness of plate (over)		
				Bottom	Side	Upper
100	500	500	550	3.2	2.0	2.0

(2) The following should be provided.

(1) Water gauge

Inspection opening and lid

(3) The water feed pipe, air pipe, etc. should be provided with necessary pipe joint openings.

5.6 Fule conveying pump

(a) The motor pump should be based on a control system to be operated and stopped automatically by an oil surface detector.

(b) The hand pump should be a wing pump and should be constructed to be mounted on the fuel reservoir base.

5.7 Muffler

The muffler should be of inflation type or sound absorbing type.

5.8 Marking

The accessory equipment of auxiliary machinery should be marked with necessary matters according to JIS, JEC, JEM, etc.

Fuel oil, etc.

6.1 Fuel oil

The fuel oil should be heavy oil and No. 1 or 2 of 1st kind heavy oil (Kind A) specified in JIS K 2205 "Heavy oil".

6.2 Lubricating oil

The lubricating oil should be of Class CD, CC or CB of classification of lubricating oil according to performance specified by US Petroleum Association and should be suitable to the engine and in accordance with No. 20, 30 and 40 of classification by density specified by US Automotive Technique Association.

7. Piping materials

7.3 Piping materials

The specifications of main piping materials in each system of the fuel oil, exhaust, air for starting, etc. should be according to Table 1.7.1. Further As for JIS marking products, they should be used.

Table 7.1 Main piping materials

Material	Description of specifications	Specification No.	Remarks
Steel pipe	Carbon steel pipe for piping	JIS C 3452	JIS Mark product
Pressure steel pipe	Carbon steel pipe for pressure piping	JIS C 3454	Kind 2 or 3 JIS Mark product
Copper pipe	Tough pitch copper seamless pipe	JIS H 3606	JIS Mark product
Pipe joint	Screw type steel pipe made pipe joint	JIS B 2302	JIS Mark product
	Steel pipe made butt-weld system pipe joint	JIS B 2304	JIS Mark product
Pipe flange	Basic dimension of flange of 2kg/cm^2 iron & steel made pipe	JIS B 2210	
	------- 5kg/cm^2 -------	JIS B 2211	
	------- 10kg/cm^2 -------	JIS B 2212	
	------- 16kg/cm^2 -------	JIS B 2213	
	------- 20kg/cm^2 -------	JIS B 2214	
	------- 30kg/cm^2 -------	JIS B 2215	
	------- 40kg/cm^2 -------	JIS B 2216	
	5kg/cm^2 Steel pipe insert-welding system flange	JIS B 2221	

Material	Description of specifications	Specification No.	Remarks
	$10kg/cm^2$ ----------	JIS B 2222	
	$16kg/cm^2$ ----------	JIS B 2223	
	$20kg/cm^2$ ----------	JIS B 2224	
	$30kg/cm^2$ ----------	JIS B 2225	
	Carbon steel castings	JIS G 5101	3 kinds
Pipe joint for pressure piping	Steel made butt-weld type pipe joint for special piping	JIS B 2305	JIS Mark product
	Steel made insett-weld type pipe joint for special piping	JIS B 2306	JIS Mark product

7.2 Packing

(a) Each packing should be good in quality and strong to keep the pipe joint parts airtight and cause no such troubles as water leakage, etc. The thickness of sheet-shaped packing excluding paper should be 0.5 mm to 2.0 mm.

(b) In case copper and lead plate is used for the high pressure air, they should be prepared by polishing the both sides flatly and smoothly after being annealed.

8. Wires, etc.

8.1 The wire, etc. should be as mentioned below.

(a) The wire should be in accordance with JIS C 3307 "600V vinyl insulated wire".

(b) The cable should be as mentioned below.

(i) The cable should be in accordance with JIS C 3605 "600V Erection Polyethylene cable".

(ii) The cable should be in accordance with JIS C 3401 "600V vinyl insulated vinyl sheath cable".

(c) The bus duct should be in accordance with JIS C 8364 "Bus duct". Further the insulation should be air insulation.

9. Heat insulation board

The heat insulation board should be in accordance with JIS A 9503 "Glass wool" and JIS A 9504 "Rock wool".

10. Spare parts, etc.

10.1 Spare parts

(a) The spare parts of generator should be as mentioned below.

(1)	Chrome-plated piston ring	1 pc.
(2)	Piston ring	2 pcs.
(3)	Oil ring	1 pc.
(4)	Oil ring	1 pc.
(5)	Piston pin	1 pc.
(6)	Connecting rod small end brush and nozzle for cooling piston	1 each
(7)	Crank pin bearing	1 set
(8)	Main bearing metal (base part on ise of gear)	1 set
(9)	Main bearing metal (base part) thrust metal	2 sets

(10)	Main bearing metal (middle part)	1 set
(11)	Connecting rod bolt and washer	2 sets
(12)	Bolt fastening main bearing metal	2 pcs.
(13)	Nut - for bolt fastening main bearing metal	2 pcs.
(14)	Washer for bolt fastening main bearing metal	2 pcs.
(15)	Air absorbing valve set	1 set
(16)	Exhaust valve set	2 sets
(17)	Fuel jet valve set	3 sets
(18)	Starting valve set	1 set
(19)	Fuel jet pump plunger & barrel	6 sets
(20)	Fuel jet pump plunger spring	6 pcs.
(21)	Fuel jet pump exhaust valve & guide	6 sets
(22)	Fuel jet pump exhaust valve spring	6 pcs.
(23)	Fuel high pressure pipe set	1 set each
(24)	Lubricating oil pump safety valve (set)	1 set
(25)	Cooling water connecting pipe rubber packing (for 26.6 mm)	2 pcs.
(26)	Cooling water connecting pipe rubber packing (for 32.7 mm)	2 pcs.
(27)	Cylinder liner rubber packing	5 pcs.
(28)	Cylinder liner packing	2 pcs.
(29)	Cylinder head packing	2 pcs.
(30)	Gasket packing for air absorbing and exhaust pipe	2 pcs. each
(31)	Anti-chamber packing	2 "
(32)	Cooling water pump impeller shaft	1 pc.
(33)	Cooling water pump mechanical seal	1 pc.

(34)	Cooling water pump V belt	1 pc.
(35)	Air feed rubber hose & hose band	1 set
(36)	O ring	2 pcs.
(37)	Spare parts box	1 pc.
(38)	Float switch	1 pc.
(39)	Other necessary parts	1 set

(b) The spare parts of generator board, etc. should be as mentioned below.

(1)	Lamp	100%
(2)	Fuse (stopper type)	100%
(3)	Box to accomodate parts	1 pc.
(4)	MCB for each capacity	1 pc. each
(5)	Lifter for ACB (excluding AC electromagnetic switch)	1 "

10.2 Tools

The tools of generator should be as mentioned below.

(1)	Disjointing and assembling tools	1 set
(2)	Wich for 10 tons	1 set

11. Inspection and test of machinery and equipment

11.1 Inspection

(a) The AC generator and generator should be inspected of their apperance, structure, dimension, finish, etc. and of the items and quantities of their spare parts.

(b) The inspection of distribution board, compressed-air equipment and DC power source should be as mentioned below.

(1) The distribution board should be inspected of its structure, dimension, finish, connection, color classification, etc. and of the items, quantity, etc. of its spare parts and accessories.

(2) The air-compressed equipment should be inspected according to (1).

(3) The AC power source should be inspected according to (1).

(c) The cable, wire and piping materials should be inspected of their apperance, dimension, finish, etc.

11.2 Test

(a) The AC generator should be teated on the following points and the results of test should be submitted to the officer in charge.

(1) The test for temperature rise of generator should in principle be in accordance with the equivalent temperature test of JEC 114.

(2) The frequency withstand voltage for commercial use should be in accordance with 1.2.3 (g).

(3) The insulation resistance test of generator should be in accordance with 1.2.3. (h).

(4) The instant voltage variation test should in principle be performed according to 1.2.3 (f) (2).
It may be confirmed by the formal test results.
However, in case 100% load (less than 0.4 in power-factor) of rated current is not obtained, the test should be in accordance with the next equivalent test.
The measuring value of the instant voltage variation rate in this instance should be below,

$$\left[0.251\ \left(0.25 + \frac{\text{Generator rated output KVA}}{\text{Starting KVA of generator}}\right)\right] \times 100\%.$$

(i) The generator of less than 100KVA should close an induction motor having starting current equivalent to more than 100% of the rated current of generator.

(ii) The generator of 100KVA to 2300KVA should close an induction motor having starting current equivalent to more than 70% of the rated current of generator.

(b) Upon combing the AC generator with the primer mover, the following tests should be permored and the results of test should be submitted to the officer in charge.

(1) The starting and stopping test shall be as mentioned below.

(i) The starting and stopping operation tests of the engine should be performed manually (push button system). Further, in the manual starting the frequency of starting till the minimum pressure to permit starting is obtained should be confirmed.

(ii) The starting time should be measured including the time for confirming the suspension of electric power.

(iii) The starting and stopping tests of the auxiliary machinery should be performed manually.

(2) The protective equipment test should be performed by using the simulation test device to the set-up value of the detection part of each protective equipment or by measuring the operating value of individual equipment.

(3) In the speed characteristic test, the speed variation rate of prime mover should be tested by closing or breaking the load of power-factor 1.0 The method of test should be in accordance with 1.3.3. (b).

(4) The load test should be performed by casting the load of power-factor 1.0 one after another as mentioned below to check the marking of the measuring instruments, electric meters, etc., the fastening state of bolts, etc., leakage of oil, water, etc., abnormal sound, etc.

(i)	L/4 load	10 minutes
(ii)	1/2 "	10 "
(iii)	3/4 "	10 "
(iv)	4/4 "	2 hours
(v)	11/10 "	30 minutes

(5) The rate of fuel consumption test shall be conducted during the load test.

(6) Immediately after the load test, temperature at the points shown in Table 1.3.3 shall be measured.

© The switchboard and the control panel shall be subject to the following tests:

(1) In the mechanism operation test, the following tests shall be conducted:

1) If the ammeter is connected to the current transformer, the ammeter shall be, in principle, tested by applying the current to its primary winding.

If the current capacity of the primary winding is large, the current may be applied to the second winding with the approval of the inspector in charge.

2) Turn on and off the pilot lamp.

3) Confirm the turning-on and tripping operations of the breakers.

4) Confirm the operation of the switches and the circuit breakers.

(2) In the relay characteristics test, the following items shall be tested:

1) The maximal and minimal operation values

2) The operation time characteristics (excluding grounding relays)

(3) In the sequence test, confirm the tripping, alarm and incidation (the lighting of the pilot lamp, etc.) caused by the operation of the relays.

(4) The temperature test of distribution board should be performed by measuring the temperature of each part after the rated current is continuously conducted to make the temperature constant. In this instance, the difference should not be over the values of Table 1.11.1.

Table 1.11.1 Rise of temperature of Distribution Board

(Unit Over 0°C)

Place		Temperature difference (Thermometer)
Bus line & connecting conductor	-	65
Contact part (1)	Copper contact	35
	Silver contact	65
Terminal & Connecting part	Between silver soldering and plating	45
	Between silver	65
Structure Part (around conductor)	-	70(2)
Air temperature inside of box	-	Not specified (2)
Limit of basic temperature outside of box		40

(Note) (1) The connecting part of the coupling mechanism, etc. of the disconnecting switch or circuit breaker.

(2) There should be no effect to raise the temperature of the equipment in the box over the maximum allowable value.

(Remarks) (1) In case the distribution board is used at an ambient temperature of over 40°C, the overvalue only should be decreased from the values in the above table.

(2) The limit of temperature rise of equipment accomodated should be according to the specifications concerning the equipment and the basic ambient temperature should be the ambient temperature outside of the box.

(3) The above table is not applied to the resistor, electric heater, thermal-type relay, etc.

(5) The insulation resistance test should be performed by measuring by a 500v insulation resistance meter and the insulation resistance value should be more than 5 MΩ between the secondary side and earth.

(6) The withstand voltage test should be as mentioned below.
The frequency withstand voltage test for commercial use should be performed by exerting for one minute by 50 Hz voltage near the sine wave shown in Table 1.11.2.

Table 1.11.2 Withstand Voltage Test

Kind	Withstand voltage value
	Commercial frequency (Sine wave 1 minute) to earth
Low pressure(Main circuit)	2E + 1000V (Minimum 2000V)
Low pressure (Control circuit	1500V

(Remarks) (1) E is the circuit rated voltage.

(2) The voltage shown in the table shuld be exterted, excluding the operational motor, meters, micro-switch, etc. which is less than 1500V of the commercial frequency in the low pressure control circuit.

(d) In case the test method of the equipment is specified in the delivery and acceptance test of JIS or JEC specifications, the test of the equipment should be according to the specifications of JIS or JEC.
The results of test should be submitted to the officer in charge.

(e) The DC power source should be tested on the following points and the resuls of test should be submitted to the officer in charge.

(1) The test should be according to 1.11.2 (c)

(2) The characteristic test should be as mentioned below.

(i) The tolerable voltage variation value of the output voltage on the DC side should be plus or minus 2% of the set-up value when the constant-voltage test is performed. Further, the return time should be within 2 seconds when the output current on the DC side has been increased rapidly from 0 to 30% or decreased rapidly from 30% to 0%.

(ii) The output terminal voltage should cause no effect on the battery when the hanging characteristic has been performed.

(iii) The DC side output voltage should be within the voltage adjustment scope when the voltage adjustment test has been performed.

(iv) The value at the power-factor test at the time of maximum voltage and rated current on the DC output side should be as below.
In case the AC output is 3-phase, the lag is over 80%.
In case the AC output is single-phase, the lag is 70%.

(v) The value at the efficiency measuring test at the time of maximum voltage and rated current on the DC output should be as below.

In case the rated current of the charger is 10 to 50A, the value should be over 70%.

In case the rated current of charger is over 50A, the value should be over 80%.

(f) The underground oil storage tank should be tested as mentioned below and the results of test should be submitted to the officer in charge.
The hydraulic test value of the underground oil storage tank should be over $0.7kgf/cm^2$.

12. Protection and maintenance manual, etc.

(a) The manual of each equipment, the matters to note for operation of all kind of equipment and other similar documents which are guide books concerning necessary protection and maintenance to ensure satisfactory performance of complete equipment should be put together in a file and should be submitted with the index as mentioned below.

(1) 2 copies at the same time when the work is started.

(2) 3 copies when the work is completed.

(b) Approval should be obtained before commencing the work.

(c) Ventilating fan in the generator room should be operated at the time when the generator start up.
Automatic and manual switch for ventilating fan should be equipped. Both start up must be possible.

4-5-2 Execution of Work

1. Installation

1.1 Earthquake-proof treatment.

The independent power plant should be treated against earthquake to prevent such troubles as the horizontal move, falling, etc.

1.2 Foundation bolt

The side to fit the equipment should be provided with foundation bolts suitable to the equipment. Further, the foundation bolt should be made of mild steel and should have enough earthquake proof section.

1.3 Generator and prime mover

(a) The installation of generator and primie mover should be as mentioned below.

(1) On the concrete foundation, by use of chalk the relative positions of horizon, center line, etc. should be worked out for the planking and on it the common bed should be installed and assembled with an earthquake proof device in between.

(2) The generator should be mounted on the common bed after the assembling of the prime mover is completed. Further, from time to time, the generator, horizon of the prime mover, canter line, bending of the crank shaft, etc. should be inspected and correct.

(3) After completing installation of the generator and prime mover, all auxiliary machines such as the radiator for cooling water, etc. should be equipped and the shaft center should be adjusted. Then, after confirming the horizon of the common bed, the mortar should be placed on the foundation bolt hole and the foundation bolt should be firmly fitted to a specified position.

(4) The generator and prime mover should be assembled to prevent water, dust, chip, etc. from coming in the inside.

1.4 Distribution board

(a) The installation of closed type distribution board should be as mentioned below.

(1) The distribution board should be installed on a position where the channel steel for the base is cornered and, after adjustment is made to make the surface of channel steel horizontal, should be firmly fixed to the floor by the foundation bolt.

(2) Other boards should be fitted to the wall, etc. by bolts.

(3) The plate mentioned matters to be especially noted for handling and operation of equipment should be provided in a place of the box to be easily seen.

1.5 Air compressor

The air compressor should be horizontally fixed to the concrete fundation by bolts. Further, the thickness of concrete fundation should be over 150mm.

1.6 Starting air tank

(a) The starting air tank should in principle be installed in a box built on the foundation or concrete floor and should be installed in such a way as the main _____ valve takes a position about 1,200mm above the floor or the operation bed.

(b) Between the air tanks a pillar made of wood, etc. should be inserted to combine the air tank with each other by steel band.

(c) Around the part of air tank which is buried, dried sand should be put in and tamped enough to allow no space.

Then the place should be coated with asphalt thickly enough to prevent the dried sand from damping and on the asphalt the concrete should be placed. In this instance, the air tank should be correctly fixed so that the center line of the tank may be vertical and the buried part should be fully coated for rust prevention.

1.7 Fuel tank, etc.

(a) For the stand of fuel tank, steel material having strength similar to or more than the same of angle steel should be used. The stand should be, if necessary, reinforced with braces, etc. to withstand the load of tank and should be assembled in a shape of tower, on which the tank should be fixed by bolts.

(1) The self-standing type stand of a tower of less than 600 l in capacity should be made of steel material of more than 50 x 50 x 6mm.

(2) The stand of a self-standing tower of 1000 l capacity should be made of steel material of more than 75 x 75 x 9 mm.

(3) The stand should be firmly fitted to the wall surface or the floor surface by use of bolts.

(b) The inflation tank should be in accordance with (a).

Further, the stand should be in accordance with (a) (1).

2. Piping

2.1 Piping in general

(a) The piping of systems for fuel oil, starting air, etc. to connect the main body of prime move and the auxiliary machines should be acceptable at the withstand test at each system after completing connection and should be performed to prevent oil leakage, air leakage, etc.

(b) The piping should be strong enough to withstand vibration, temperature rise, etc. which occurs with the operation of generator and prime mover.

(c) The piping should be profided with washers in the places where it passes through the ceiling, floor, wall, etc. in case the piping is not with frost-proof covering nor heat-insulation covering.

(d) The piping inside of the pit should be as mentioned below.

(1) The pipe fittings should be fixed on the pit side wall or floor in such a way as it does not interfere with the drainage, etc. and should be arranged and fitted according to proper order of systems for fuel oil, starting air, etc.

(2) The pipes should be laid out not to corss with each other.

(3) In case each equipment is raised from the inside of pit, it should be raised vertically by providing flanges at its proper places.

(e) The pipe should be cut at the right angle to its axial center to prevent deformation of the section and its cut place should be finished smooth.
The pipe should be inspected before it is jointed and should be jointed after it is confirmed that no foreign matter exists and all chips, dust, etc. are removed. In case the execution of piping is suspended temporarily, the inside of pipe should be cured to prevent foreign matters.

(f) The packing made of oil-resistant rubber or fibre may used for the flange of cooper pipe used for the fuel oil and lubricating oil in combination with the adhesive.

(g) The connection of pipe should be as mentioned below.

(1) The connection of copper pipe should be performed by use of inserted joint, Flaver joint or flange joint. In case of inserted joint, after the outside of pipe and the inside of joint are fully cleaned, the pipe should be correctly inserted into the joint and in the joint part the brass wax or silver wax heated at a proper temperature should be cast in. In case it is necessary to remove, the Flayer joint or flange joint should be used.

(2) The joint of steel pipe should be done by use of screws or by welding. The joint by screws should be in accordance with JIS B 0203 "Tapered screws for pipe". Further, for the joint a stiff paste paint, hemp, etc. must not be used.

(h) The caulking of piping should not repaired.

(i) The supporting interval for the side run of piping should be according to Table 2.2.1. Further, the bending part and branch part should be supported when necessary.

Table 2.2.1 Maximum supporting Interval of Pipe

(Unit: m)

Nominal dia. (A)		Less than 20	20 to 40	50	50 to 90	More than 100
Interval	Steel pipe	1.8	2.0	3.0	3.0	4.0
	Copper pipe	1.0	1.5	2.0	2.5	-

(j) The piping provided with expansion joints should be provided with metal fixtures at effective places as a starting point of the expansion and compression.

(k) For the rising and pulling parts of the piping of the generator, fuel tank, etc. flexible pipes should be used. The flexible pipes should be used in places where consideration has been given to the vibration direction and amplitude at the connection point between each pipe and the prime mover, fuel tank, etc.

2.2 Cooling water system piping

(a) In the main piping the flange joint should be inserted in proper places to make removal easy.

(b) The purge valve should be provided at a place where air in the piping is accumulated.

(c) The suction pipe of the inflation tank should be provided with a float valve with a strainer at the edge and should be connected to the entrace of engine cooling water pump through the piping pit.

(d) At the bottom of the water jacket and the cooling water pipe in principle the drain cock should be provided.

(e) The cooling water pipe should be tested for hydraulic pressure after the piping is completed and should be withstand the pressure for the minimum time of 60 minutes at a pressure value of 5kg/cm^2.

(f) The flexible joint for the cooling water tank should be made of metal.

2.3 Fuel oil system piping

(a) In case the oil is fed from the fuel oil drum to the indoor fuel tank directly, the synthetic resin made hose should be provided between the fuel-oil mounting pump or hand pump and the drum and its tip on the drum side should be provided with a copper pipe, longer than 1200mm.
Further, the tip should be slantly cut or cut in concave.

(b) The joint of pipe should be made by welding.
Further, in case the screw joint is performed for the buried piping, the at the joint part the box for inspection opening made of concrete should be provided.

(c) For the screw joint and flange joint the oil-resistant paint and the oil-resistant packing should be used.

(d) The rising pipe or lowering pipe from the piping pit or concrete floor to the equipment such as the prime mover and indoor fuel tank, etc. should be arranged along the equipment concerned or in parallel with the side.

(e) The connection to the prime mover and indoor fuel tank should be made by use of metal bellows-shape flexible joints. The length of flexible joint should be according to Table 2.2.2.

Table 2.2.2 Length of flexible joint

Dia. of pipe (A)	Length (mm)
Less than 25	More than 300
25 to 50	" " 500
More than 50	" " 800

(f) The steel pipe buried in the earth should be painted and covered. The method of painting and covering should be according to one coat and one roll (double roll) in JIS G 3491 "Method of painting and covering of asphalt of steel pipe for waterworks" or JIS G 3492 "Method of painting and covering of coaltar enamel steel pipe for waterworks". The depth of buring should be more than 300mm in general sites, more than 750mm in the vehicle roads and more than 1000 mm in the heavy behicle roads.

(g) The fuel oil pipe should be tested for the air pressure after the piping is completed and should withstand the pressure for the minimum time of 30 minutes at a pressure value of 1.5 times of the maximum working pressure.

2.4 Starting air system piping

(a) The pressure steel pipe or high pressure steel pipe should be connected perfectly to allow any air leakage.

(b) The steel pipe small in the outer diameter may be replaced with a flexible pipe and be given flexibility by making it ring-shaped, etc.

(c) The starting air piping should be tested for the air pressure after the piping is completed and should withstand the pressure for the minimum time of 30 minutes at a pressure value of 1.2 times of the maximum working pressure.

2.5 Exhaust pipe system piping

(a) The pipe should be a carbon steel pipe for piping or a pipe welded on the spot which is more than 3.2mm thick.

(b) The piping of the exhaust pipe should be connected to the engine aggregate exhaust port or the supercharger exhaust turbine outlet flange by use of an exhaust flexible pipe and should be ceiling piping unless specified otherwise.

(c) The connection of pipe should be made by use of cast-steel or steel-plate made inserted type flange 90° bend, 45° bend, etc.

(d) The supporting fittings of the exhaust pipe and muffler should be vibration-proof s fittings or vibration-proof supporting fittings strong enough to withstand the weight of the exhaust pipe or muffler to prevent propagation of vibration.

(e) The piping should be performed with consideration to the termal expansion during operation time.

(f) The exhaust pipe should be as mentioned below:

(1) The pipe should be insulated for heat by use of rockwool 25mm thick and be 3-ply roll-finished.

(2) The insulating material should be fixed by steel wire and on it a hexagonal rope should be wound.

(3) In case the outer diameter of insulation is less than 250mm, it should be finished by binding with zinc-plated iron plate of more than 0.3mm etc. and in other cases, by binding with zinc-plated iron of more than 0.4mm.

(4) The expansion joint part should be covered with blanket of rockwool insulation material at its circumference and should be stetched by steel wire. The same is applied to the flange part.

(g) The muffler should be treated for heat insulation by a method similar to or better than the method mentioned in the preceding item.

(h) The piping which passes through the building materials or is close to them should be performed very carefully to prevent causing fire.

3. Wiring

3.1 General matters

(a) The wiring should be more than 0.5 m away from the high temperature part to prevent being influenced by the

heat which generates from the prime mover. However, in case it is difficult to put an equipment such as the water-temperature relay, etc. more than 0.5 m away, a heat-resistant wire or a wire having heat-resistance similar to or better than it should be used or protection by the electric wire pipe, etc. or the heat-resistance treatment should be given.

(b) The charging part should be provided with protection, covering, etc. to prevent it from being touched easily.

3.2 Cable wiring

(a) In case the cable is wired in the pit, the cleat made of china, etc. should be provided in the pit and should be arranged in order according to the destination of wiring.

(b) The cable for control should be seperated as far as possible from other cables. If it is inevitable that the cable for control comes in contact with other cable, the insulation, etc. should be used to prevent direct contact.

(c) In case the electric wire or cable is wired upon mounting on a frame it should be wired in good order by use of fittings. Further, the wiring should be made in places hard to cause damage on the covering of electric wire or sheathing of cable.

3.2 Connection of electric wire

(a) In case of connecting electric wires, it should be avoided to increase the electric resistance. Further the strength of electric wire should not be decreased more than 20%.

(b) The terminal of electric wire should be treated to prevent damage on the core and further treated as mentioned below.

(1) The cover of the vinyl electric wire should be removed by the wire stopper method or the pencil sharpening method.

(2) The cover of cable should be removed in the order of cable sheath, cloth tape, inbetween jute, etc. and in a way to prevent damage on the core.

(c) It should be avoided to connect the electric wire or cable in the midway.

3.3 Connection of electric wire with the equipment terminal

(a) The electric wire should be connected with the equipment terminal without exerting tension to the connecting point.

(b) The electric wire should be treated at the edge in accordance with 2.3.2.

(c) The connection should be made by tightly fastening to prevent risk of slackening. In case there is possibility of slackening due to vibration, etc., a double nut or spring washer should be used.

(d) In case the equipment terminal is not of bush-button type, clamp type nor of structure similar to them, the strand should be properly treated to prevent it from being broken in disorder. However, this is not applied to connecting terminals of push-button type.

(e) To the terminal, the structure of which allows the connection by one electric wire, more than 2 electric wire should be connected.

(f) On the terminal of wind-fastening structure, the electric wire should be tightly wound in 3/4 to 1 round of the circumference.

4. Bus duct wiring

4.1 Accessories of duct

The accessories should be suitable to the duct and the facilities site.

4.2 Laying of duct

(a) The supporting interval of duct should be less than 3 m and it should be firmly fitted to the building materials. Further, in case the duct is fitted to concrete, beforehand the insert bolt, etc. for fitting should be buried. If it is compelling, a drill anchor bolt, etc. having enough strength should be used.

(b) The edge part of duct and the inserting opening of the plug-in duct which is not used should be closed to prevent the dust and water from coming inside of the duct. However, in case of the ventilation type, this is not necessarily applied.

4.3 Connection of duct

(a) In connection between the ducts, between the duct and distribution board and between the conductors, the butt should be complete and the connection should be made perfect mechanically by use of bolts, etc. Further, the connection should be made electrically completely by use of mild copper wire thicker than shown in Table 2.4.1, copper belt or plain stitch zinc-plated copper wire. The connection should be non-soldering connection.

Table 2.4.1 Thickness of Bond Wire

Rated current of overcurrent circuit breaker	Thickness of bond wire
Below 600A	38mm^2
" 800A	50 "
" 1000A	60 "
" 1200A	80 "
" 2000A	100 "

(b) In case the duct goes through the wall, the connection should not be made at such a place.

(c) The earthing should be according to 5. Earthing.

5. Earthing

5.1 Kind of earthing work and resistance value of earth

The kind of earthing work and the earth resistance value at the earthing work should be as mentioned below.

(1) Kind No. 3 earthing work -------- less than 100Ω

(2) Special Kind No. 3 earthing work---less than 10 Ω

5.2 Electric works to be treated for No. 3 earthing work.

The following works are to be treated for Kind No. 3 earthing work.

(1) Iron base and outer box made of metal of machinery and implement of less than 300V in working voltage.

(2) The iron core of the transformer for meters of less than 300V in working voltage. However, this is not necessarily applied to the transformers without box covered with insulation made of rubber, synthetic resin, etc.

(3) The electric circuit of more than 300V in working voltage.

(4) The wiring of metal pipe of low voltage, less than 300V in working voltage, bus duct wiring, the metal part of the cable protective device used for the cable wiring of less than 300V in working voltage.

(5) The outer box made of metal of the distribution board, etc.

5.3 Special Kind No. 3 earthing work

(a) The iron bed and outer box made of metal of machinery and implement for low voltage over 300V.

(b) The iron core of transformer for meters of low voltage over 300V. However this is not necessarily applied to the transfer for meters without box, covered with the insulation such as rubber, synthetic resin, etc.

(c) The pipe of electric circuit for low voltage over 300V by the metal pipe wiring.

(d) The metal pipe to accommodate the cable of electric wire by cable wiring of low voltage 300 V, the connection pipe made of metal and the metal part of the protective device of the cable.

(e) The metal pipe wiring, the pipe of low voltage indoor wiring over 300V and duct.

5.4 Earth line

(a) For the earth line the green-colored vinyl electric wire should be used.

(b) The thickness of earth line should be according to Table 2.5.1.

Table 2.5.1 Thickness of Earth Line

Earthing of iron bed and piping, etc. of low voltage motor		Earthing of others (rating of fuse, circuit breaker for wiring)	Thickness of earth line
200V class motor	300V class motor		
Below 3.5 kw	below 7.5 kw	below 50A	Over 2.0 mm
" 7.5 kw	" 15 "	" 100A	" 5.5 "
" 15 "	" 30 "	" 225A	" 14 "
" 37 "	" 75 "	" 400A	" 22 "
		" 600A	" 38 "
		" 800A	" 50 "
		" 1000A	" 60 "
		" 1200A	" 80 "

(Remarks) When the rating output exceeds * mark, the thickness of earth line should be determined according to the rated current of fuse or circuit breaker for wiring.

6. Painting

In wiring of the oil feed pipe, air pipe, etc. the color-classification painting should be performed.

7. Heat insulation board

The heat insulation board should be used also for absorbing sound and should be provided on the concrete part (ceiling and wall) of the generator room.
Further, the thickness of heat insulation board should be more than 50mm.

8. Inspection and test of Work

8.1 Inspection

(a) The inspection should be performed for the base , installation, installation conditions, method, etc. of the equipment.

(b) The inspection should be performed for the conditions of connection of piping (including support).

(c) The inspection should be performed for the isolation of wiring and protection of charging part.

(d) The inspection should be performed for the current capacity of the protective device, the current capacity of circuit breaker, etc.

(e) The inspection should be performed for isolation between the cable and oil feed pipe, etc.

(f) The inspection should be made for the paint finished conditions, etc. of the machinery and piping.

8.2 Test

The test as mentioned below should be performed in presence of the officer in charge upon coming the generator with the prime mover and the results of test should be submitted to the officer.

(1) The starting test should be according to 1.11.2 (b)(1).

(2) The test of protective equipment relay and sequence test should be according to 1.11.2(b)(2) and (c)(3) and (4).

(3) The speed characteristics test, load test, fuel consumption rate test and temperature test should be according to 1.11.2 (b)(3) (4), (5) and (6).

(4) The voltage variation rate test should in principle be performed in a way same as the actual load test or in a way near to it and should practically be not different from the specifications of 1.2.3 (f).

(5) In the vibration test, at the time of rated operation at the places shown in Table 1.3.2 vibration in the up and down direction, axial direction and the horizontal direction at a right angle to the axis should be measured.

(6) The insulation resistance test should be performed according to 1.11.2 (a) (3).

(7) The withstand voltage test should be performed according to 1.11.2 (a) (2).

(8) The earth resistance test should be according to Chapter 2, Paragraph 5.

(9) The preasure test should be performed for all kinds of piping for fuel, starting air, etc.

4-5-3 Maintenance

1. Maintenance, etc.

1.1 Period

(a) The period should be for 2 years after concluding contract.

(b) The frequency of maintenance should be 2 times.

1.2 Personnel

The personnel should comprise about 4 technicians at one time.

4-5-4 Work division

1. Work division

1.1 The division of work concerning the generator between Indonesia and Japan is determined as below.

1.2 Domestic work on the side of Indonesia

(a) All of building, generator foundation, forming and reinforcing of the necessary opening of the suction and exhaust system, fitting of hook supporters, fitting of insect prevention metal net, pit making, etc.

(b) Supply of fuel oil, lubricating oil, etc. and water, drainage, etc. and facilities for them.

(c) Various facilities such as the electric lamps, plug socket, toilet, etc. inside of building.

1.3 Work on the side of Japan

(a) All works for in-plant transportation, installation or machinery, fitting of foundation bolt and buring of concrete.

(b) All works for excavation of the outdoor underground buried fuel oil tank, rolling, frame, concrete placing, tank installation, burnt sand, rolling, contrete placing and burying again.

(c) All works for execution of piping, etc. of air, water, oil and electricity required between machinery and for machinery.

(d) All works for electricity for the power source between the boards and machines, signals, controls, etc.

(e) Responsibility for adjustment before hand regarding the works to be shared on the side of Indonesia.

4-6 Special Specifications for Independent Power Plant Facilities Work

Special Specifications of Indapendent
Power Plant Facilities Work

1. RS Guhung Wenang

2. Matters to apply

The matters which are not in this specifications and the drawings should be according to the common specifications of independent power plant facilities work.

3. Independent power plant facilities specifications

	Type	Horizontal Synchronous AC Generator
AC Generator	Rated output	500 KVA
	Rated voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase & 4-line system 50Hz
	R. P. M.	Below 1000 rpm
	Power-factor	Over 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous rating
	Starting Time	Within 40 seconds
	Excitation System	Brush-less system
	Type	Single-acting 4 cycle diesel engine
	Rated output	Over 584 PS
	Starting System	Pneumatic System
	R. P. M.	Over 1000 r.p.m.

Prime Mover	Rated Time	Over 72 hours
	Cooling system	Radiator system 220/380V 11KW
	Air Compressor	3-phase 220/380V 3.7 KW
	Air Tank	150 l x 2 with pressure switch
	Inflation Tank	100 l -
Fuel	Kind	A heavy oil
	Fuel Tank	1000 l
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of board		Closed type
Control system		Hand Push Button system
Elevation		150 m
Heat Insulation Plate		Ceiling and wall of generator room
Ventilating Fan		3-phase 220/380V 0.75 KW with automatic shutter hood

Special Specifications of Independent
Power Plant Facilities Work

1. RS Tondano

2. Matters to apply

The matters which are not in this specifications and the drawings should be according to the common specifications of independent power plant facilities work.

3. Independent power plant facilities specifications

	Type	Horizontal Synchronous AC Generator
AC Generator	Rated output	250 KVA
	Rated voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase & 4-line system 50Hz
	R.P.M.	Below 1000 rpm
	Power-factor	Over 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous rating
	Starting Time	Within 40 seconds
	Excitation System	Brush-less system
	Type	Single-acting 4 cycle diesel engine
	Rated output	Over 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System
	R. P. M.	Below 1000 r.p.m.

Prime Mover	Rated Time	Above 72 hours
	Cooling system	Radiator system 220/380V 7.5 KW
	Air compressor	3-phase 220/380V 3.7 KW
	Air Tank	150 l x 2 with pressure switch
	Inflation Tank	100 l -
Fuel	Kind	A heavy oil
	Fuel Tank	600 l
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of board		Closed type
Control system		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and wall of generator room
Ventilating Fan		3-phase 220/380V 0.75 KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Work

1. RS Kotamobagu

2. Matters to apply

The matters which are not in this specifications and the drawings should be according to the common specifications of independent power plant facilities work.

3. Independent power plant facilities specifications

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated output	250 KVA
	Rated voltage	220/380V
	Number of phase and frequency	3-phase & 4-line system 50Hz
	R.P.M.	Below 1000 rpm
	Power-factor	Over 80%
	Class of insulation	Above kind B
	Rated Time	Continuous rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless system
	Type	Single-acting 4 cycle diesel engine
	Rated output	Above 300PS
	Starting Time	Within 40 seconds
	R.P.M.	Below 1000 r.p.m.

Prime Mover	Rated Time	More than 72 hours
	Cooling system	Radiator system 220/380V 7.5 KW
	Air compressor	3-phase 220/380V 3.7 KW
	Air Tank	150 l with pressure switch
	Inflation Tank	100 l
Fuel	Kind	A heavy oil
	Fuel Tank	600 l
	Fuel pump	3-phase 220/380V 0.4 KW
Type of board		Closed type
Control system		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and wall of generator room
Ventilating Fan		3-phase 220/380V 0.75 KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Work

1. RS Gorontalo

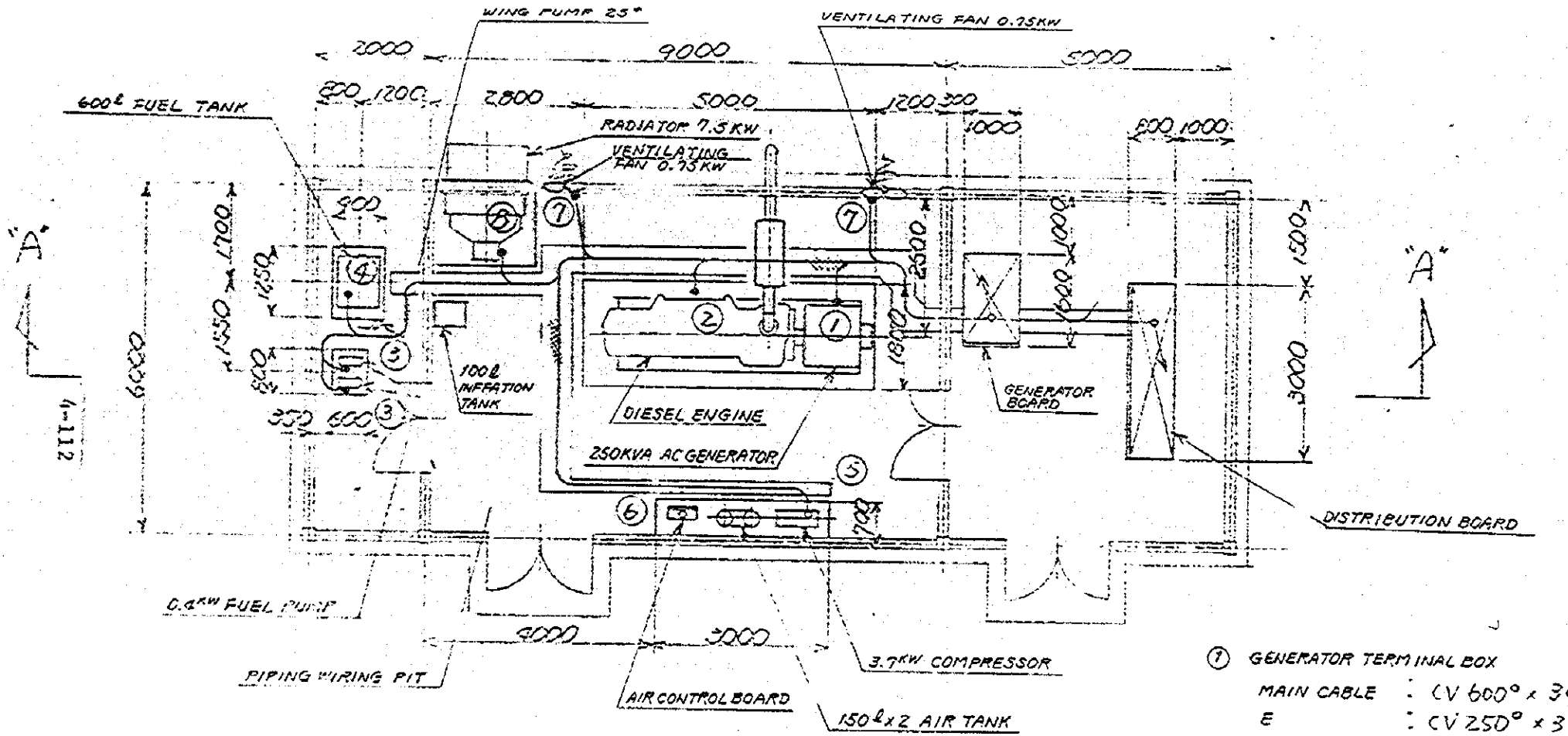
2. Matters to apply

The matters which are not in this specifications and the drawings should be according to the common specifications of independent power plant facilities work.

3. Independent power plant facilities specifications

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated output	250 KVA
	Rated voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase & 4-line system 50Hz
	R.P.M.	Below 1000 rpm
	Power-factor	Over 80%
	Class of insulation	Above kind B
	Rated Time	Continuous rating
	Starting Time	Within 40 seconds
	Excitation System	Brush-less system
	Type	Single-acting 4 cycle diesel engine
	Rated output	Above 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic system
	R. P. M.	Below 1000 r.p.m.

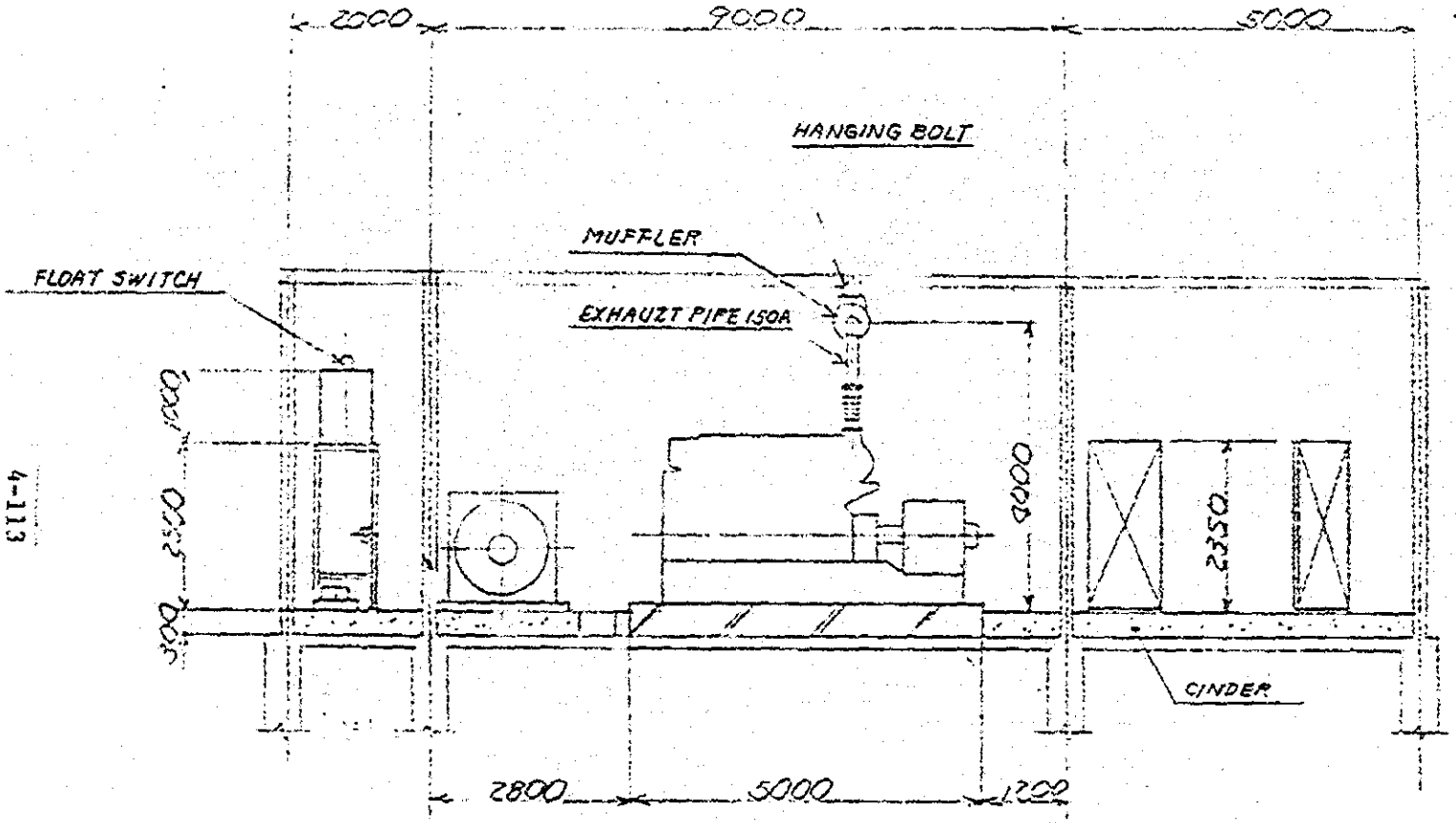
Prime mover	Rated Time	More than 72 hours
	Cooling system	Radiator system 220/380V 7,5 KW
	Air compressor	3-phase 220/380V 3.7 KW
	Air Tank	150 l with pressure switch
	Inflation Tank	100 l -
Fuel	Kind	A heavy oil
	Fuel Tank	600 l
	Fuel pump	3-phase 220/380V 0.4 KW
Type of board		Closed type
Control system		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Celling and wall of generator room
Ventilating Fan		3-phase 220/380V 0.75 KW with automatic shutter hood



LAYOUT OF 250KVA GENERATOR ROOM SCALE: 1/100

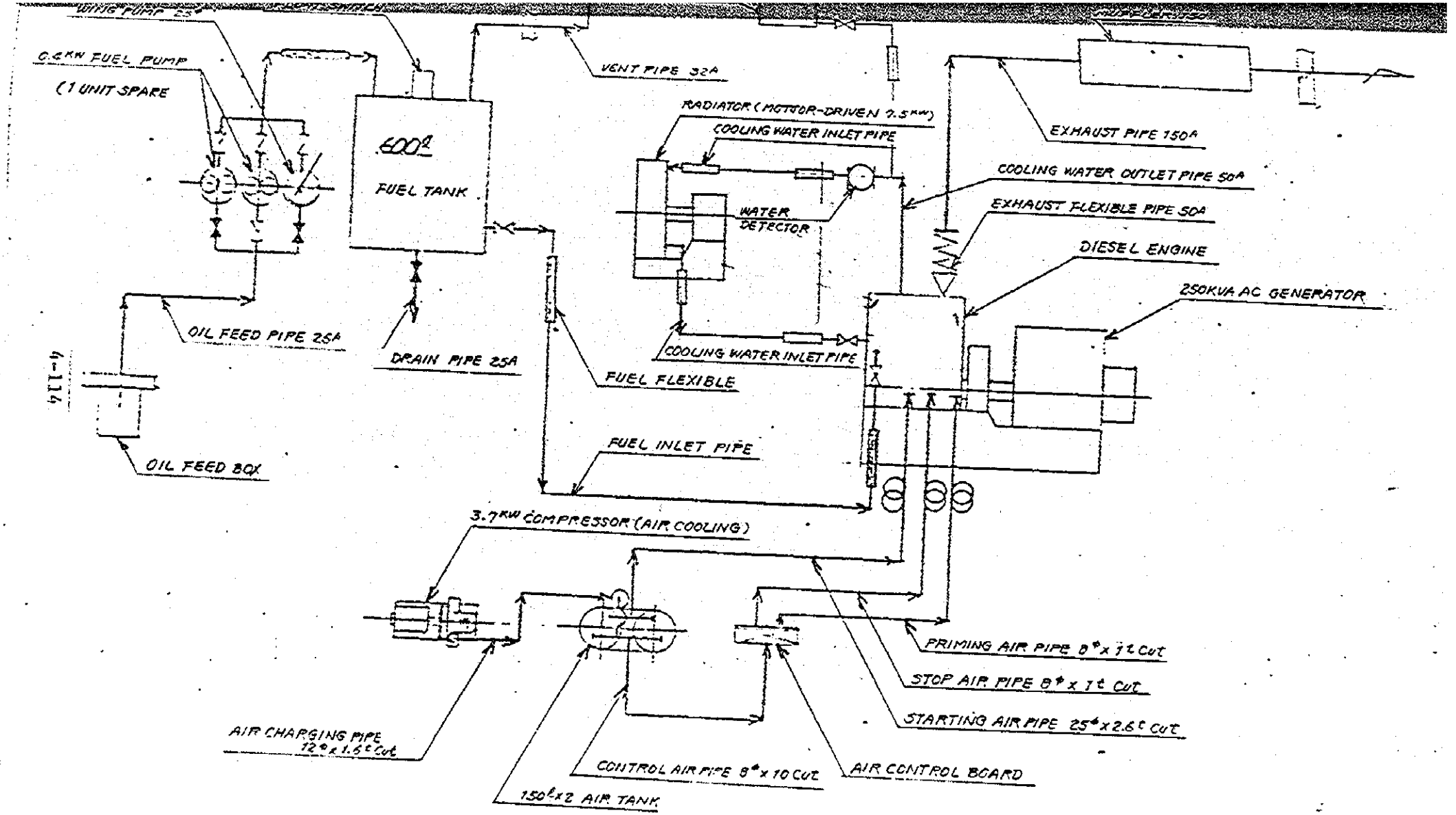
① GENERATOR TERMINAL BOX
- MAIN CABLE : CV 600° x 3C
- E : CV 250° x 3C
- EARTH : IV 38° x 1C
- EXCITATION : CV 22° x 2C

② ENGINE TERMINAL BOX : CVV 2° x 8C
③ FUEL PUMP : CV 3.5° x 4C x 2
④ FLOAT SWITCH : CVV 2° x 5C
⑤ COMPRESSORE : CV 5.5° x 4C
⑥ AIR CONTROL BOARD : CVV 2° x 8C
⑦ VENTILATING FAN : CV 3.5° x 4C x 2
⑧ RADIATOR : CV 5.5° x 4C

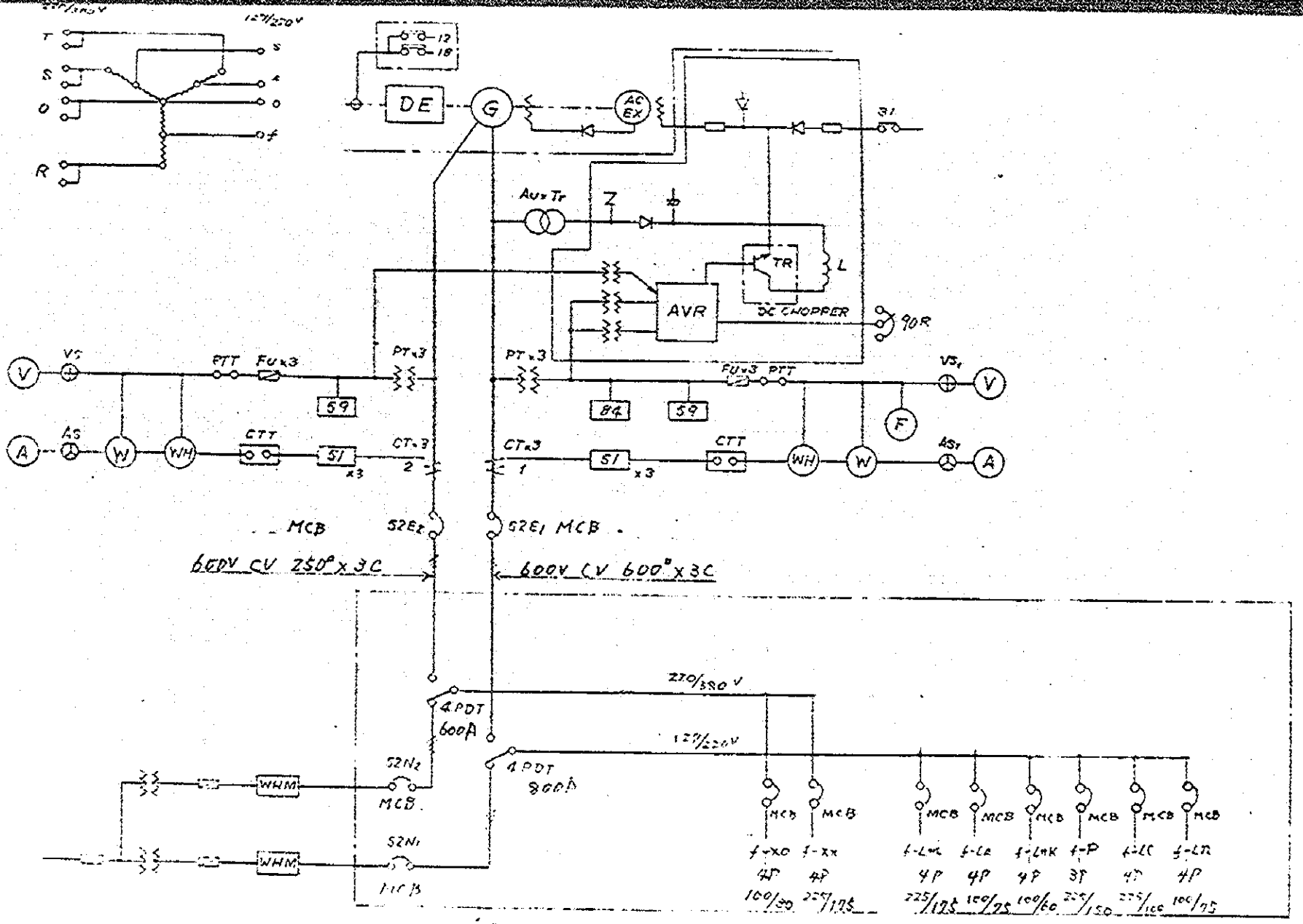


"A" ~ "A" SECTION

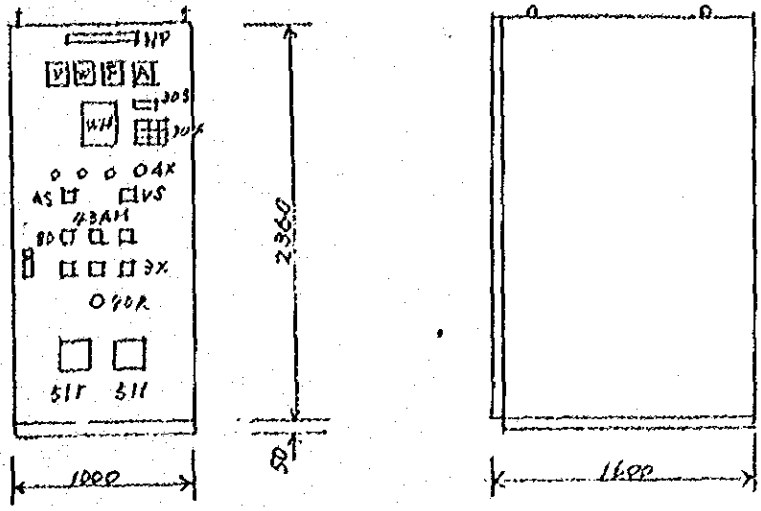
SECTIONAL VIEW OF 250KVA GENERATOR SCALE 1/100



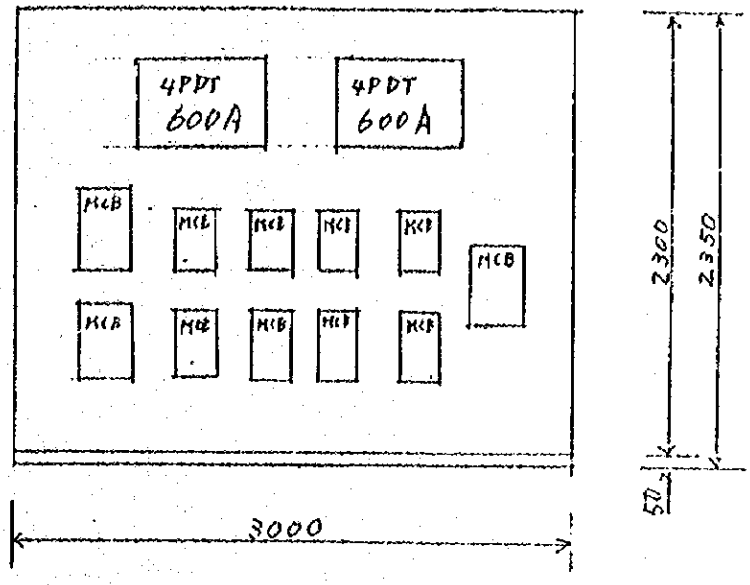
FROW SHEET OF 250KVA GENERATOR PIPING

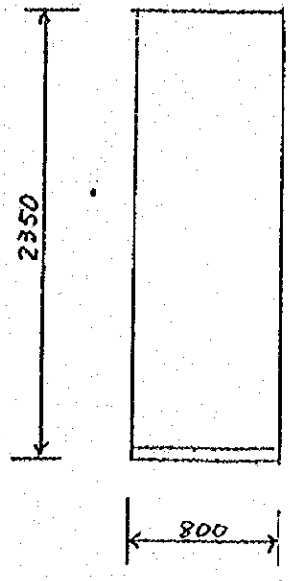


FROW SHEET OF 250KVA WIRING



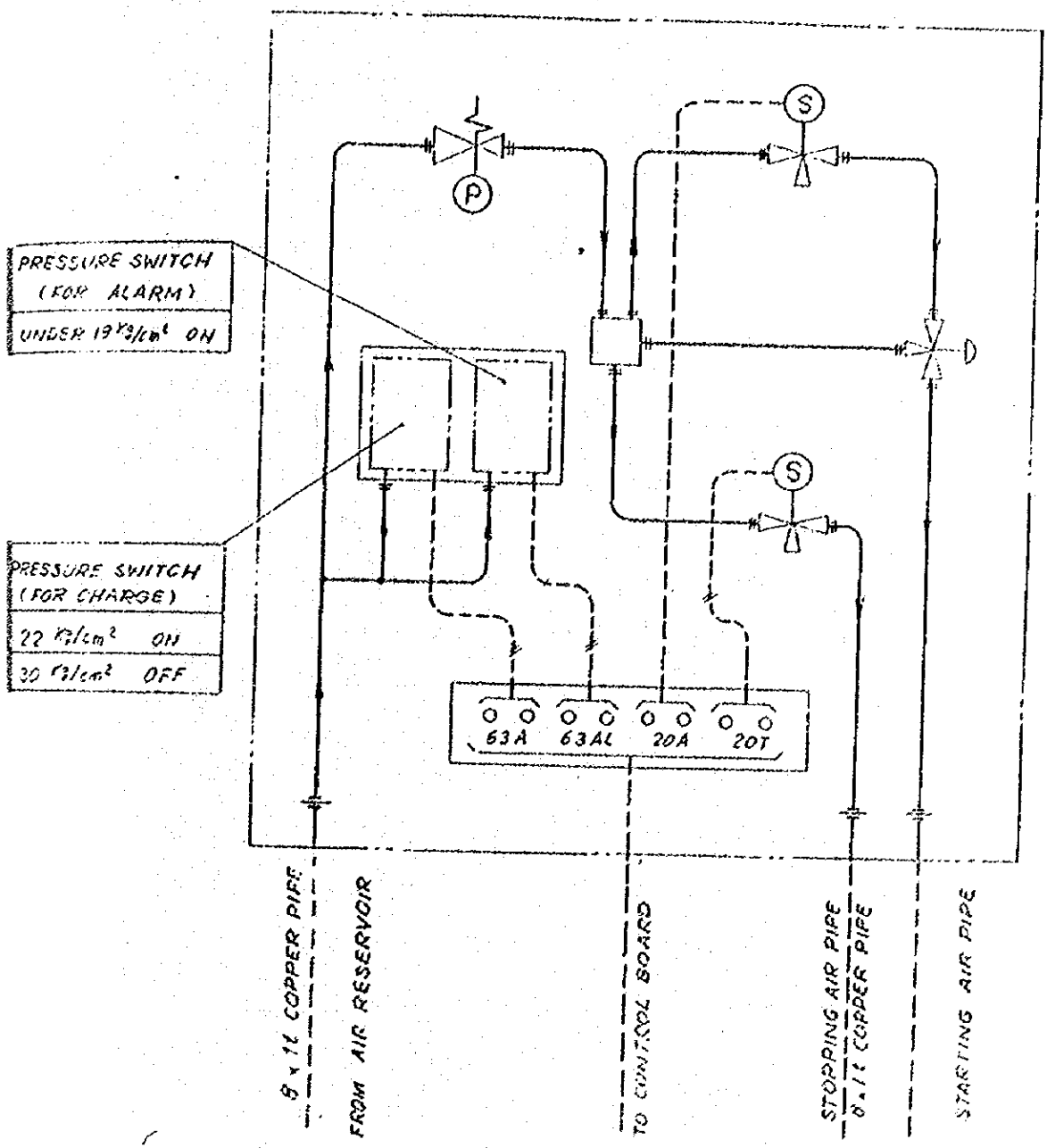
Symbol	Description
A	AC ammeter
W	Indiating Watt Meter
F	Prequency Meter
V	AC Voltmeter
WH	Electric Energy Meter
43 AM	Control Switch (Automatic-Manual)
8D	" (Control Power Source)
90R	Voltage
5/r 51t	Overcurrent Relay
3x	Push Button Switch (Lamp Test)
3x	" (Trouble Return)
3x	" (Alarm Stop)





DISTRIBUTION BOARD

MODEL : ML · RL · UL · GL · ZL · AL



AIR CONTROL BOARD

Special Specifications of Independent
Power Plant Facilities Works

1. R. S. Gorontalo

2. Matters to Apply

Matters which are not mentioned in this specifications and in the drawings should be according to the common specifications of Independent Power Plant Facilities Works.

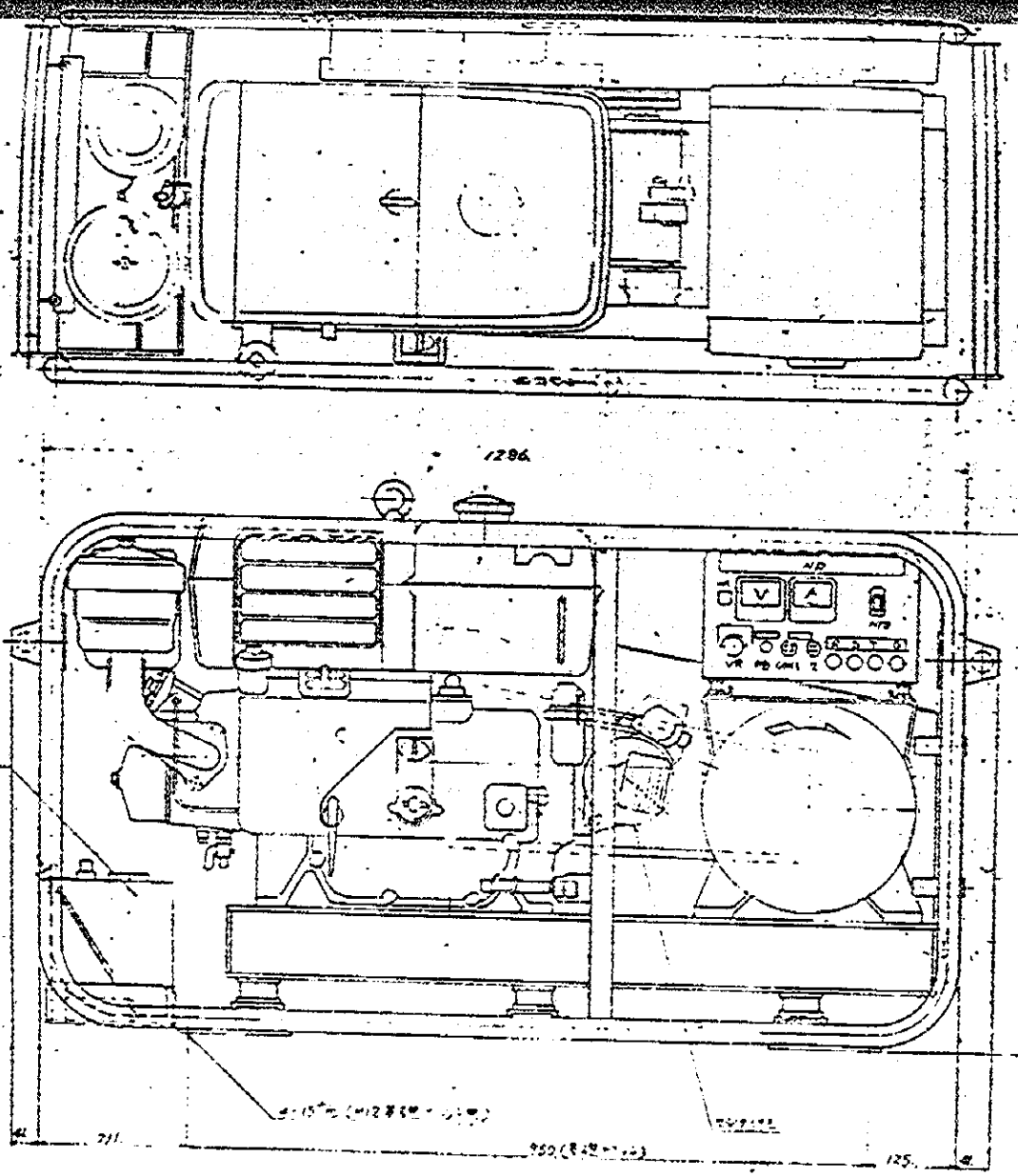
3. Specifications of Independent Power Plant Facilities

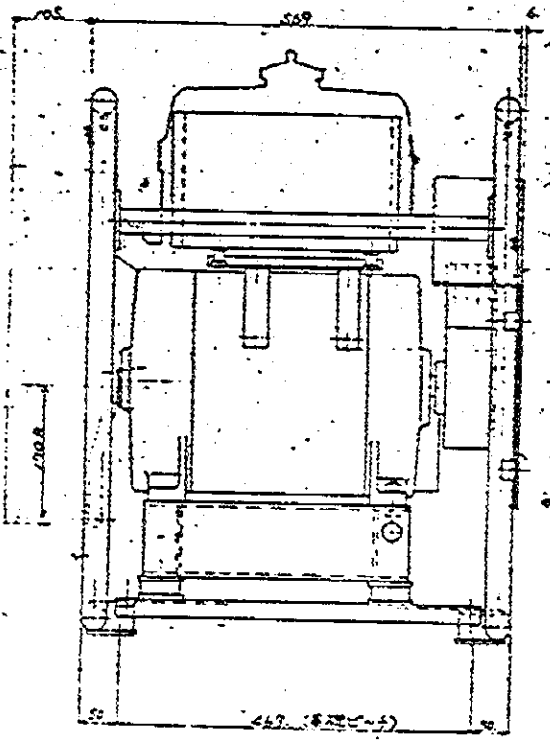
AC Generator	Type	Revolving Field Brushless System
	Rated Output	10KVA
	Rated Voltage	127/220V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	3000 r.p.m.
	Power-factor	Above 80%
	Class of insulation	Above Kind E
	Rated Time	10 hours
	Starting Time	Within 40 seconds
	Excitation System	Brushless Self-exciting system
	Type	Horizontal Water-cooling 4-cycle Diesel Engine
	Rated Output	Above 15PS
	Starting Time	Within 40 seconds
	Starting System	Electric System

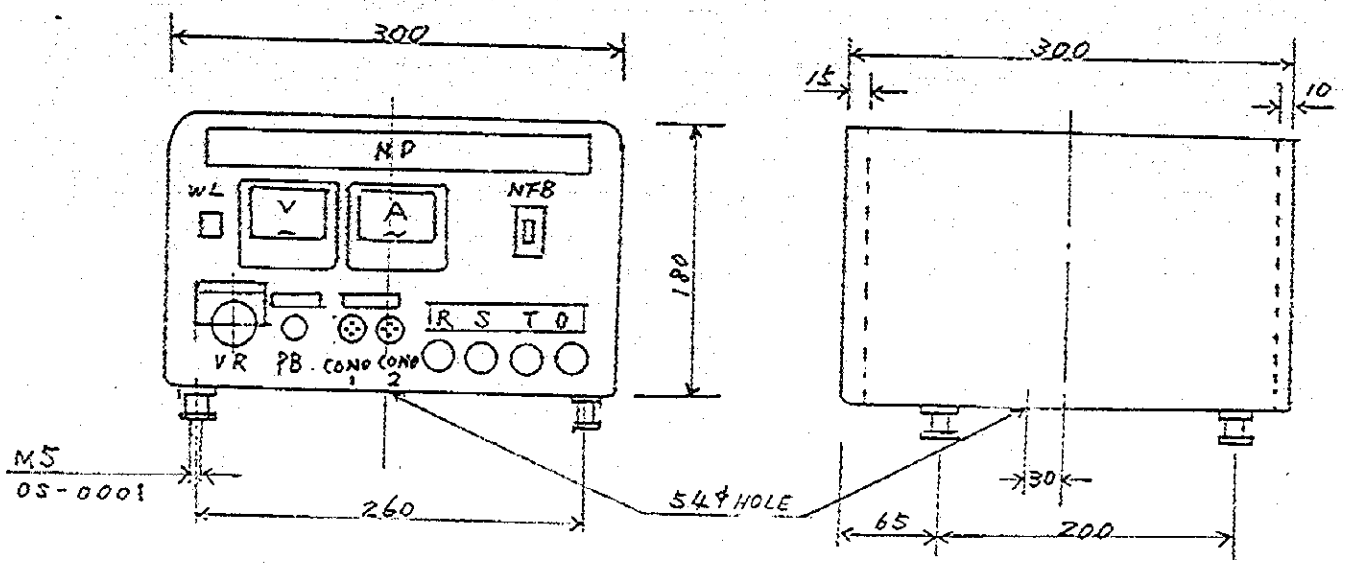
Prime mover	Dynamo Capacity	DC, 12V 1.25KW
	Battery Capacity	DC, 12V 70AH
	R. P. M.	2200 r.p.m.
	Rated Time	10 hours
	Cooling system	Condenser system
Fuel	Kind	A heavy Oil
	Fuel Tank	14 l.
Type of Board		Closed type
Control system		Hand Push Button System
Elevation		150 m

(Remarks) The matters which are not mentioned in this specifications should be according to the manufacturer's standard

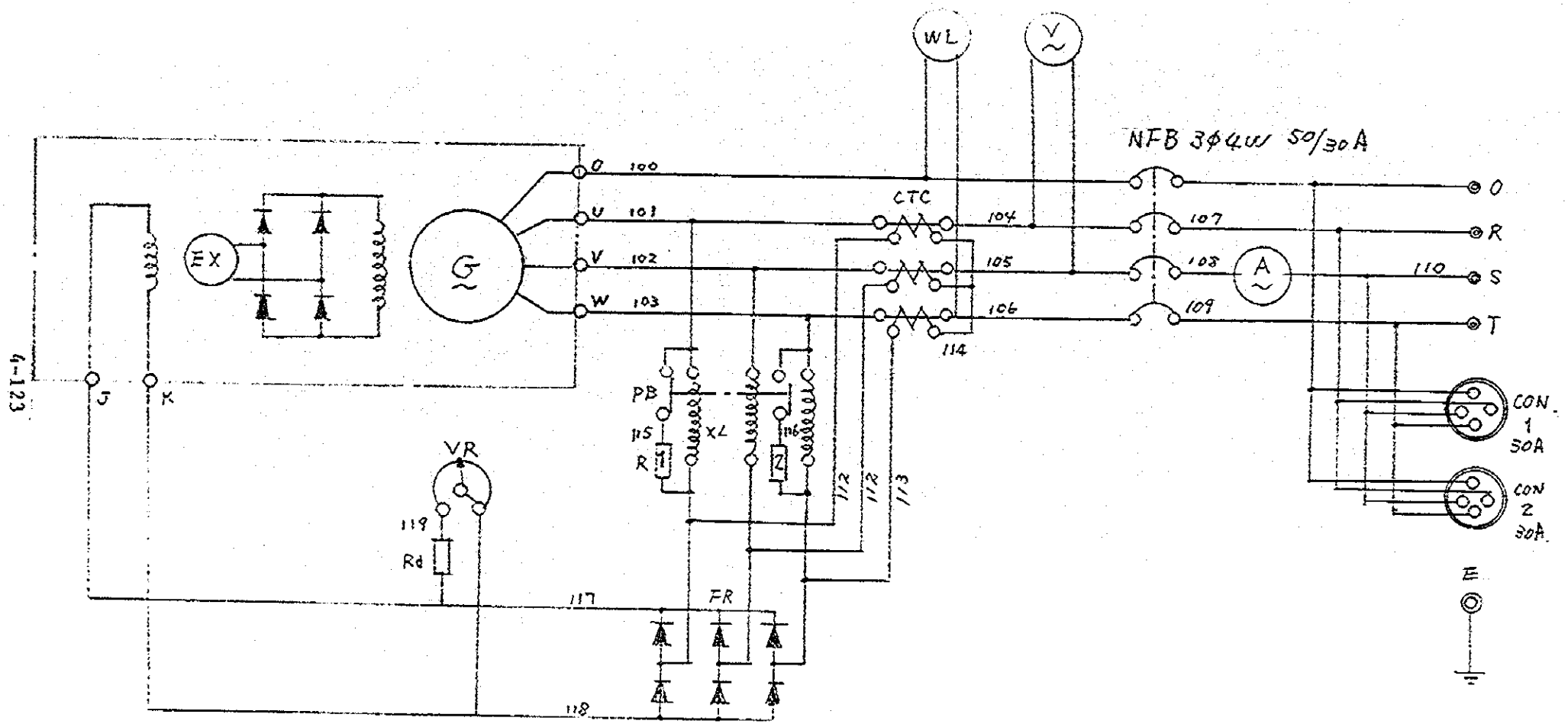
10 KVA INDEPENDENT POWER PLANT FACILITIES







10KVA GENERATOR (OPEN)



10KVA GENERATOR BOARD

Special Specifications of Independent Power Plant Facilities Works

1. RS Lim Kendage

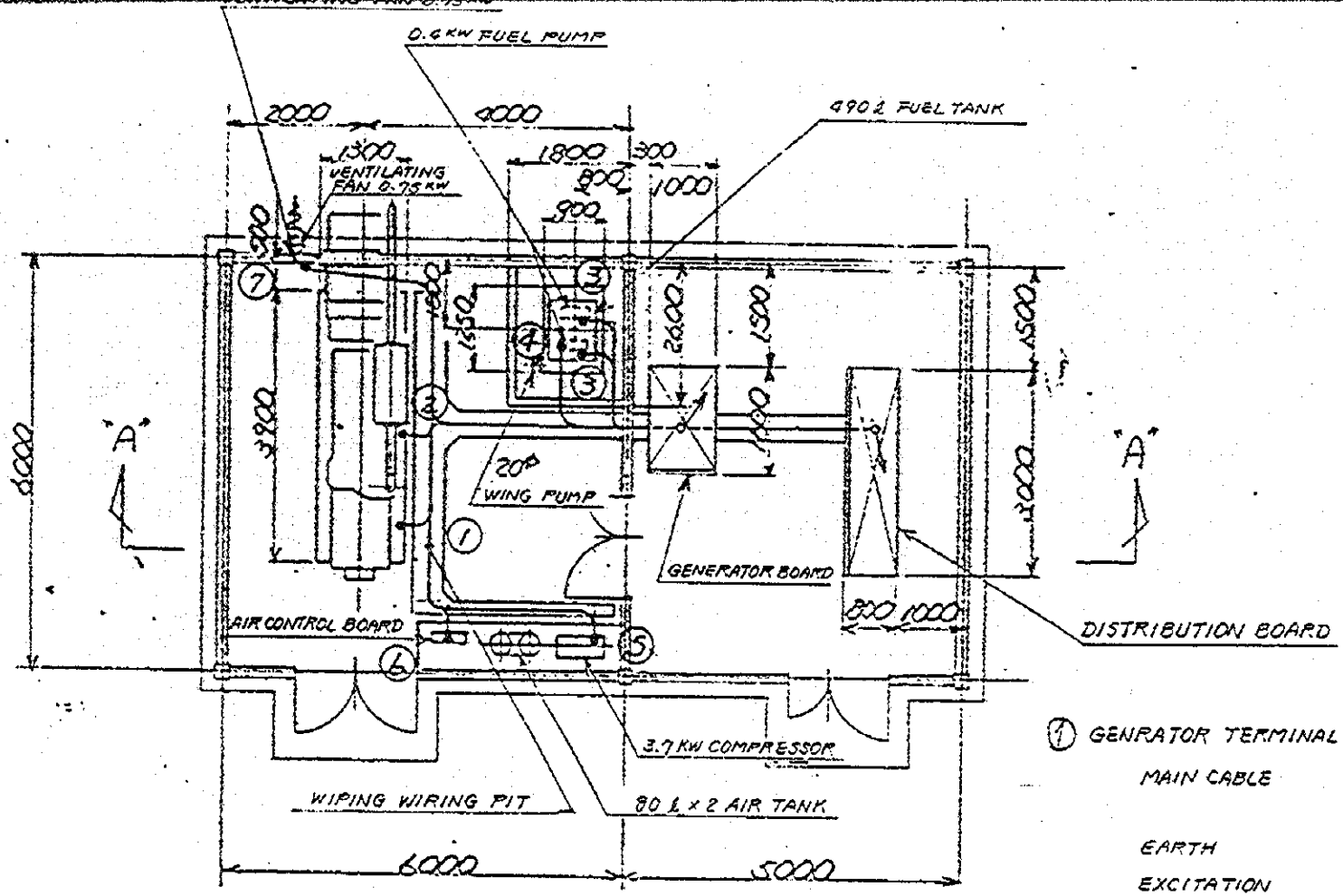
2. Matters to Apply

Matters which are not mentioned in this specifications and drawings should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

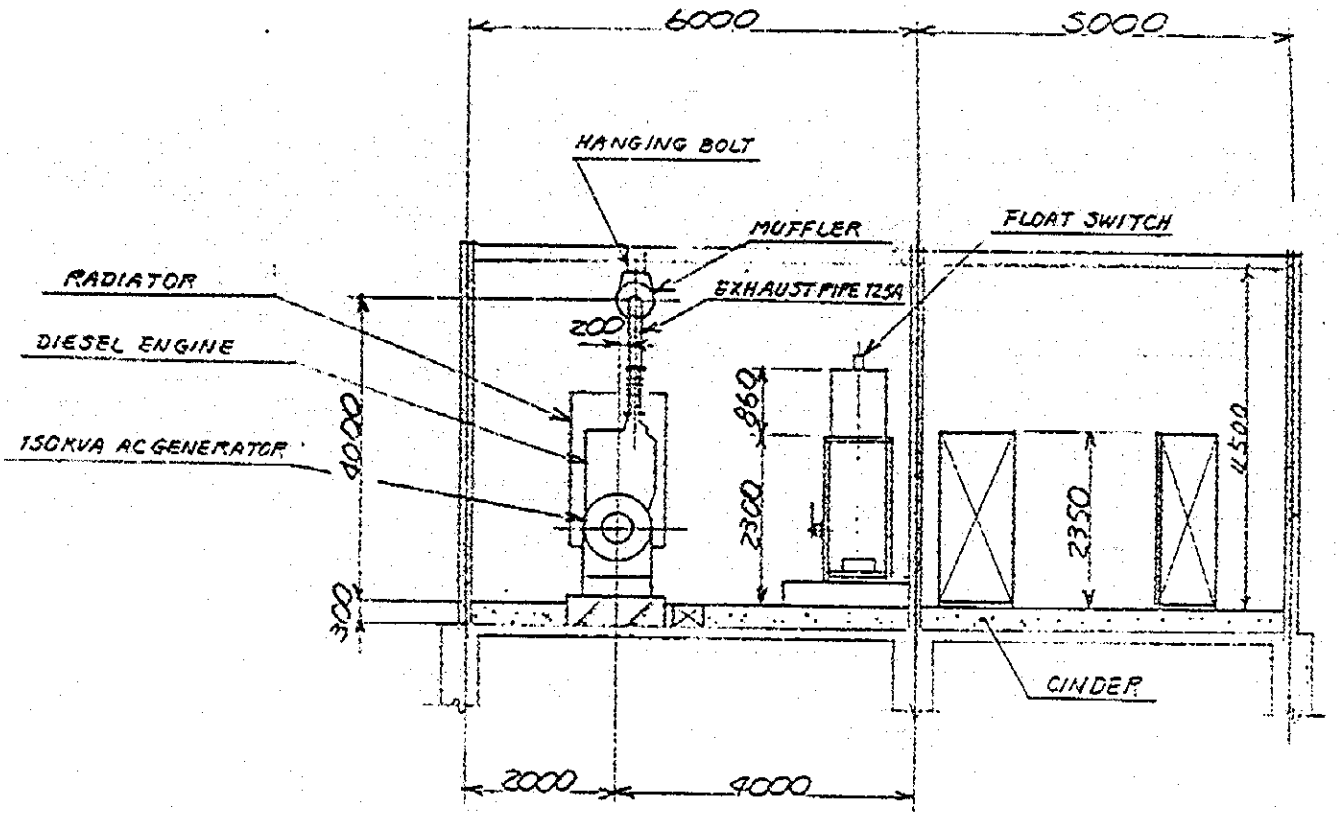
AC Generator	Tupe	Horizontal Synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (Engine driven fan)
	Air Compressor	3-phase 220/380V 3.7KW
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control system		Hand Push-button System
Elevation		150 M
Heat-Insulation Plate		Ceiling and wall of Generator
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood



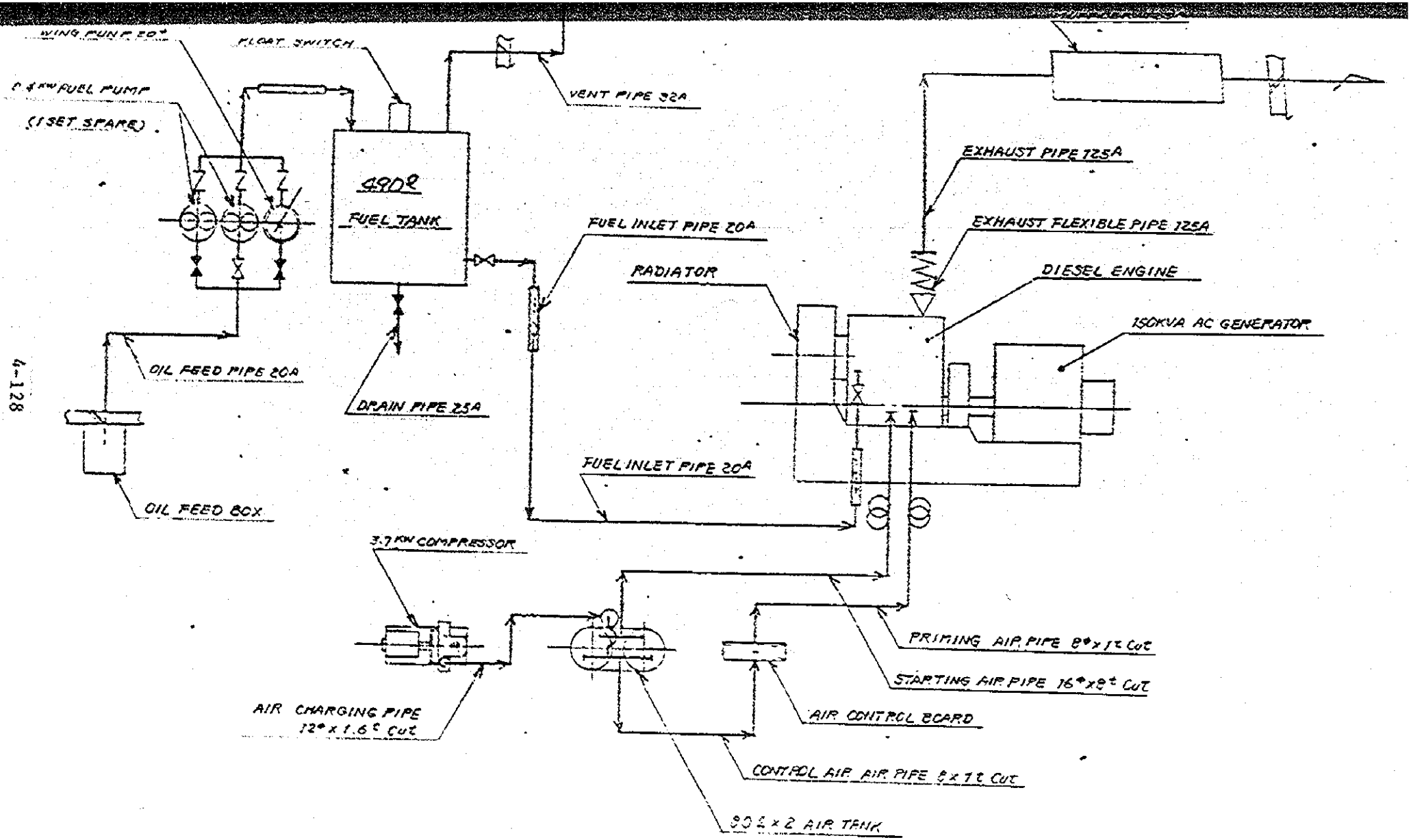
LAYOUT OF 150KVA GENERATOR ROOM

①	GENRATOR TERMINAL BOX	
	MAIN CABLE	: CV 250°×3C
	EARTH	: IV 38°×1
	EXCITATION	: CV 22°×2C
②	ENGINE TERMINAL BOX	: CVV 2°×3C
③	FUEL PUMP	: CV 3.5°×4C×2
④	FLOAT SWITCH	: CVV 2°×6C
⑤	COMPRESSOR	: CV 5.5°×4C
⑥	AIR CONTROL BOARD	: CVV 2°×8C
⑦	VENTILATING FAN	: IV 3.5°×4C

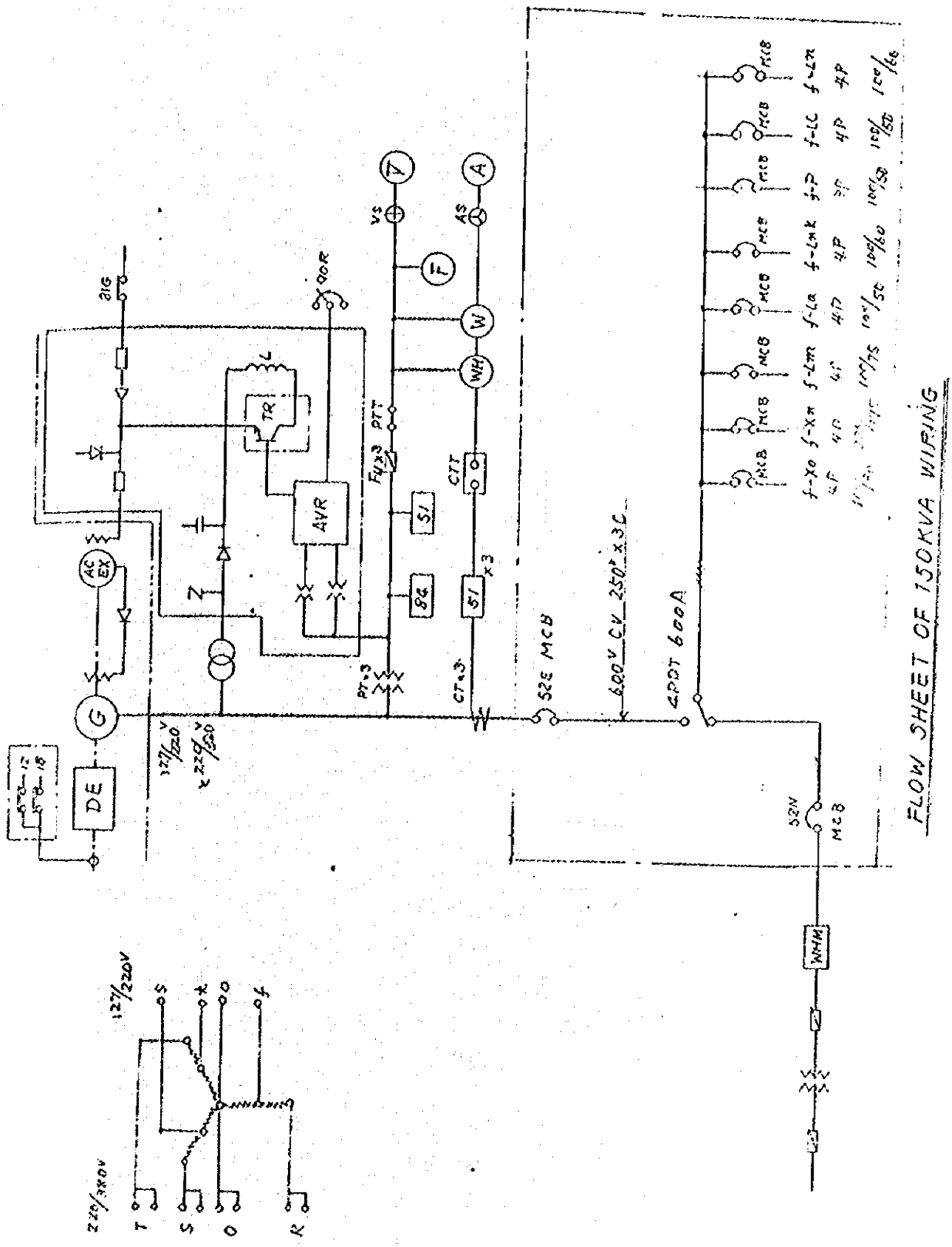


"A" ~ "A" SECTION

SECTIONAL VIEW OF 150KVA GENERATOR SCALE: 1/100



FLOW SHEET OF 150KVA GENERATOR PIPIPING


FLOW SHEET OF 150KVA WIRING
DE
G
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CTT
PT.3
CT.3
S2E MCB
600V CV 250 SQ.MM x 3C
4POT 600A
S2N MCB
WHM
127/220V
220/380V
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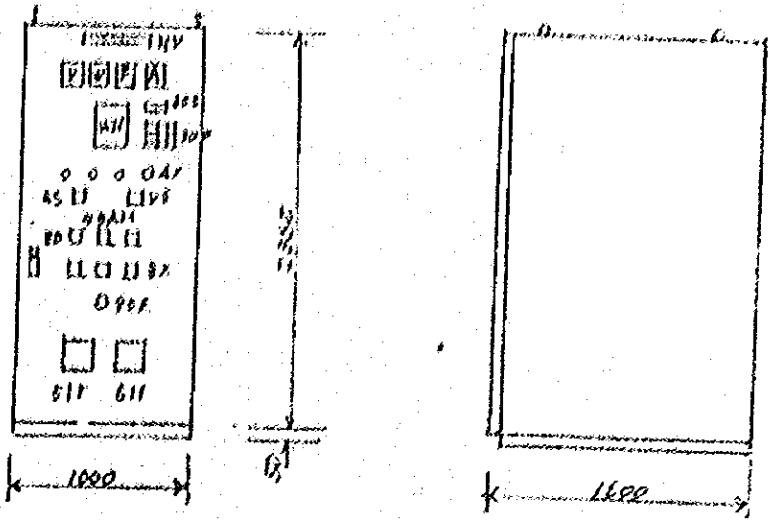
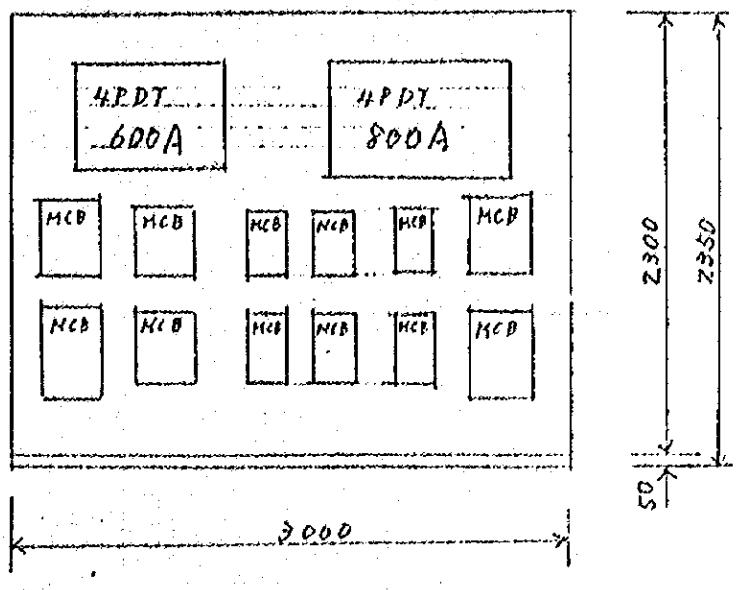
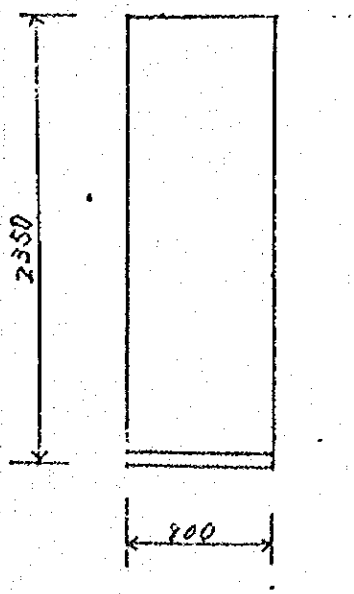


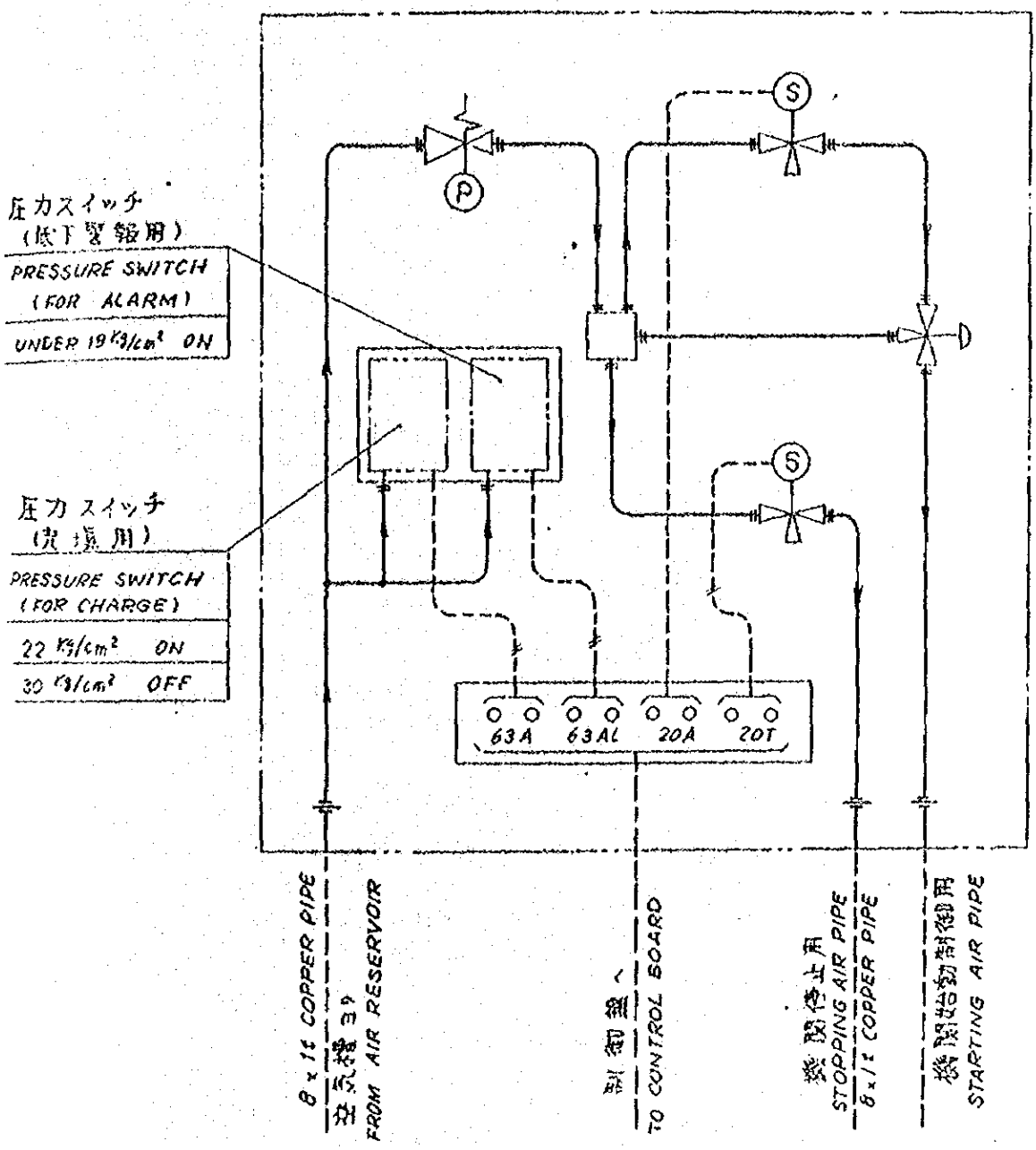
Symbol	Description
A	AC ammeter
W	Indicating Watt Meter
F	Frequency Meter
V	AC Voltmeter
WH	Electric Energy Meter
43 AM	Control Switch (Automatic-Manual)
8D	" (Control Power Source)
90R	Voltage
5/r 51t	Overcurrent Relay
3x	Push Button Switch (Lamp Test)
3x	" (Trouble Return)
3x	" (Alarm Stop)





DISTRIBUTION BOARD

MODEL : ML · RL · UL · GL · ZL · AL



AIR CONTROL BOARD

Special Specifications of Independent Power Plant Facilities Works

1. RS Ujung Pandang

2. Matters to Apply

The matters which are not mentioned in this specifications and drawings should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	500 KVA
	Rated Voltage	127/220V 220/380V
	Number of phase and frequency	3-phase 4-line system 50 HZ
	R. P. M.	Below 1000 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 384 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R.P.M.	Below 1000 r.p.m.
	Rated Time	More than 72 hours
	Cooling system	Radiator system 220/380V 11 KW
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	150 l, with pressure switch
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuel Tank	1000 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control System		Hand Push-button System
Elevation		150 m
Ventilating Fan		3-phase 220/380 V 0.75KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Watampone

2. Matters to Apply

Matters which are not mentioned in this specifications and drawings should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brussless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (Engine-driven Fan)
	Air Compressor	3-phase 220/380V 3.7 KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Storage Tank	5000 l.
	Fuel Pump	
Type of Board		Closed type
Control System		Hand Push-button system
Elevation		150 m
Heat Insulation Plate		Ceiling and Wall of Generator
Ventilating Fan		3-phase 220/380V 0.75 KW with Automatic shutter hood

Special Specifications of Independent Power Plant Facilities Work

1. RS Sopping

2. Matters to Apply

Matters which are not mantioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	More than 150KVA
	Rated Voltage	127/220 and 220/380V
	Number of phase and frequency	3-phase 4-line system 5 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R.P.M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator system (Engine-driven fan)
	Air Compressor	3-phase 220/380V 3.7 KW
	Air Tank	80 l. with pressure switch
	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Reservoir	5000 l.
	Fuel Pump	3-phase 220/380 V 0.4 KW
Type of Board		Close type
Control System		Hand Push-button system
Elevation		500 m
Heat-Insulation Plate		Ceiling and Wall of Genertor Room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Para Para

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	250 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1000 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1000 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System 220/380 V 7.5 KW
	Air Compressor	3-phase 220/380V 7.5KW
	Air Tank	150 l. with pressure switch
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuel Tank	600 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and wall of generator room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent
Power Plant Facilities Works

1. RS Elim Rantepao

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	150KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase & frequency	3-phase 4-line system 50 HZ
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Primer Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator system (Engine-driven fan)
	Air Compressor	3-phase 220/380V 3.7 KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Reservoir	5000 l.
	Fuel Pump	3-phase 220/380 V 0.4 KW
Type of Board		Closed type
Control System		Hand Push-button system
Elevation		500 m
Heat-Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent Power

Plant Facilities Works

1. RS, Palopo

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities.

AC Generator	Type	Horizontal synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Startation Time	Within 40 seconds
	Excitation system	Brushless system
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (engine-driven fan)
	Air Compressor	3-phase 220/380 V 3.7 KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Oil Reservoir	5,000 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control System		Hand Push-Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Bantaeng

2. Matters to Apply

   Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50Hz
	R. P.M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling system	Radiator System (Engine-driven fan)
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Pil Reservoir	5000 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Closed type
Control System		Hand Push-Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380v with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Medan

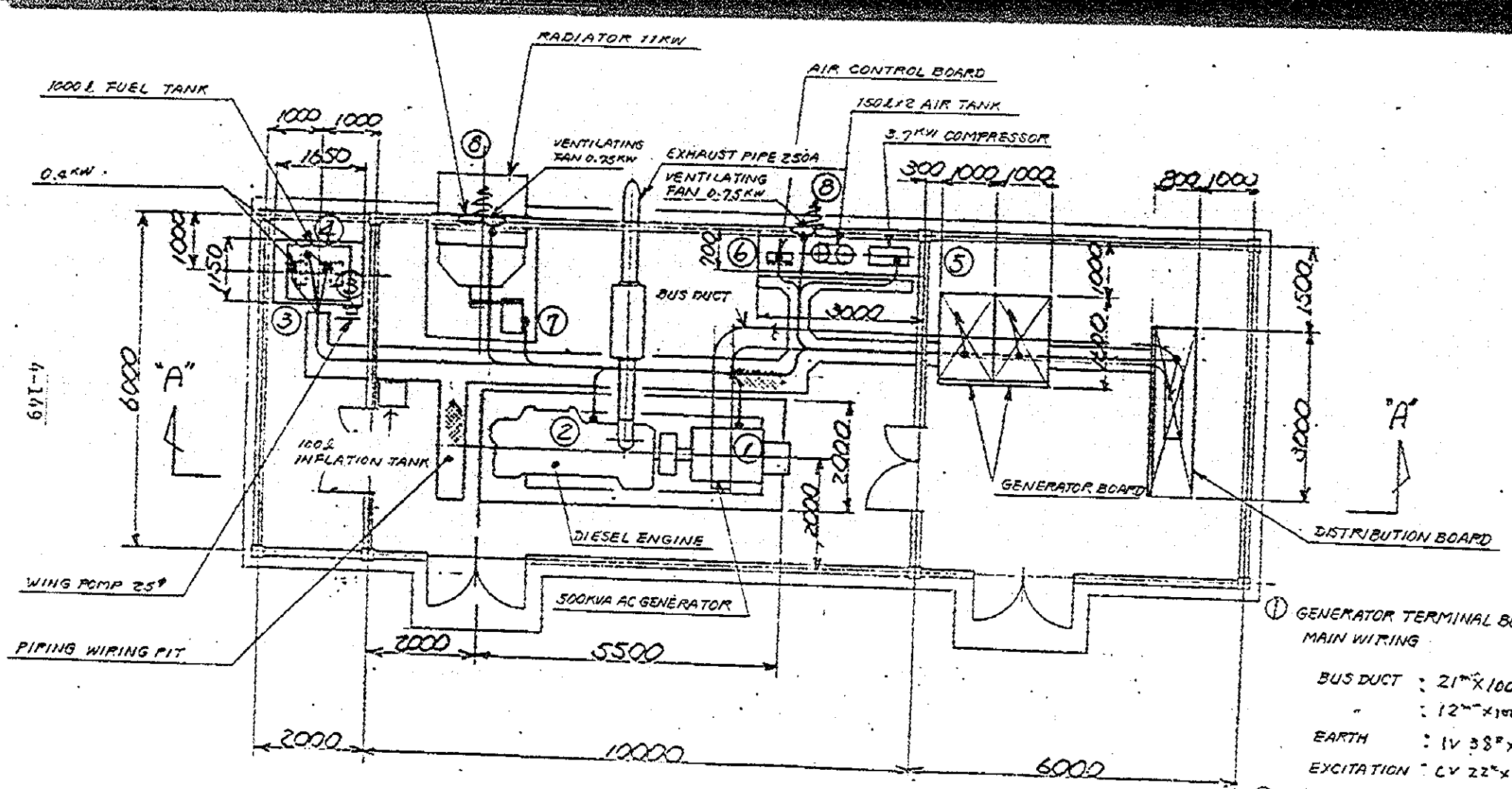
2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	500 KVA
	Rated Voltage	127/220 V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50Hz
	R. P. M.	Below 1000 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	About 584 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

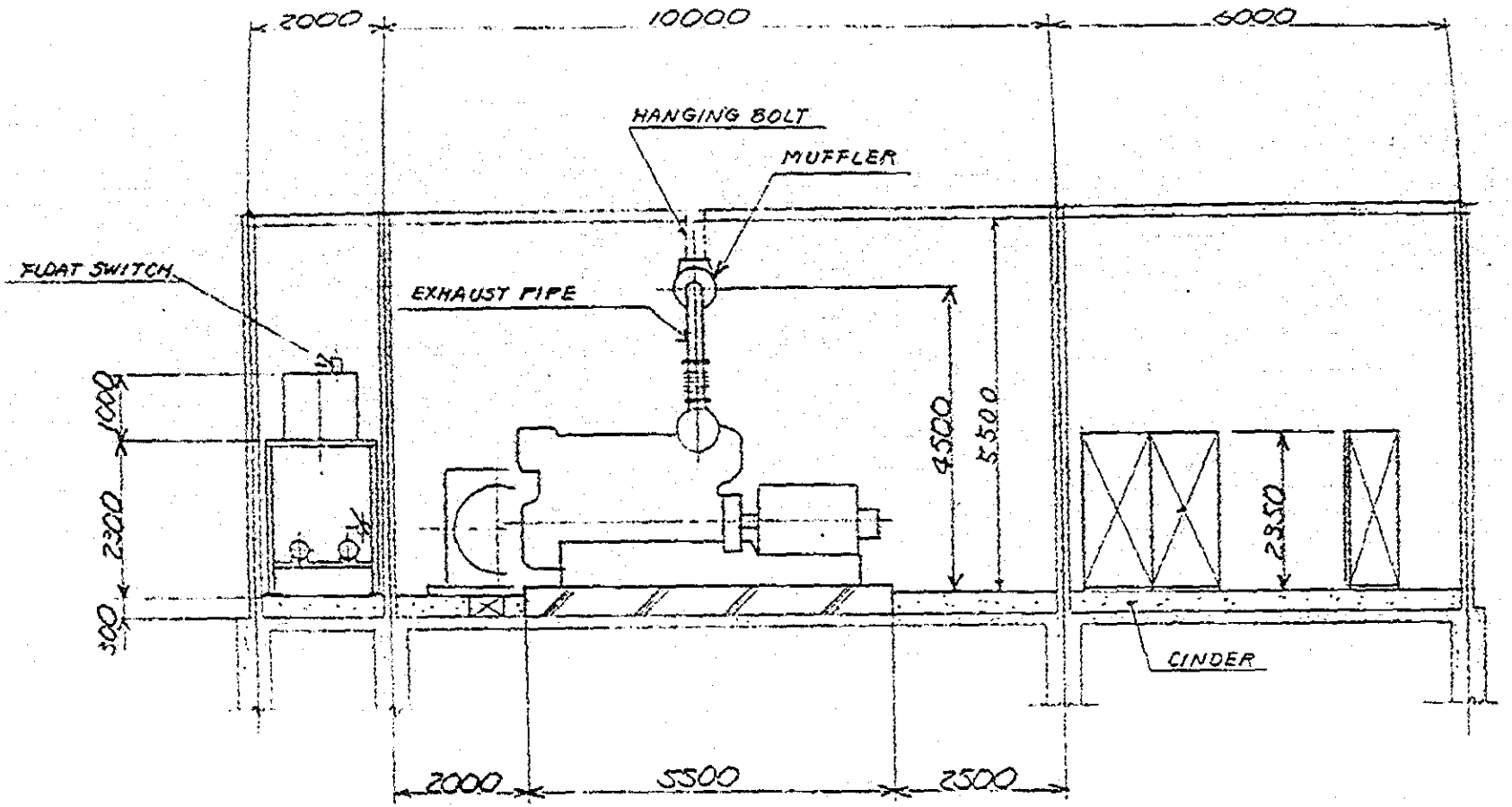
Prime mover	R. P. M.	Below 1000 r.p.m.
	Rated Time	More than 72 hours
	Cooling system	Radiator System 220/380V 1.1KW
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	150 l. with pressure switch
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuel Tank	1000 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V 0.75 with automatic shutter hood



LAYOUT OF 500KVA GENERATOR ROOM SCALE 1/100

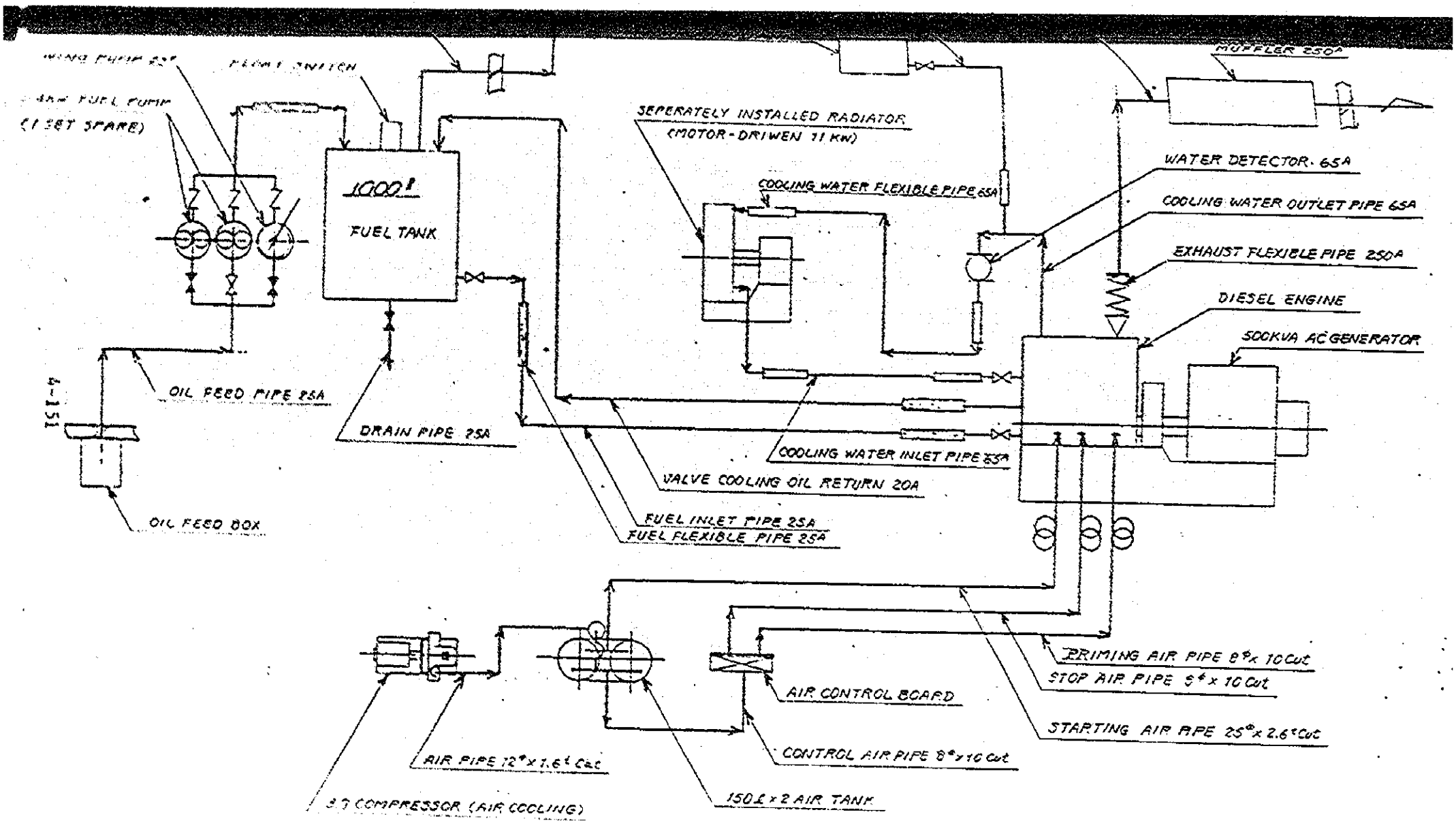
① GENERATOR TERMINAL BOX
MAIN WIRING

BUS DUCT	: 21ᵐᵐ×100ᵐᵐ×4
"	: 12ᵐᵐ×100ᵐᵐ×4
EARTH	: 1V 38ᵐᵐ×1
EXCITATION	: CV 22ᵐᵐ×2C
② ENGINE TERMINAL BOX	: CVV 2ᵐᵐ×8C
③ FUEL PUMP	: CV 3.5ᵐᵐ×4C×2
④ FLOAT SWITCH	: CVV 2ᵐᵐ×6C
⑤ COMPRESSOR	: CV 5.5ᵐᵐ×4C
⑥ AIR CONTROL BOARD	: CVV 2ᵐᵐ×8C
⑦ RADIATOR	: CV 5.5ᵐᵐ×4C
⑧ VENTILATING FAN	: CV 3.5ᵐᵐ×4C×2

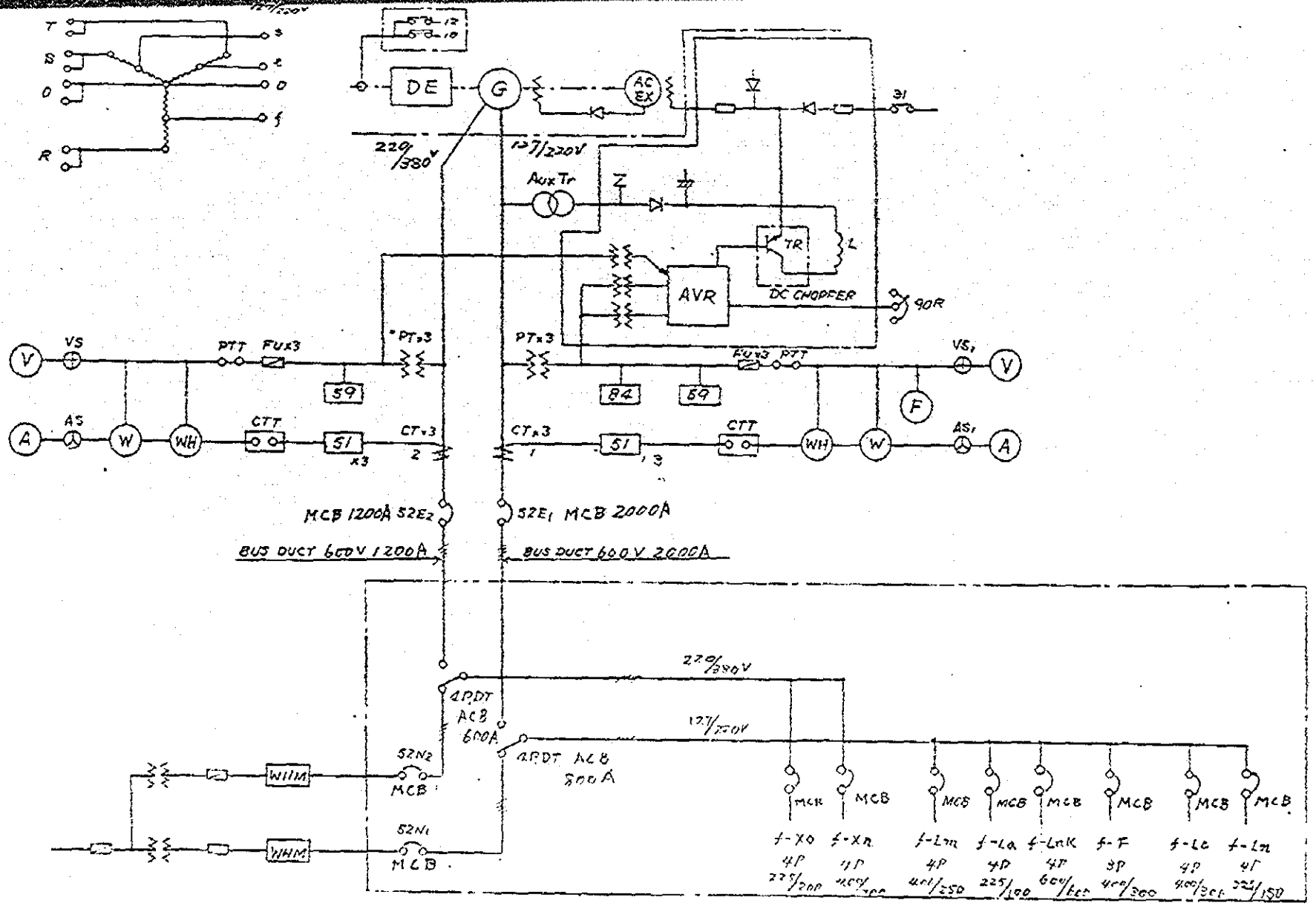


"A" ~ "A" SECTION

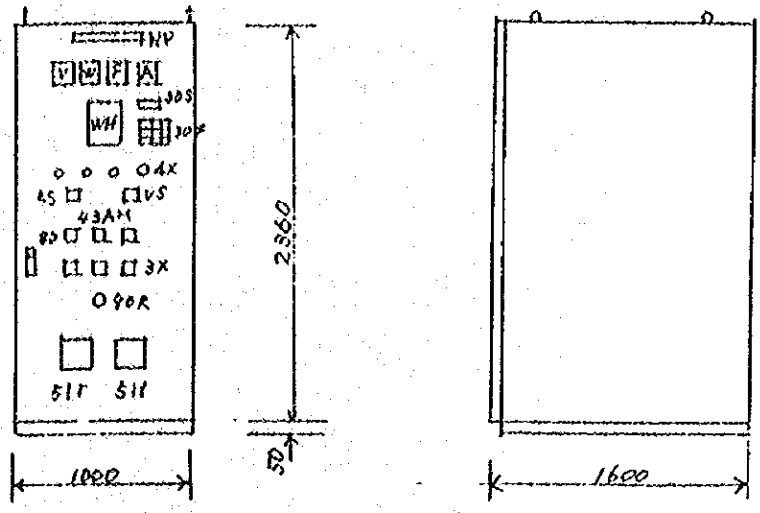
SECTIONAL VIEW OF 500KVA GENERATOR SCALE : 1/100



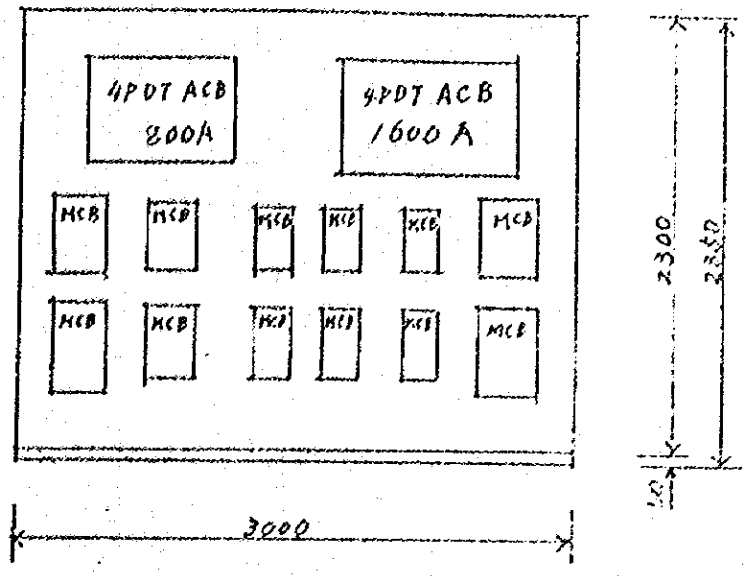
FLOW SHEET OF 500KVA GENERATOR PIPING

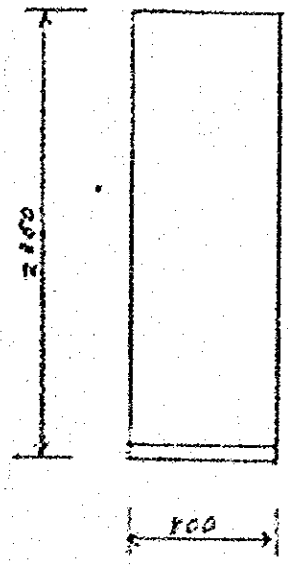


FLOW SHEET OF 500 KVA WIRING



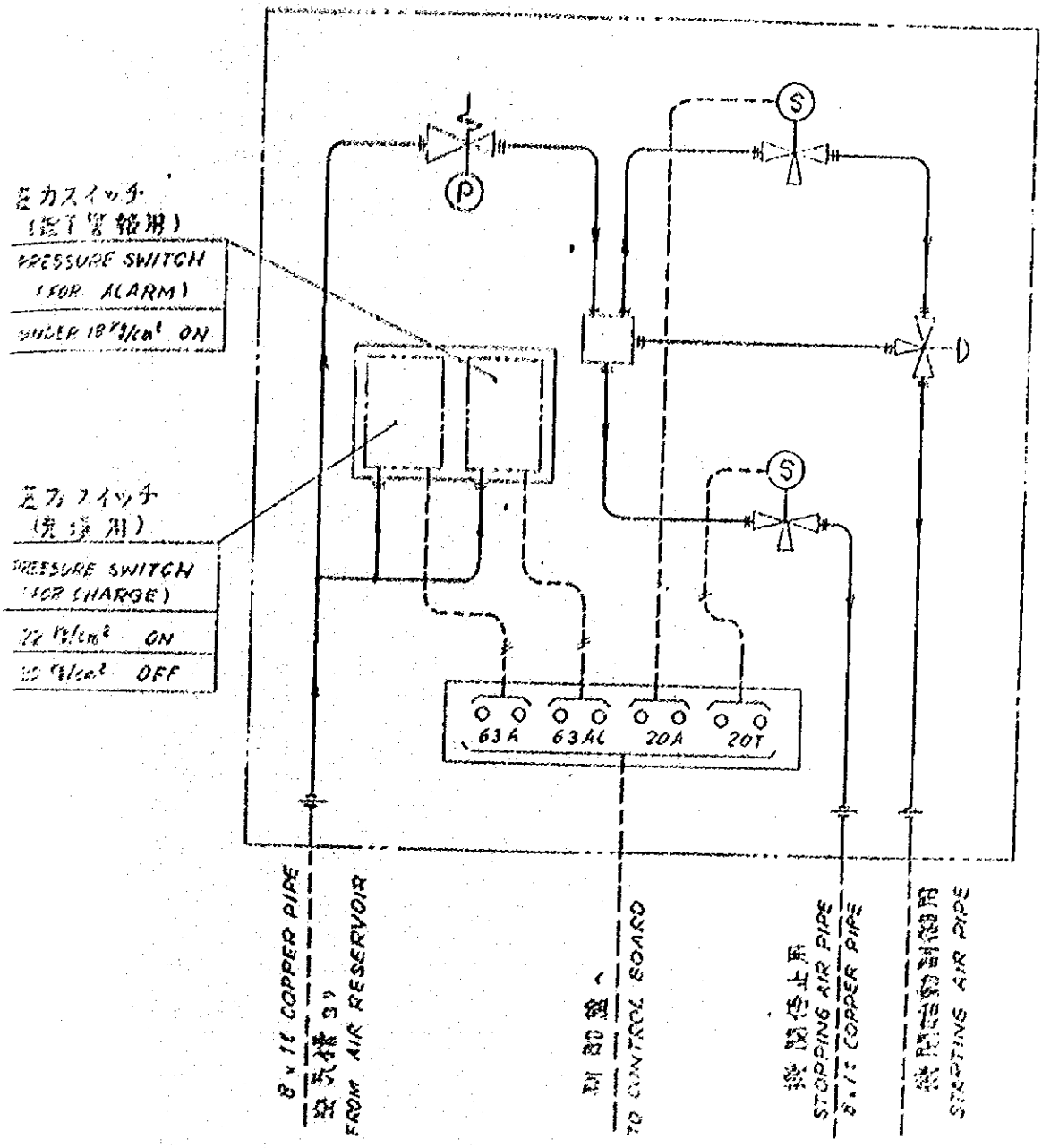
Symbol	Description
A	AC ammeter
W	Indicating Watt Meter
F	Frequency Meter
V	AC Voltmeter
WH	Electric Energy Meter
43 AM	Control Switch (Automatic-Manual)
8D	" (Control Power Source)
90R	Voltage
5/r 51t	Overcurrent Relay
3x	Push Button Switch (Lamp Test)
3x	" (Trouble Return)
3x	" (Alarm Stop)





DISTRIBUTION BOARD

MODEL : ML · RL · UL · GL · ZL · AL



AIR CONTROL BOARD

Special Specifications of Independent Power Plant Facilities Works

1. RS Tartung

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities Works.

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	250 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1000 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1000 r.p.m.
	Ratod Time	More than 72 hours
	Cooling System	Radiator System
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	150 l. with pressure switch
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuelt Tank	600 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Closed Type
Control System		Hand Push Button System
Elevation		1200 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent
Power Plant Facilities Works

1. RS Porsea

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities Works

AC Generator	Type	Horizontal synchronous AC Generator
	Rated Output	150KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	R. P. M.	Below 1500 r.p.m.
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (Engine-driven fan)
	Air Compressor	3-phase 220/380V 0.4KW
	Air Tank	80.1 with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Oil Reservoir	5000 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Close type
Control System		Hand Push Button System
Elevation		900 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Pematang Siantar

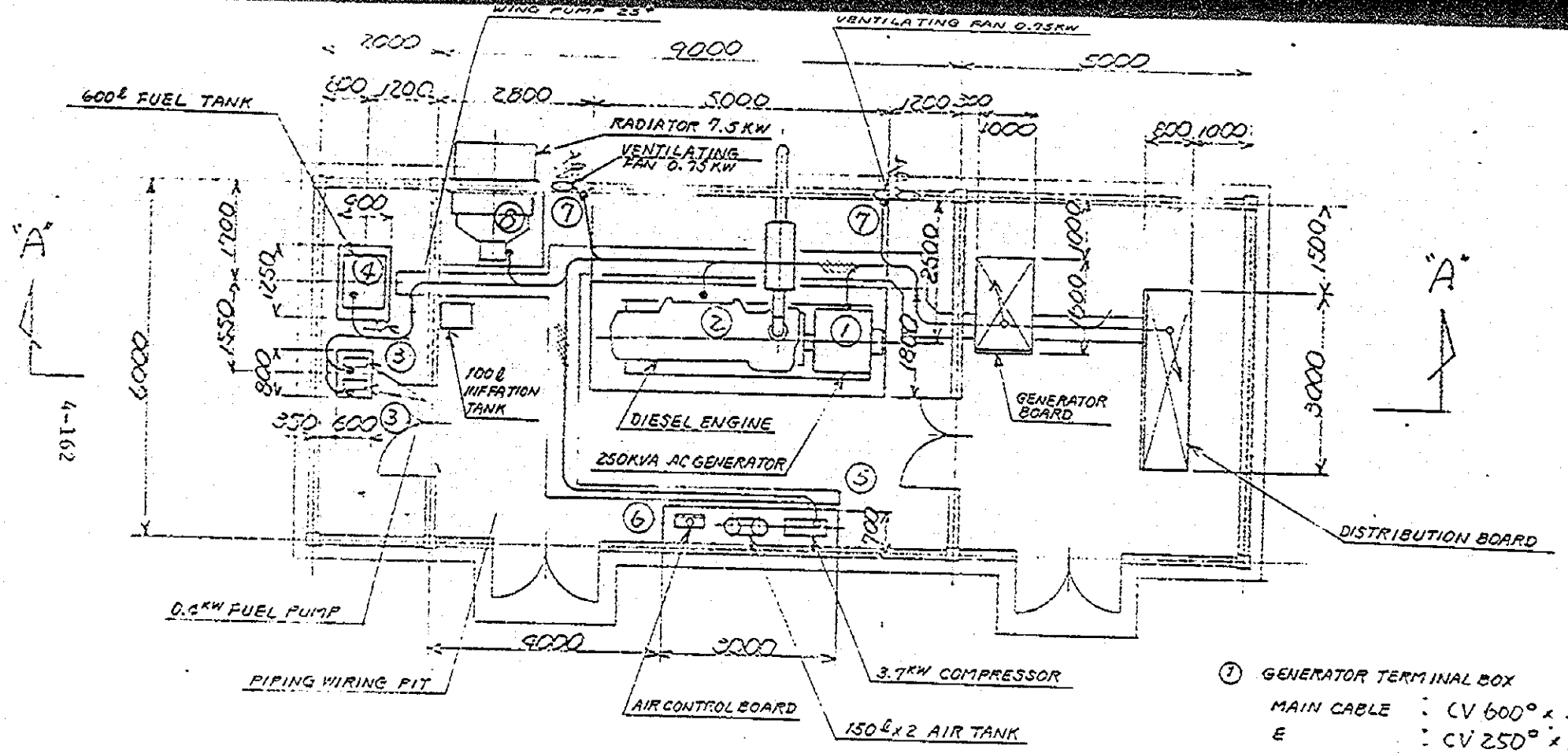
2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities.

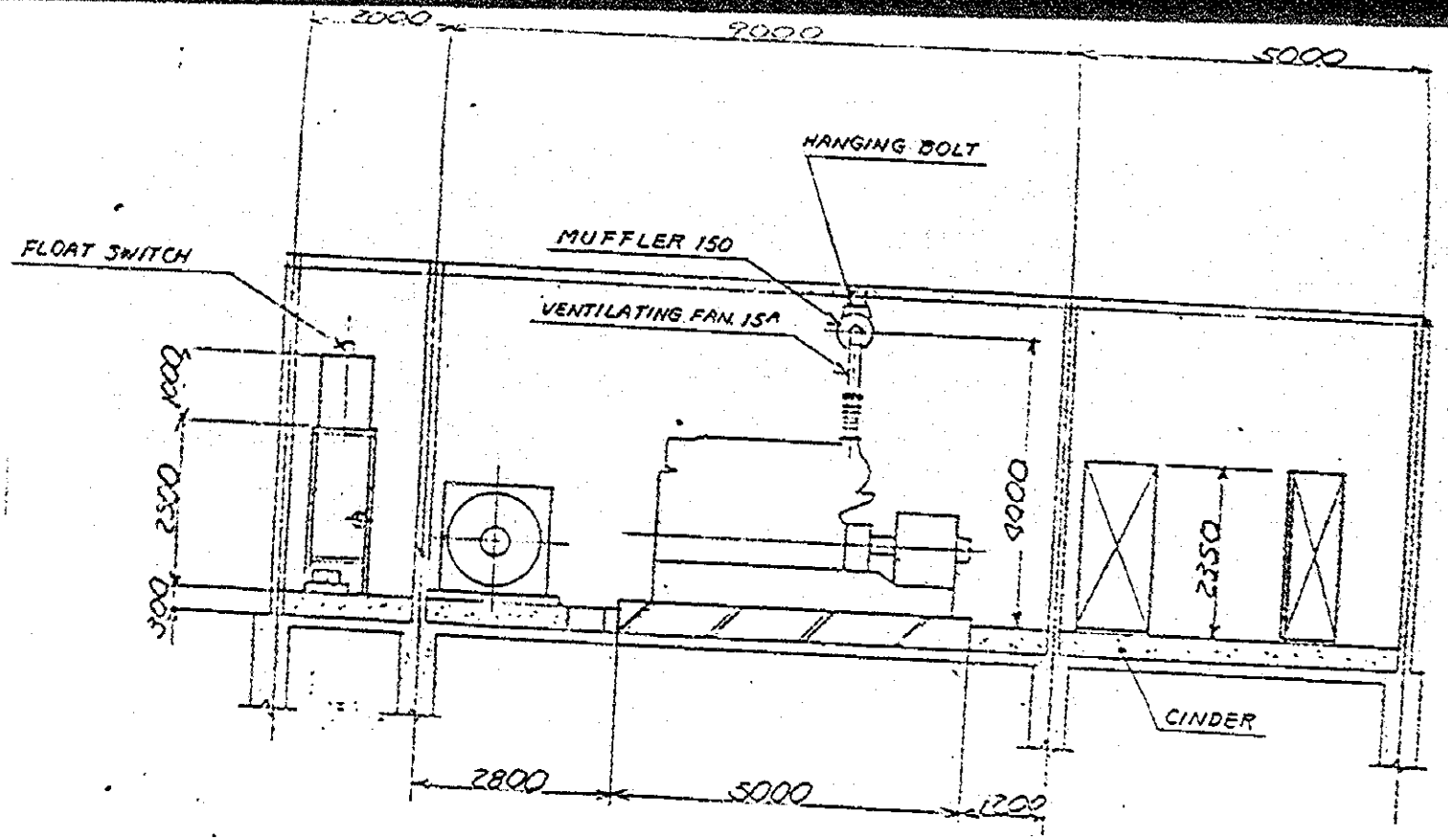
AC Generator	Type	Horizontal synchronous AC Generator
	Rated Output	250 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1000 r.p.m.
	Power-Factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1000 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator system 220/380 V. 7.5KW
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	150 l.
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuel Tank	600 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		400 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V, 0.75KW with automatic shutter Hood



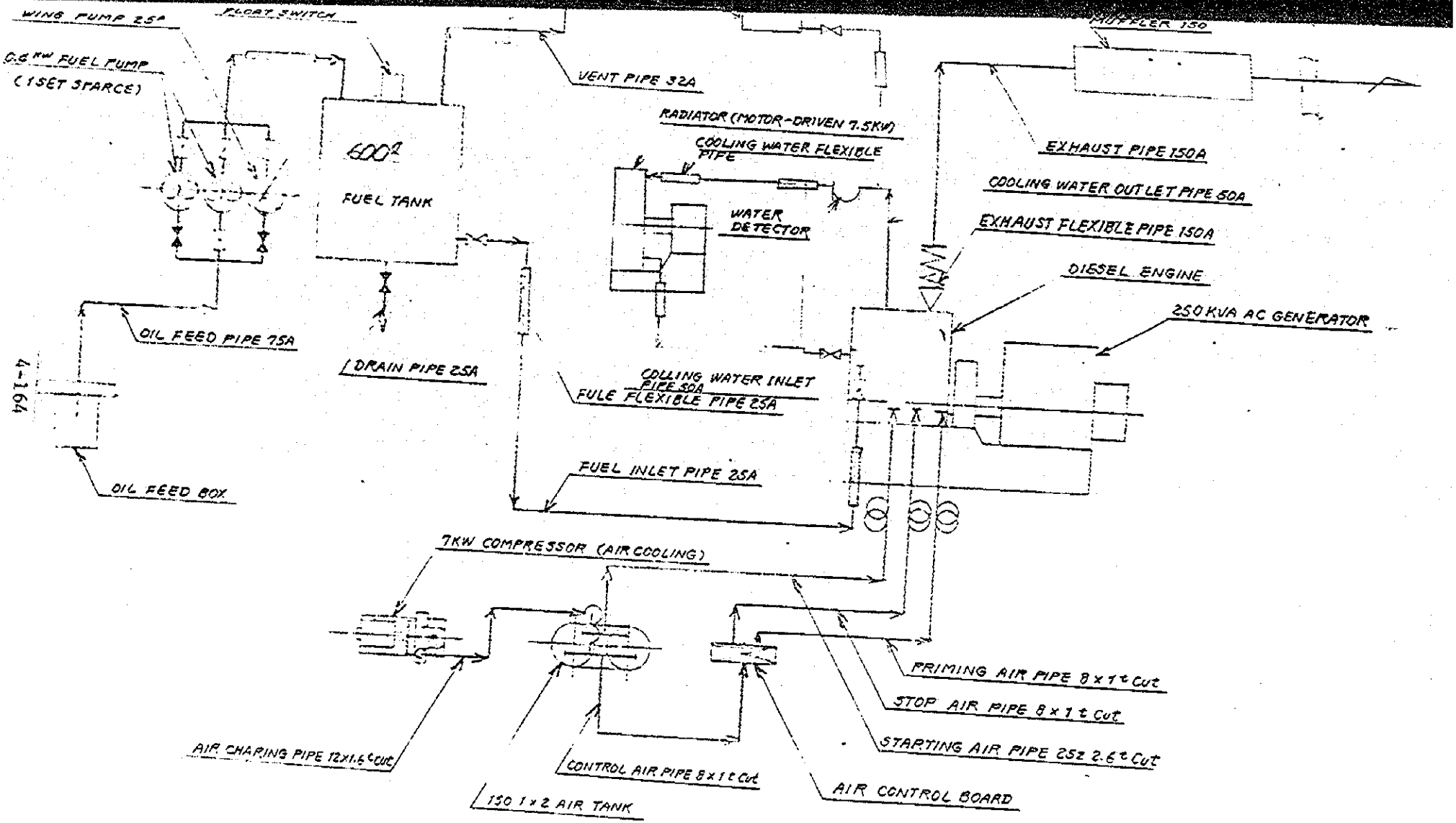
LAYOUT OF 250KVA GENERATOR ROOM SCALE: 1:100

①	GENERATOR TERMINAL BOX	
	MAIN CABLE	: CV 600° x 3C
	E	: CV 250° x 3C
	EARTH	: IV 38° x 1C
	EXCITATION	: CV 22° x 2C
②	ENGINE TERMINAL BOX	: CVV 2° x 8C
③	FUEL PUMP	: CV 3.5° x 4C x 2
④	FLOAT SWITCH	: CVV 2° x 6C
⑤	COMPRESSORE	: CV 5.5° x 4C
⑥	AIR CONTROL BOARD	: CVV 2° x 8C
⑦	VENTILATING FAN	: CV 3.5° x 4C x 2
⑧	RADIATOR	: CV 5.5° x 4C

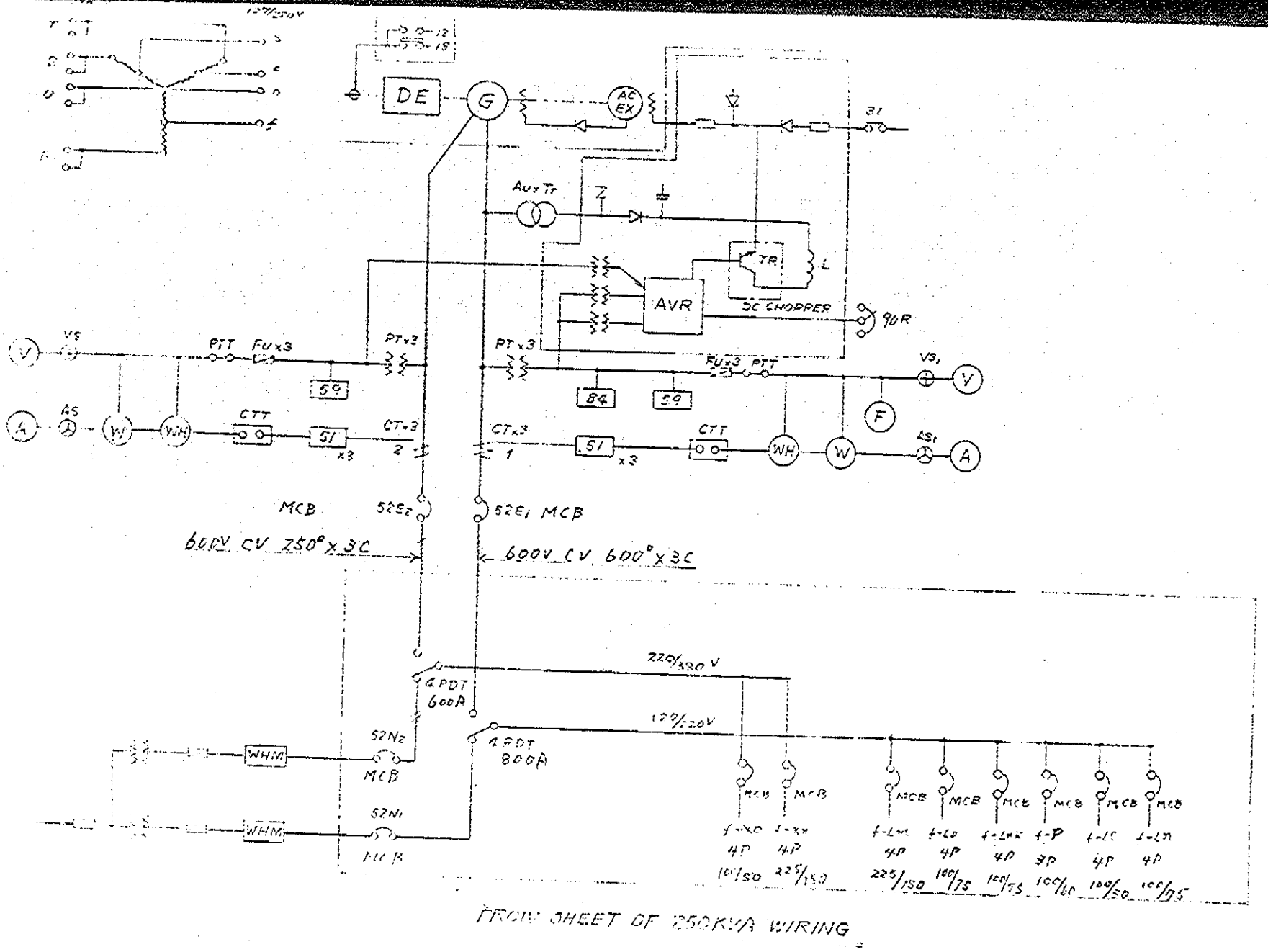


"A" ~ "A" SECTION

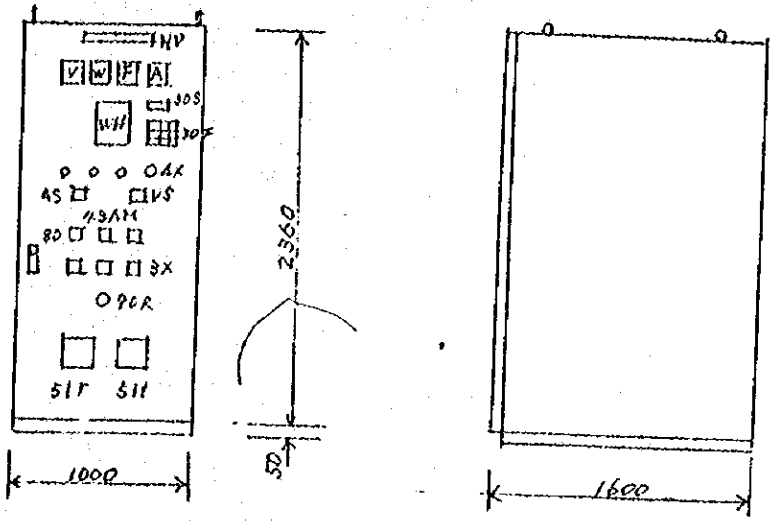
SECTIONAL VIEW OF 250KVA GENERATOR SCALE 1/100



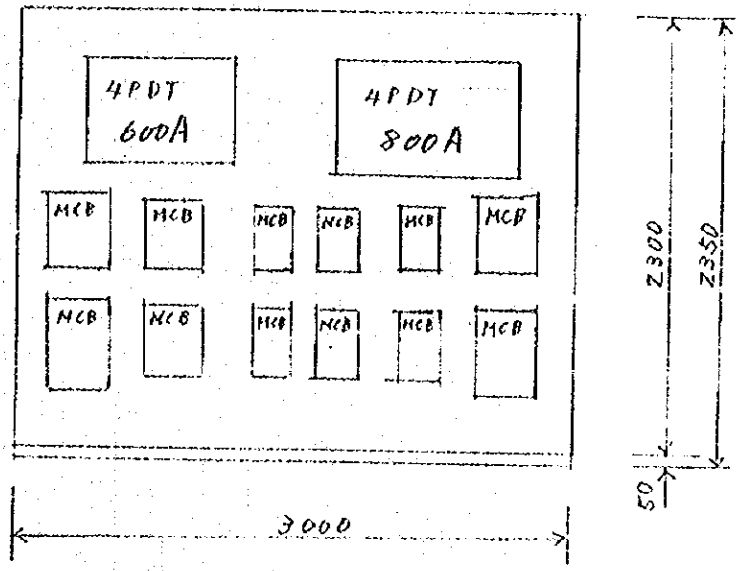
FLOW SHEET OF 250 KVA GENERATOR PIPING

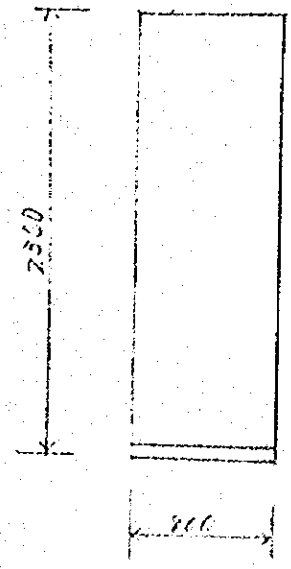


FROM SHEET OF 250KVA WIRING



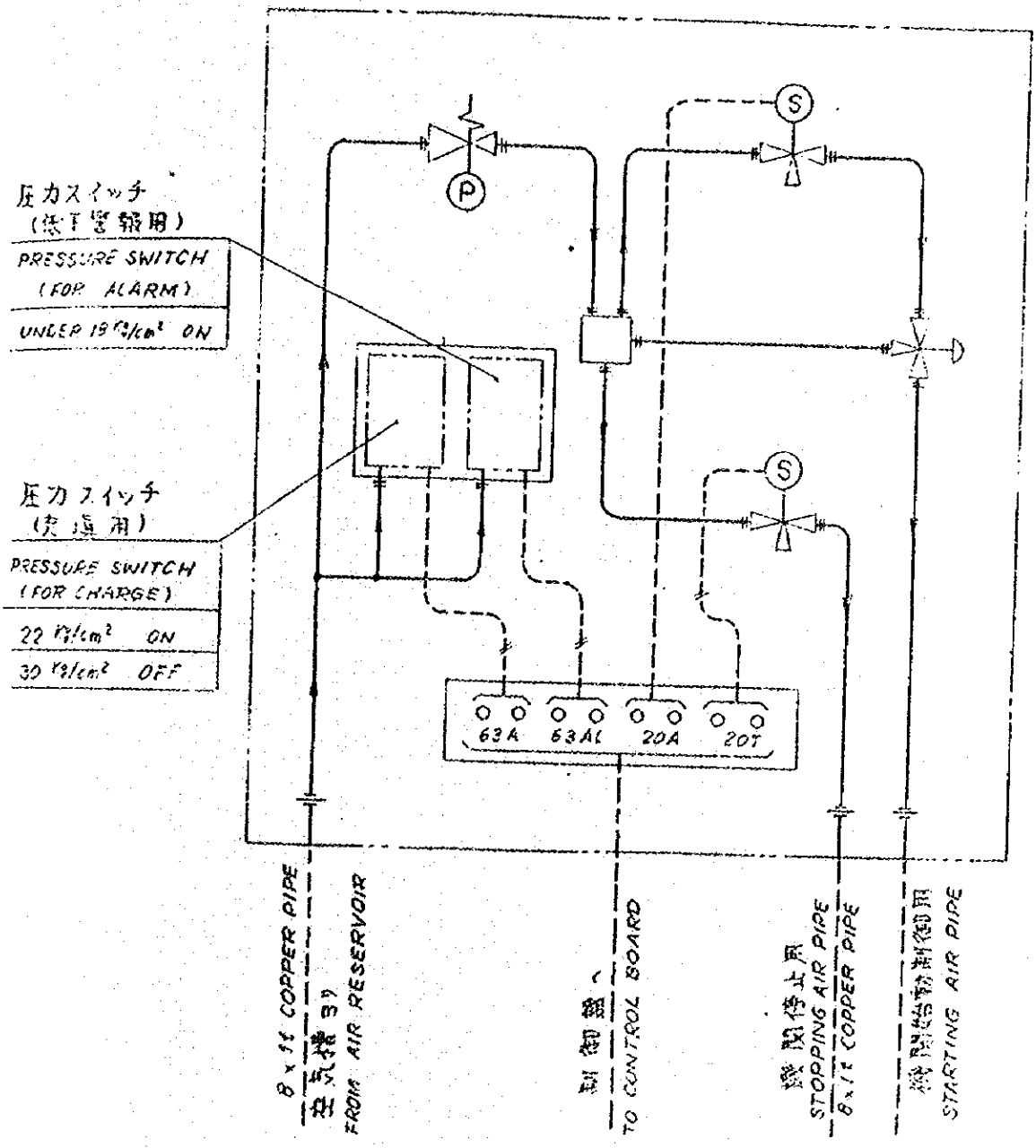
Symbol	Description
A	AC ammeter
W	Indicating Watt Meter
F	Frequency Meter
V	AC Voltmeter
WH	Electric Energy Meter
43 AM	Control Switch (Automatic-Manual)
8D	" (Control Power Source)
90R	Voltage
5/r 51t	Overcurrent Relay
3x	Push Button Switch (Lamp Test)
3x	" (Trouble Return)
3x	" (Alarm Stop)





DISTRIBUTION BOARD

MODEL : ML · RL · UL · GL · ZL · AL



AIR CONTROL BOARD

Special Specifications of Independent
Power Plant Facilities Works

1. RS Tebing Tinggi

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities Works

AC Generator	Type	Horizontal synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Single-acting 4-cycles Diesel Engine
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (Engine Driven fan)
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Pump	3-phase 220/380V. 3.7 KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		200 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. Building Rules

2. Matters to Apply

Matters which are not mentioned in this specifications and drawings shall be according to the common specifications of Independent Power Plant Facilities Work.

3. Specifications of Independent Power Plant Facilities

A) Generator	Type	Horizontal revolving field type
	Rated Output	15 MW
	Rated Voltage	13.8 kV
	Number of phase and frequency	3 phase 60 Hz
	I. P. F.	0.85 lag
	Power-factor	0.85
	Class of insulation	Class F
	Rated Time	Continuous rating
	Starting Time	Within 10 seconds
	Excitation system	Brushless system
	Type	Single stage impulse reaction type
	Rated Output	15 MW
	Starting time	Within 10 seconds
	Starting system	Hydraulic system

Prime Mover	R. P.M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling system	Radiator System (Engine driven fan)
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		150 m
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Kisaran

2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Facilities Works.

3. Specifications of Independent Power Facilities Works

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	250 KVA
	Rated Voltage	127/220V and 220/380V
	Number of phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1000 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation system	Brushless System
	Type	Single-acting 4-cycle Diesel Engine
	Rated Output	Above 300 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

Prime Mover	R. P. M.	Below 1000 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System 220/380V 7.4 KW
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	150 l. with pressure switch
	Inflation Tank	100 l.
Fuel	Kind	A Heavy Oil
	Fuel Tank	600 l.
	Fuel Pump	3-phase 220/380V 0.4KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		
Heat Insulation Plate		Ceiling and Wall of Generator Room
Ventilating Fan		3-phase 220/380V 0.75KW with automatic shutter hood

Special Specifications of Independent Power Plant Facilities Works

1. RS Rantan Prapat

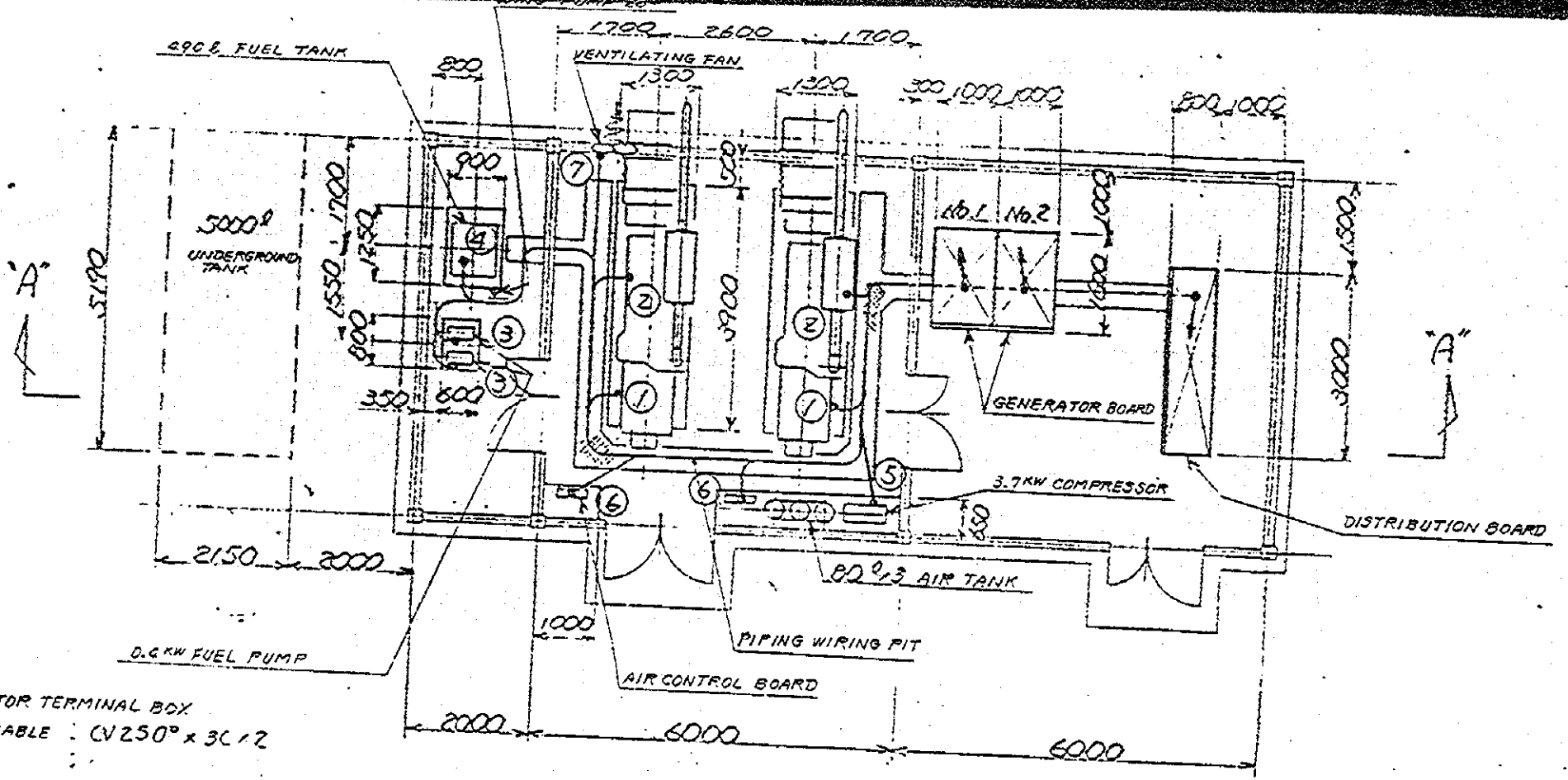
2. Matters to Apply

Matters which are not mentioned in this specifications and drawing should be according to the common specifications of Independent Power Plant Facilities Works.

3. Specifications of Independent Power Plant Facilities Work.

AC Generator	Type	Horizontal Synchronous AC Generator
	Rated Output	150 KVA
	Rated Voltage	127/220 and 220/380V
	Number of Phase and frequency	3-phase 4-line system 50 Hz
	R. P. M.	Below 1500 r.p.m.
	Power-factor	Above 80%
	Class of Insulation	Above Kind B
	Rated Time	Continuous Rating
	Starting Time	Within 40 seconds
	Excitation System	Brushless System
	Type	Brushless System
	Rated Output	Above 180 PS
	Starting Time	Within 40 seconds
	Starting System	Pneumatic System

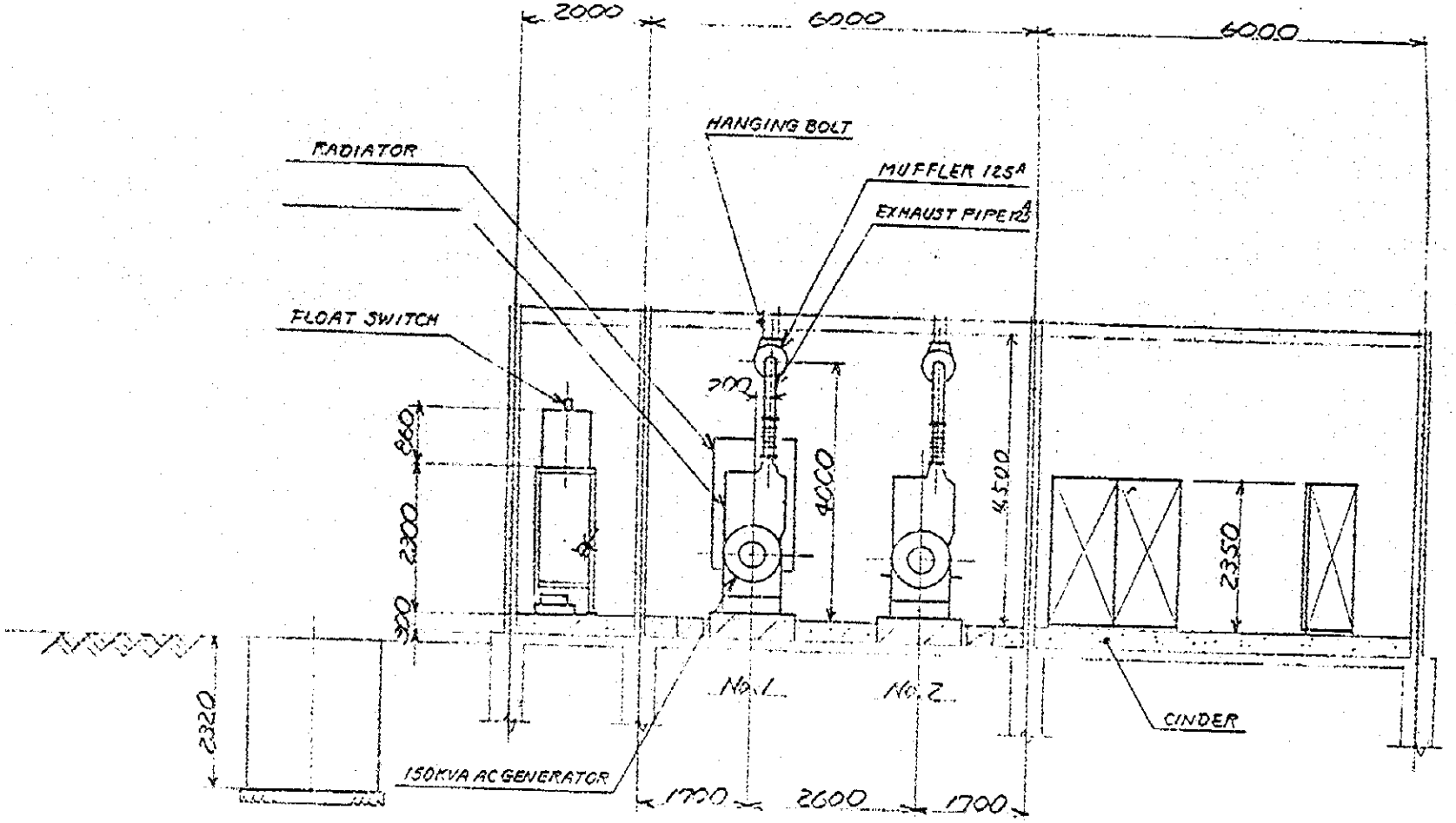
Prime Mover	R. P. M.	Below 1500 r.p.m.
	Rated Time	More than 72 hours
	Cooling System	Radiator System (Engine-driven fan)
	Air Compressor	3-phase 220/380V 3.7KW
	Air Tank	80 l. with pressure switch
Fuel	Kind	A Heavy Oil
	Fuel Tank	490 l.
	Fuel Oil Reservoir	5000 l.
	Fuel Pump	3-phase 220/380V 0.4 KW
Type of Board		Closed type
Control System		Hand Push Button System
Elevation		300 m
Heat Insulation Plate		Ceiling and Wall of generator room
Ventilating Fan		3-phase 220/380V with automatic shutter hood



LAYOUT OF 150KVA × 2 GENERATOR ROOM

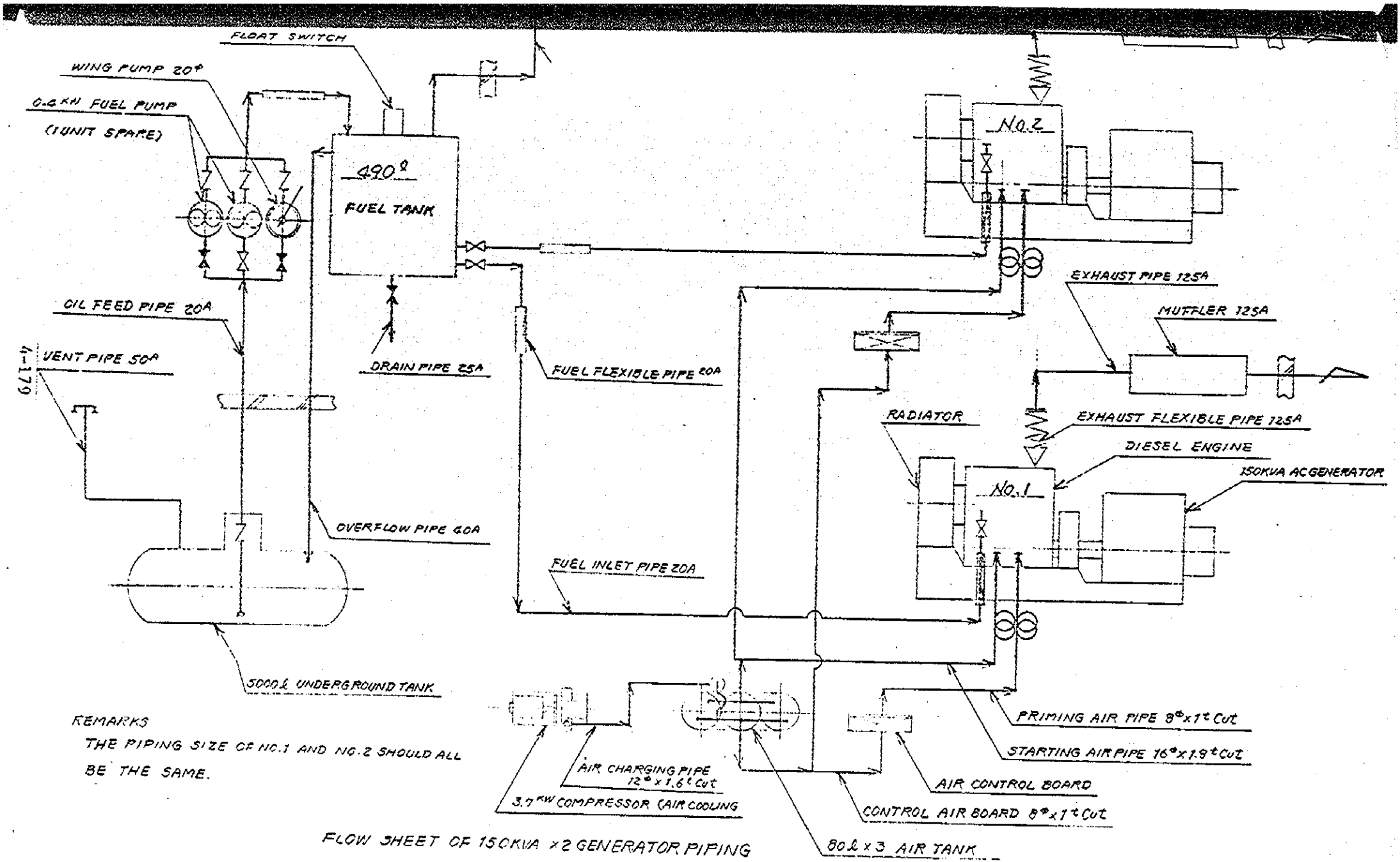
① GENERATOR TERMINAL BOX
- MAIN CABLE : CV 250° × 3C × 2
- EARTH : IV 38° × 1C × 2
- EXCITATION : CV 22° × 2C × 2

② ENGINE TERMINAL BOX : CVV 2° × 8C × 2
③ FUEL PUMP : CV 3.5° × 4C × 2
④ FLOAT SWITCH : CVV 2° × 6C
⑤ COMPRESSOR : CV 5.5° × 4C
⑥ AIR CONTROL BOARD : CVV 2° × 6C × 2
⑦ VENTILATING FAN : CV 3.5° × 4C



"A" ~ "A" SECTION

SECTIONAL VIEW OF 150 KVA x 2 GENERATOR SCALE : 1/100

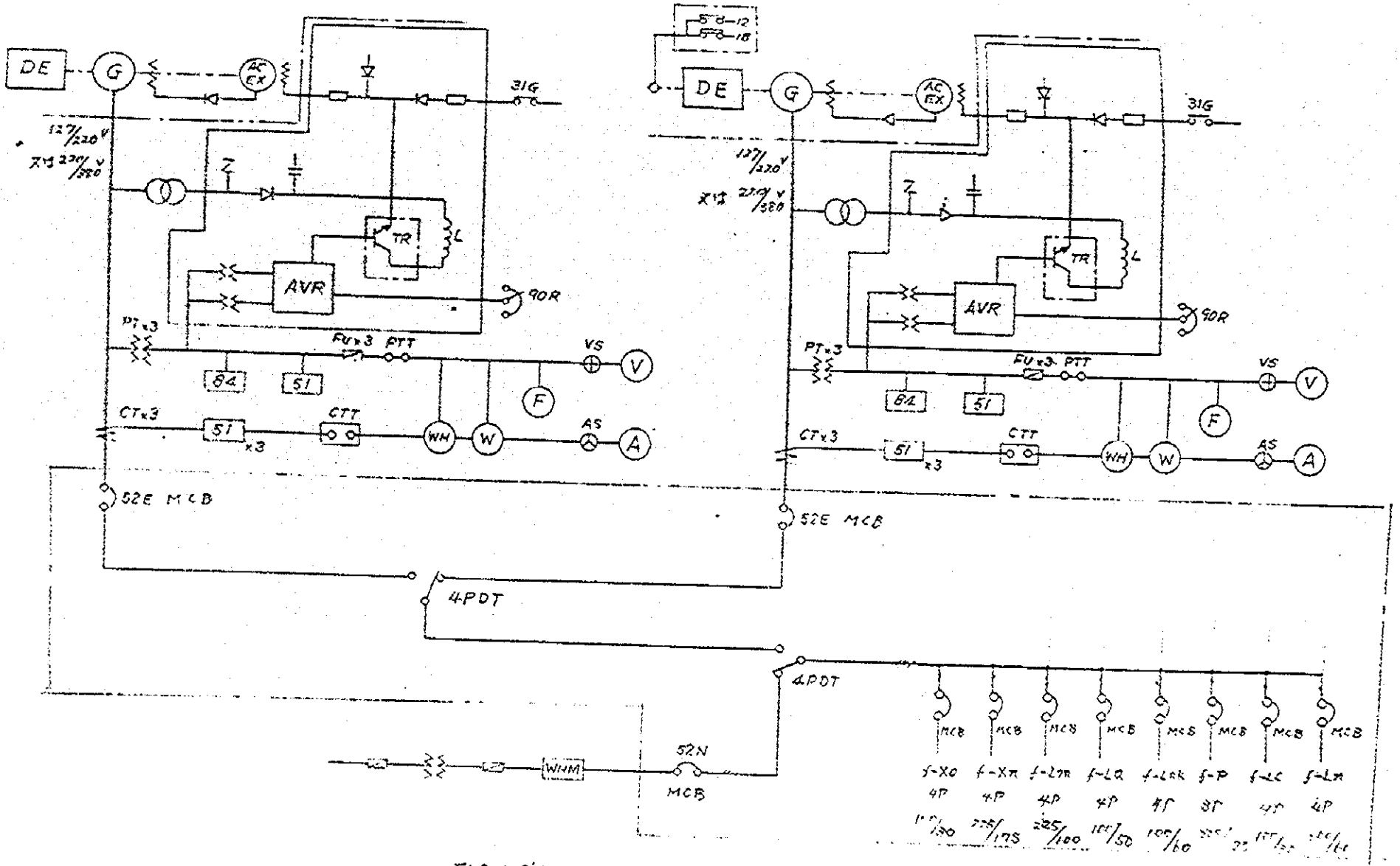


4-179

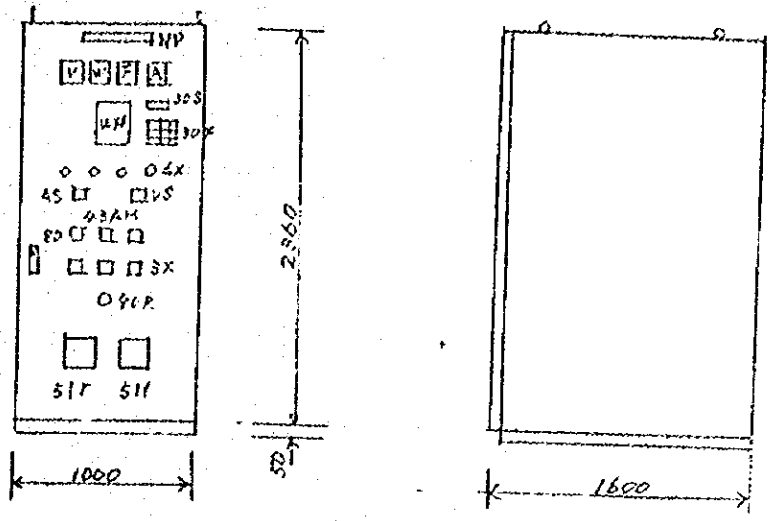
REMARKS

THE PIPING SIZE OF NO.1 AND NO.2 SHOULD ALL BE THE SAME.

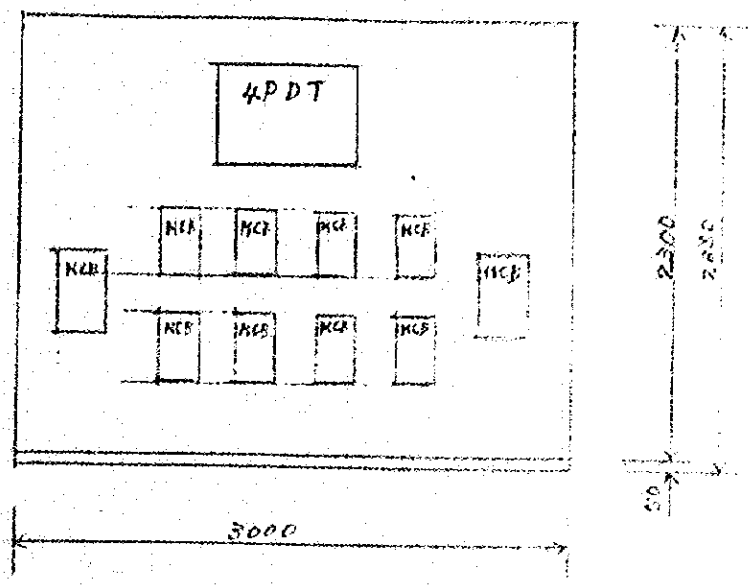
FLOW SHEET OF 150KVA ×2 GENERATOR PIPING

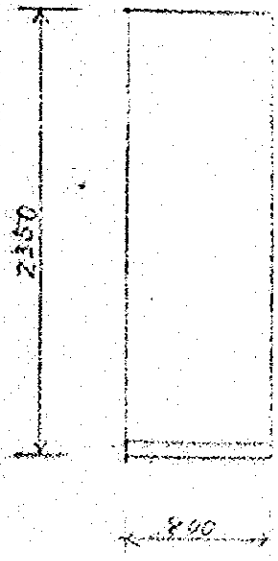


FLOW SHEET OF 150KVA × 2 WIRING



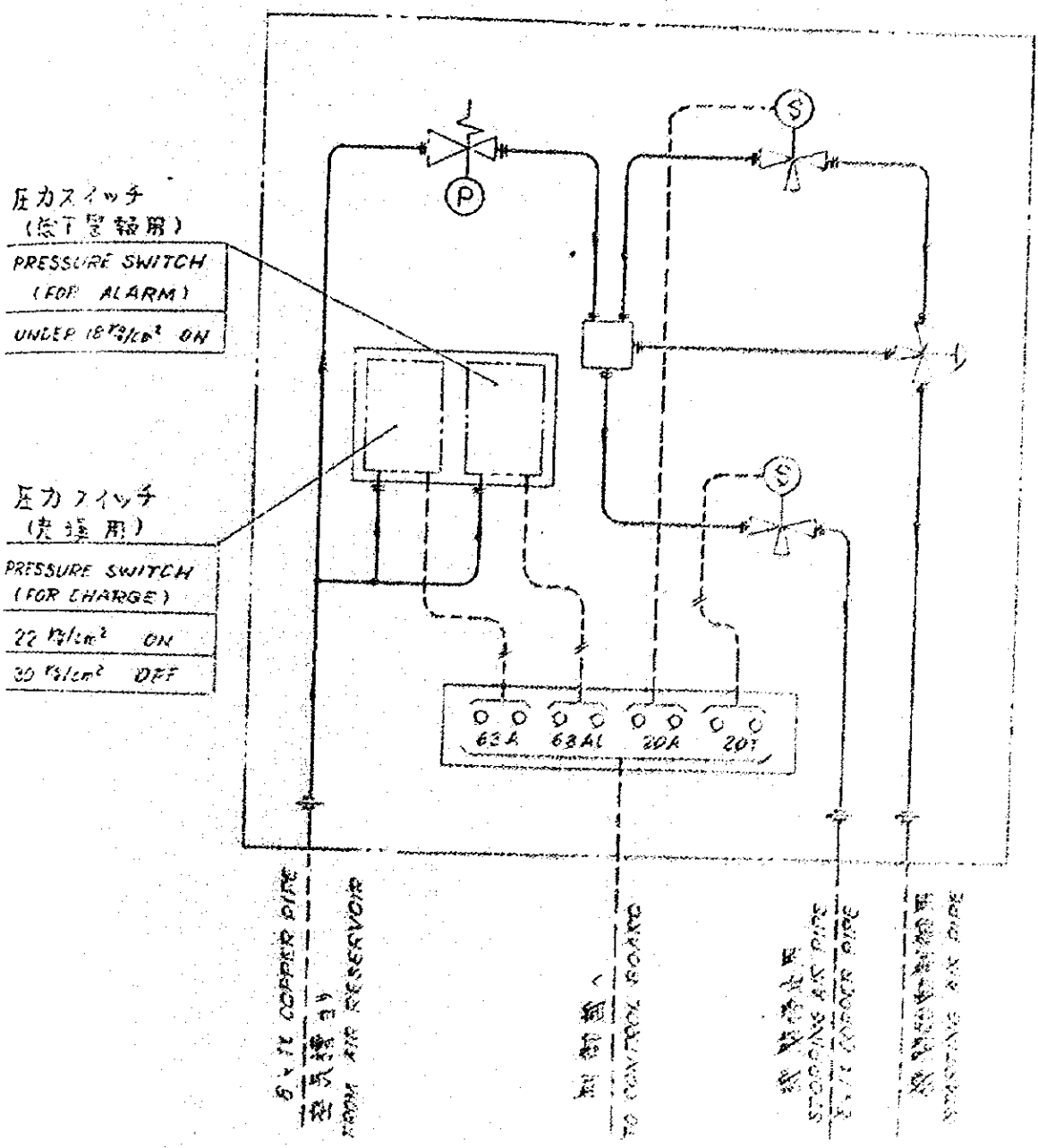
Symbol	Description
A	AC ammeter
W	Indicating Watt Meter
F	Frequency Meter
V	AC Voltmeter
WH	Electric Energy Meter
43 AM	Control Switch (Automatic-Manual)
8D	" (Control Power Source)
90R	Voltage
5/r 51t	Overcurrent Relay
3x	Push Button Switch (Lamp Test)
3x	" (Trouble Return)
3x	" (Alarm Stop)





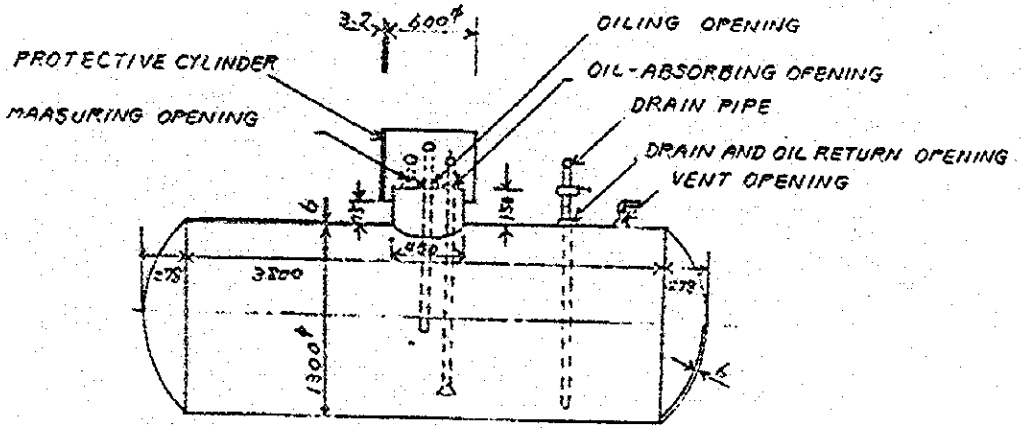
DISTRIBUTION BOARD

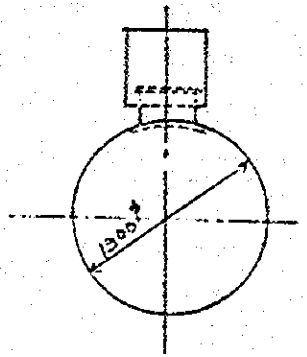
MODEL : ML · RL · UL · GL · ZL · AL



AIR CONTROL BOARD

UNIT : mm





(NOTES) (1) TO BE MANUFACTURED ACCORDING TO "GOVERNMENT ORDINANCE REGARDING DANGEROUS OBJECTS" AND "REGLATIONS REGARDING DANGEROUS OBJECTS".

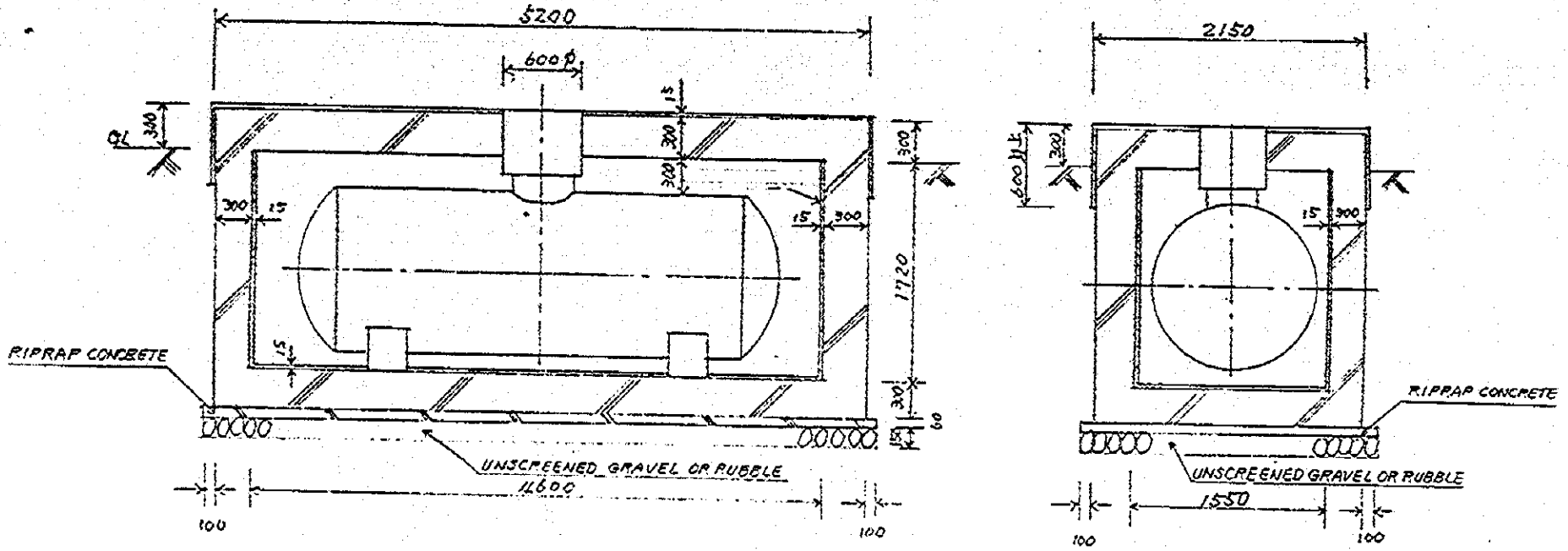
(2) THE POSITION OF CONNECTION OPENINGS SHOULD BE ACCORDING TO THE POSITION WHERE THE TANK IS INSTALLED.

(5000ℓ)

	32
	40
	40

4-184

UNIT : mm

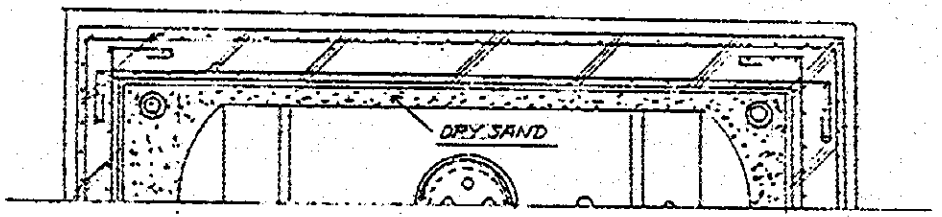


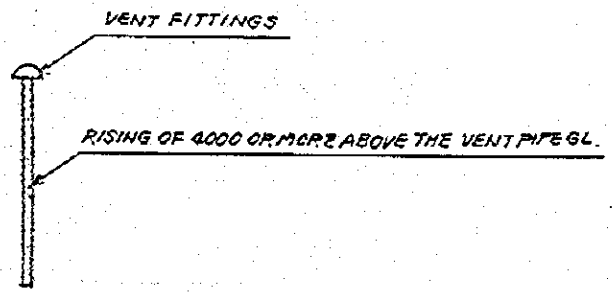
OUTSIDE OF UNDERGROUND OIL TANK AND ESSENTIALS OF ITS CONSTRUCTION

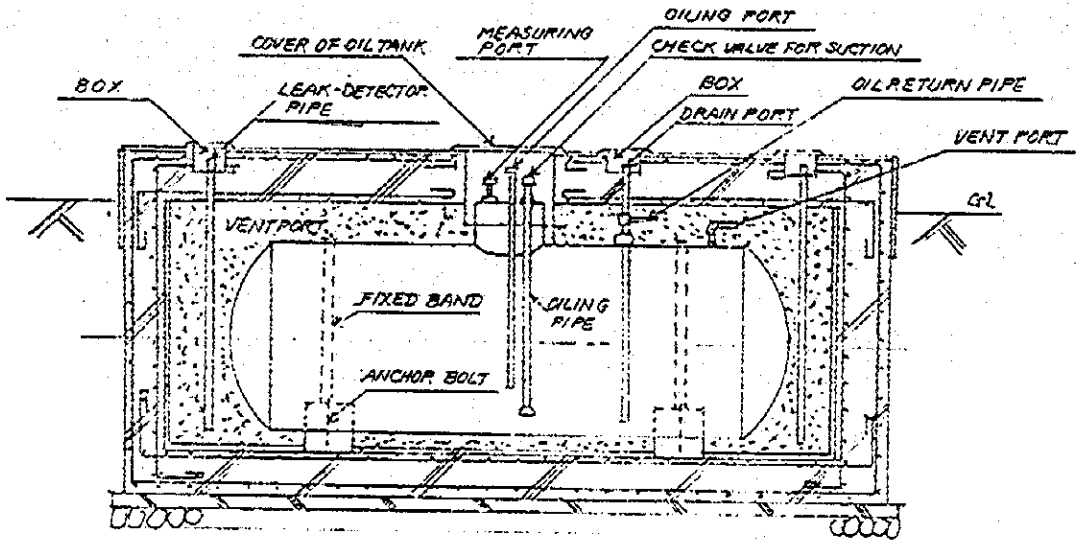
ARRANGEMENT TABLE

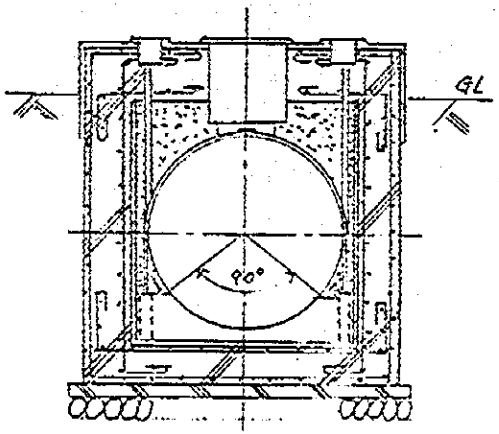
UNIT : mm

SLAB	SHORT AND LONG SIDES : 9φ - 200@ DOUBLE
WALL	D 〃









(REMARKS) (1) OPEN PORTS SHALL BE REINFORCED.

(2) EXECUTION OF WORKS SHOULD BE CARRIED IN ACCORDANCE WITH "GOVERNMENT ORDINANCE CONCERNING THE REGULATION OF DANGEROUS OBJECTS" AND "REGULATION CONCERNING THE CONTROL OF DANGEROUS OBJECTS"

INTALLATION DRAWING OF UNDERGROUND OIL TANK

4-7 Specification Common to Outside Line Construction Works

General	Scope of Application	Construction shall be carried out in accordance with this common specification, excepting the items specified in drawings and special specification.
	Supervisory Personnel	Supervisory personnel is the supervisory staff specified in construction contract.
	Execution	Construction shall faithfully be executed so that the all installations shown in drawings and specifications may function properly.
	Doubts	If the item shown in drawings is different from that specified in specifications or vice versa, or if item is not specified, or if doubt arises, consult with supervisory personnel. However, follow the instructions of supervisory personnel as to trifling matters.
	Slight change	If a slight change is needed due to the field conditions or other arrangements which does not require such design change as dimension, position or construction method, follow the instruction of supervisory personnel. However, the inevitable change of route due to the field conditions may be included in the scope of the present construction work to be carried out by following the instructions of supervisory personnel provided that the route to be changed does not exceed 30% of total extension.

Construction Schedule	(a) Construction schedule shall be prepared and approved by supervisory personnel. (b) Detailed schedule of each construction work shall be prepared if necessity arises and approved by supervisory personnel.
Drawings and Specifications	Drawings, specifications and samples necessary for manufacture or the execution of construction shall be prepared without delay and approved by supervisory personnel.
Equipment Parts and Materials	(a) Equipment parts and materials (hereinafter referred to as "line parts") shall be new ones. (b) Line parts shall pass the examination of supervisory personnel, excepting, however, minor line parts approved by supervisory personnel. (c) If the quality of line parts is not specified, those of a reasonable quality shall be used. (d) As for the examination of line parts, such tests instructed by supervisory personnel as appearance, function and property tests shall be carried out. (e) Examination to be conducted by supervisory personnel shall, in principle, be sampling inspection by item.
Inspection of Works by Witness	(a) When a part of works is completed, it shall, in principle, be inspected in the presence of supervisory personnel. (b) The function and property tests of any part of works shall be conducted in the presence of supervisory personnel.

	(c) Inspection of works Each construction work shall be inspected by supervisory personnel at each stage. (b) However, minor case out of those mentioned in (b) and (c) above may be excepted subject to the approval of supervisory personnel.
Related Works of Other Contract	As to the related construction works under after contract, consult with the persons concerned so that the related works may smoothly be carried out.
Procedures for authorities Concerned	Procedures necessary for the authorities concerned and others as to the construction works shall be taken without delay.
Control of Construction Site	(a) Construction site shall be controled strictly in accordance with the regulations concerned. (b) Efforts shall be made to prevent such accidents as fire, robbery etc. in Construction site.
Disasters and Public Hazards	Efforts shall be made to prevent disasters and public hazards in accordance with the regulations concerned.
Curing	Line parts and completed parts of works which might be fouled or damaged shall be cured by proper method.

	Report on Works	Reports on the progress of works, construction operation of workers, examination of line parts etc. shall be submitted to supervisory personnel.
	Cleaning and Sweeping	In completing works, the area surrounding the construction site shall be neatly cleaned and swept.
	Drawings of Completed Works and Maintenance Instructions	When works is completed, necessary drawings showing the states of equipments at the time of completion shall be submited. Entry shall be made on reduced scales of 1/10∿1/200 and list of main equipment parts shall be attached. Number of drawing to be submited is 1 (one), respectively; Original drawing and white photograph; Microfilm of them; Micro-reproduced drawing in 1/8 size; White photographs of the above drawing binded into A3 plate book.
Line Parts	Electrical Wires	OW wire JIS C3340 DV wire JIS C3341 IV wire JIS C3307
	Path Duct	JIS C8364
	Cable	CV Cable JIS C3606
	Control Cable	CVV Cable JIS C3401
	Porcelain Insulator	Ball insulator JIS C3832 Low-tension pin insulator JIS C3844 Low-tension anchor insulator JIS C3845

	Metal Tube	Conduit tube JIS C8305 Conduit tube fittings JIS C8330, 8331, 8332, 8333 and other qualified item.
	Pole	Concrete pole JIS A5309
	Assembling	Galvanized steel materials shall be used
Execution of Works		Execution of works shall be made in accordance with Specification Common to Electric Installation Construction Works prepared by Government Buildings Department, Ministry of Construction.

4-8. Special Specification for Outside Line Construction Works

Particulars	Classification of Voltage	The voltage to be used for the present works shall be as follows: Type — Voltage — Frequency 3φ4W type — 127-220 volt — 50 Hz 3φ4W type — 226-380 volt — 50 Hz
	Construction of Support	Support and Selection of Its Position (a) Kind of support Kind of support shall be as follows: Concrete pole (b) Selection of position Selection of support's position shall be as follows; (b-1) At roadside and near the positions shown in drawing. (b-2) At positions where such underground installations as gas pipe, water pipe, sewer pipe, cable etc. are not interfered with. (b-3) At positions where aerial line can easily be branched. (b-4) At positions where main line can be stretched straight. (b-5) If supervisory personnel's instruction is given, follow the instruction.
	Construction of Pole	(A) Setting (a) General case Total Length (H) — Standard Setting (H/b) 13 m — 2.2 m or more

(b) On slope

In case of slope, the standard mentioned in (a) above shall apply correspondingly and in addition, base shall be reinforced with concrete.

(c) On weak ground

On the ground having a small resistance such as Bog-land, proper increase shall be made.

(d) On rocky ground where excavation is extremely difficult, setting may be about 2/3 of the standard setting and reinforced with concrete basing and stay.

(B) Excavation of Pole-Erecting Hole

(a) Pole-erecting hole shall not be dug larger than necessity taking into consideration the size of pole, setting, posture of pole etc.

(b) If there are the following articles in the place where pole is to be erected, special attention shall be paid to them:

(1) crops (2) buildings

(3) garden-trees (4) underground installations

(C) Sort of Excavation

(a) Round hole

Standard dimension shall be as follows:

Length of Pole(m)	Size of Hole(mm)	Depth of Hole (m)
13	400	2.25

Remark : If the ground is hard and not damaged, guy anchor is not required.

(D) Installation of Earthing Conductor

$8mm^2$ or more of insulated wire shall be installed at fixed place on ple and earth plate shall be equiped with earthing of the third kind.

(E) Direction of Concrete Pole

On a road, concrete pole shall be erected so that the lower step bolts may be parallel to the road or line and the pole plate perpendicular to the road or line.

(F) Installation of Guy Anchor

Guy anchor shall be installed excepting where round hole is excavated.

(a) Direction of guy anchor

(a-1) In case of straight pole, guy anchor shall be installed zigzag.

(a-2) In case of curved line pole, branch pole and terminal pole, guy anchor shall be installed zigzag and in case of a pole erected at the place where tension is great, a clamp guy anchor shall be installed.

(a-3) In case of H pole and triangle pole, common clamp guy anchor shall be installed.

(G) Operation after Erection of Pole

(a) Step bolt

The lowest step bolt shall be more than 2m and less than 2.5 m high above the ground surface.

Additional step bolt shall be installed at every 450 mm.

(a-1) When step bolt is installed, insulated packing shall be first installed and then step bolt installed.

Assembling

(A) Position and Interval of Arm

(a) Position of arm

(a-1) The uppermost arm shall be 250 mm from the top of pole.

(a-2) The arm for higher volt shall be at the upper row.

(a-3) In case of same volt, the arm for the distribution to farther distance shall be at the upper row.

(a-4) The supporting point of the arm for a line having more than 80 mm^2 of size shall be 1500 mm or less from the top of pole.

(b) Interval of Arm

The center distance when line arm is fixed to supporting structure shall be as follows:

Classification	Single Pole		H. Triangle Poles	
	Straight Pole Terminal Pole	Angle Pole	Straight Pole Terminal Pole	Angle Pole
Between low-tension	600 mm	900mm	750mm	900mm

(B) Standard Assembling

(a) The assembling of line shall be made on the following standard.
A core fixing assembling with low tension arm, having the following dimension;

Single Pole	1500×75□×2.3 or more (mm)
H, Triangle Poles	2700×75□×3.2 or more (mm)

(b) Classification of pole shall be as follows:

Step Number of arm	Structure of Pole
1 ∿ 5	Single pole
6 ∿ 8 or more	H pole or triangle pole

(C) Arm

(a) Classification in use of arm
Line arm shall be used depending upon the voltage and the condition of use as follows:

Assembling Method	Number of Line	Low Tension
Core fixing	2 ∿ 3	1500 × 75□ × 2.3
"	4	"
"	6 ∿ 8	H pole, 2700 × 75□ × 3.2, clamp arm

(b) Classification of single clamp arm

(b-1) In case line is anchored

Arm	General Case
Low Tension 1500	22 mm^2 or more
" 2700	clamp-type for all

(b-2) In case 6 lines are anchored with 2700x75x75° arm, reinforcing plate shall be used.

(c) Fixture of arm

(c-1) Fixing side of arm

Arm shall be fixed to support as follows:

Type	Remarks
General	at load side
Branch (anchor)	at opposite side to tension

(c-2) Lower arm shall be on the same side as upper arm.

(c-3) Fixing method of arm

Fixing method to support shall be as shown in the following table:

Condition of Support	Fixing Method
Straight road pole, branch pole, terminal pole	perpendicular to line

(D) Fixing Method of Binding Bolt and Arm-Tie

(a) Binding bolt

Clamp arm 1500 --- 2 places

Clamp arm 2700 --- 4 places

(b) Arm-tie

Position: At greater load side

Number: 1 for single arm,
2 for clamp arm

Method: Arm-tie washer and variable arm-tie band are used.

(E) Porcelain Insulator

(a) Classification in use of porcelain insulator

Classification of use shall be as follows.

Class	Insulator to be Used				
	Type			Color	
	through line curb line jumper line	anchor branch anchor	lead-down line lead wire	tension side	earthing side
127-220V 220-380V 3-phase 4-line common to lighting & power	low tension large pin insulator	low tension anchor insulator	low tension large pin insulator	White brown	blue

(F) Step Bolt

(a) Driving of bolt

Rotating step bolt and upper step bolt shall be driven at 45°.

(G) Pole plate

(a) Fixture of pole plate

A pole Plate on which Company's abbreviation, number of supporting structure, date of construction and total length of supporting structure are printed shall be fixed to the supporting structure.

(a-1) Fixing height shall be 2.5 - 3 m.

(a-2) Pole plate shall be fixed with 2 bolts.

Construction of Stay

(A) Installation of Stay

(a) Stay shall be installed at uneven tension, angle pole, terminal pole, long span and other necessary places as well as in an area where strong wind prevails.

(b) Stay shall be installed so that traffic may not be interfered with.

(c) Type of stay

(c-1) Anchor stay

It shall be installed for anchor, branch, curve line and other supporting structure which is always subject to tension.

(c-2) Longitudinal stay

It shall be installed at every 6 spans.

(c-3) Side anchor stay

It shall be installed at every 3 spans.

(B) Sort of Stay

(a) Ordinary stay

(a-1) Angle between support and stay shall, in principle, be maintained at 30°.

(a-2) Strip number of stay shall be 7/40 galvanized iron wires,

(a-3) Anchor of stay shall be driving anchor, which must be driven into theground by less than 1.5 m.

(a-4) Ball insulator shall be fixed at the place more than 2.5 m above the ground surface.

(a-5) Anchor bolt of stay shall have a sufficient thickness and be wrapped with an anticorrosive tape over each 300 mm or more above and under the ground surface.

(a-6) The bending part of stay shall be protected with wire thimble, clamped at 3 points with suitable wire clip and its ends shall be found 5 times or more with 1.6 mm or more galvanized wire.

(a-7) Fixing point of stay to the top of pole shall, in principle, be less than 1.5 m from the top.

(b) Horizontal stay

It is a stay for which stay pole is used and consists of common part and additional stay. It is used where ordinary stay cannot be installed due to the condition of the ground.

(b-1) Items provided for in (a) above shall apply to the details of horizontal stay.

(b-2) Stay pole shall be more than 5 m high on road and building site and 13 m high in case stay passes over a building so that stay may be installed sufficient above the ground surface.

(c) Common stay

It is a stay common to both supporting structures and is used when they are comparatively near to each other.

(c-1) Items provided for in (a) above apply to the details of common stay.

(c-2) This stay shall be same high as in (b-4) above.

(d) Y stay

It is constructed with two ordinary stays which are fixed to the upper and lower points or right and left-hand points of supporting structure and tied into a bundle at a suitable point above the ground to make a Y-shape. This stay is used for such a pole as having many line arms or being subject to a large tension.

(d-1) Y stay is fixed to H pole and single pole having 4 stage or more assembling.

(d-2) Items provided for in (a) above shall apply to the details of this stay.

(d-3) Guy anchor shall be installed 1.2 m or more deep under the ground.

(e) Materials of stay

(e-1) Following materials shall be used for stay:

Stay strip \ Sort	Sort of iron and steel wire	Anchor driven	Stay guy anchor	Anchor bolt	Stay band	Stay clip	Stay thimble	Turn-buckle
7 or less	7/4.0 iron wire	No.9	No.9	No.9	No.9	No.9	Large	No. 9
	4.0 iron wire							

(e-2) Steel wire to be used shall be galvanized steel wire of 1st kind.

Construction of Pole Brace

(A) Fixture of Pole Brace

Pole brace is used when longitudinal stay or side anchor stay is needed, but it cannot be installed.

(a) Fixing position of pole brace to pole

It shall be fixed in the direction of tension and in principle, at lower position from line arm.

(b) Fixture of pole brace to pole

It shall be fixed with 2 variable armtie bands, 2 bolts and 1 set of pole brace fittings.

(b-1) Angle of pole brace shall be in the range of 20° ~ 25°.

Construction of Electric Wire

(A) Height of Electric Wire Above Ground

The height of aerial wire shall be 5.0 m or more above the ground.

(B) Clearance of Electric Wire

Separation of aerial wire from others shall, depending upon the sort of electric wire, voltage and relative position, be more than the following value (m).

(a)	Sort of Electric Wire	Low tension
Upper	bare wire, OW wire vinyl wire	2.0
Side	OW wire	1.0
Lower	Vinyl wire	0.6

(a-1) Separation of aerial wire from upper approach and crossing shall be more than 0.6 (low tension).

(C) Position of Neutral (Earthing) Conductor

In case of common system for lighting and power (4 wire drawing), neutral conductor shall be gathered at one side of supporting structure.

(D) Classification of Passage and Anchor of Electric wire

(a) Aerial wire shall generally be through line.

(b) The method to pull aerial wire straight shall be two methods of anchor and split anchor.

(b-1) In case of use of anchor

For wire at terminal or branching point

For curved wire having 40° or more of horizontal angle.

(b-2) In case of use of split anchor

For the connection of different wires in strength and thickness.

Before and after angle pole.

(E) Looseness

Aerial wire shall be provided with a looseness corresponding to span, season and wind load.

(a) Looseness Table

Unit: m

Span	30	35	40	45	50	55	60
Season	0.26	0.35	0.45	0.58	0.71	0.86	1.02

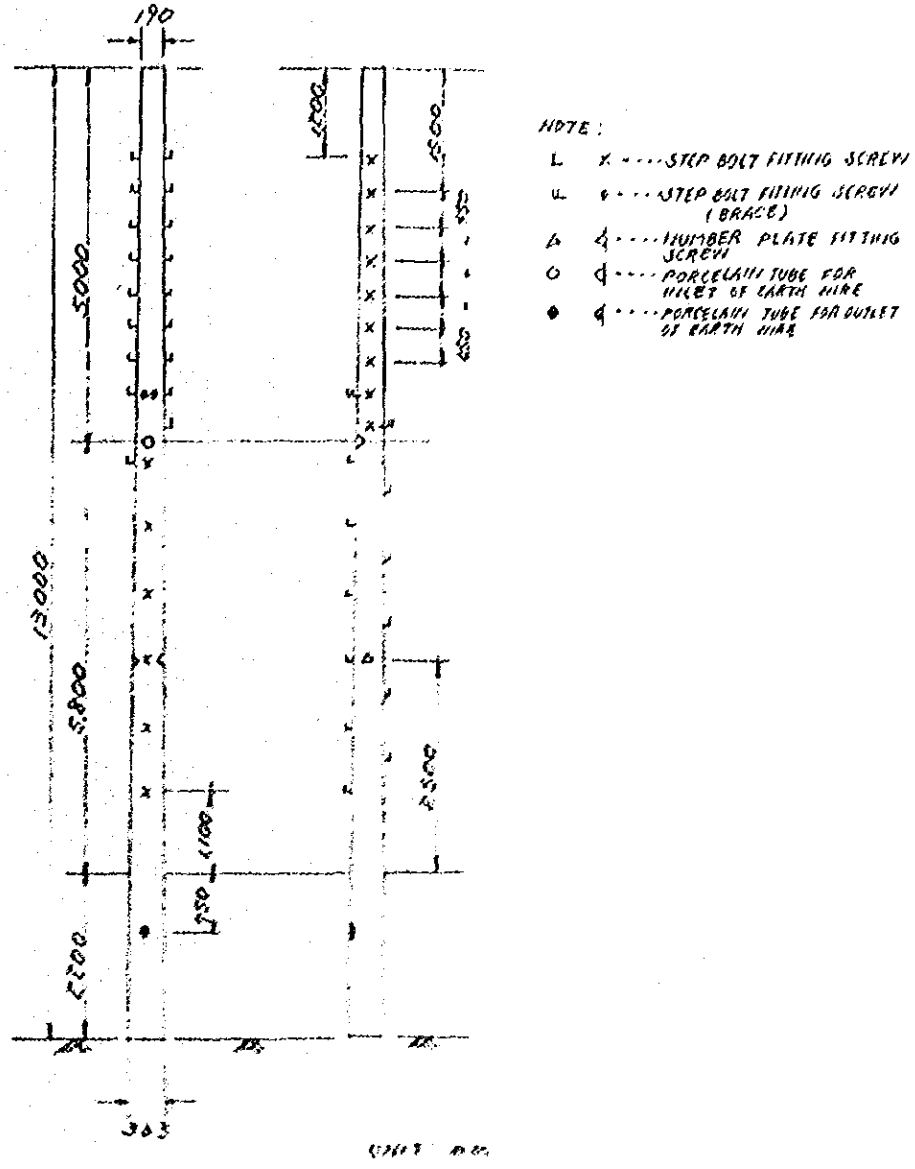
Main Line Parts

(A) Concrete Pole (Centrifugal Reinforced Concrete Pole)

(a) Dimension, Design Load and Weight

Length (m)	Tip diameter (mm)	Design load (kg)	Weight (kg)	Root diameter (mm)
13	190	500	1070	363

(b) Drawing to show fixture of fittings



(B) Arm; Dimension and Weight

Finished Dimension (mm)	Angle (mm)	Weight (kg)	Parts Dimension (mm)
1500 arm	75	6.8	2.3
2700 arm	75	18.1	3.2

(C) Electric Wire (OW wire)

Conductor		Vinyl insulator's thickness (mm)	finished outer diameter (mm)	Resistance (20°) Ω/km	Tensile load (kg)	Weight (kg/km)	Allowable current A
Sectional area (mm^2)	Structure (mm)						
14	7/1.6	1.0	6.8	1.35	574	160	91
22	7/2.0	1.2	8.4	0.849	889	250	122
30	7/2.3	1.2	9.3	0.642	1160	320	145
38	7/2.6	1.4	11	0.502	1480	410	170
50	19/1.8	1.4	12	0.394	1960	520	201
60	19/2.0	1.4	13	0.313	2410	630	231
80	19/2.3	1.5	145	0.237	3160	820	276
100	19/2.6	1.5	16	0.185	4010	1030	322

(D) Cable (600 V 4C CV Cable)

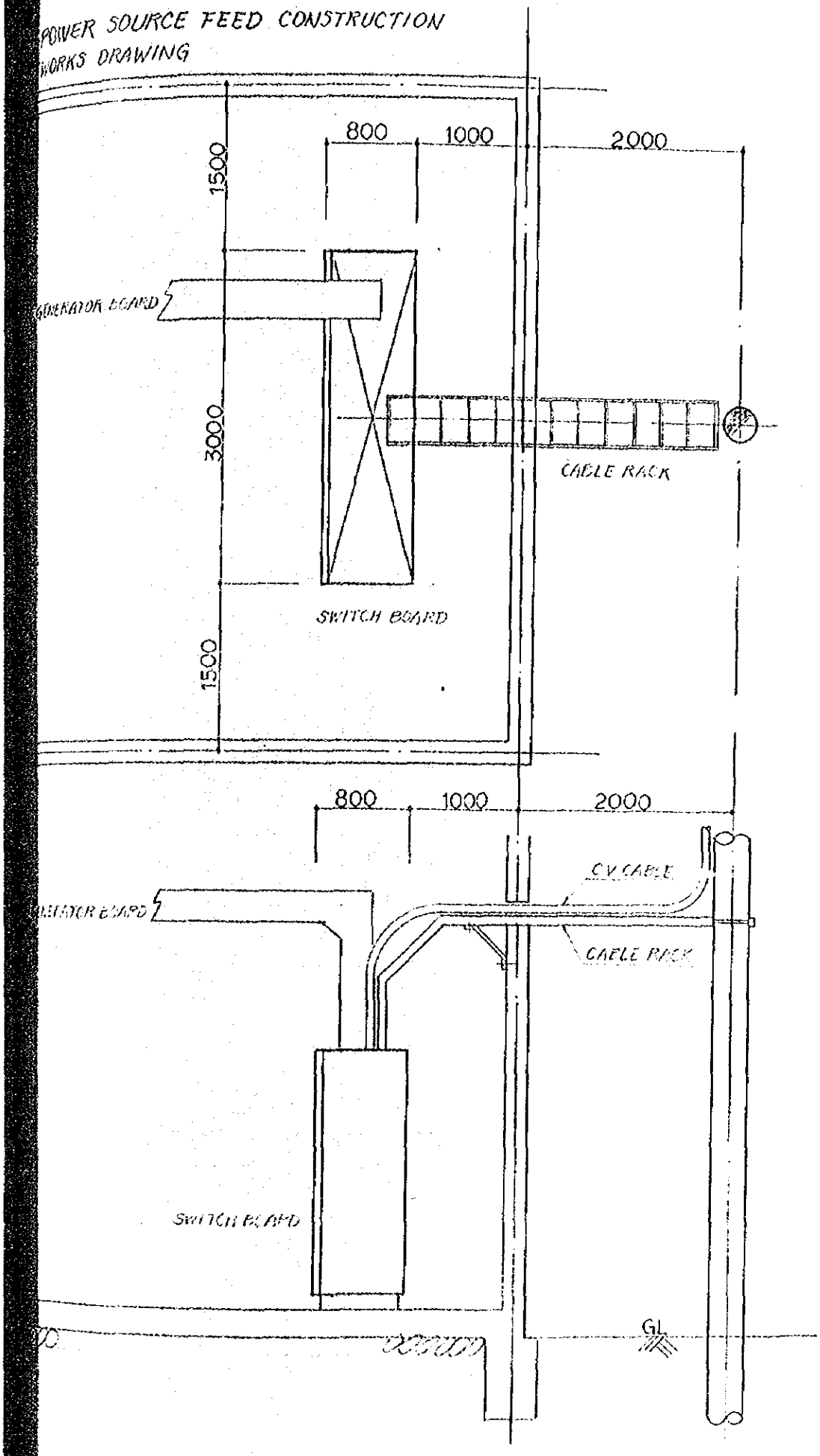
Conductor		polyethylene insulator's thickness (mm)	sheath's thickness (mm)	finished outer diameter (mm)	resistance (kg/km)	weight (kg/km)	allowable current (A)
Sectional area (mm^2)	Structure (mm)						
14	7/1.6	1.0	1.5	20	1.33	765	60
22	7/2.0	1.2	1.6	24	0.84	1150	80
38	7/2.6	1.2	1.8	29	0.497	1830	109
60	19/2.0	1.5	2.1	37	0.309	2860	144
100	19/2.6	2.0	2.5	47	0.184	4790	200

* As to the Cables other than those shown in above table, JIS standard shall apply.

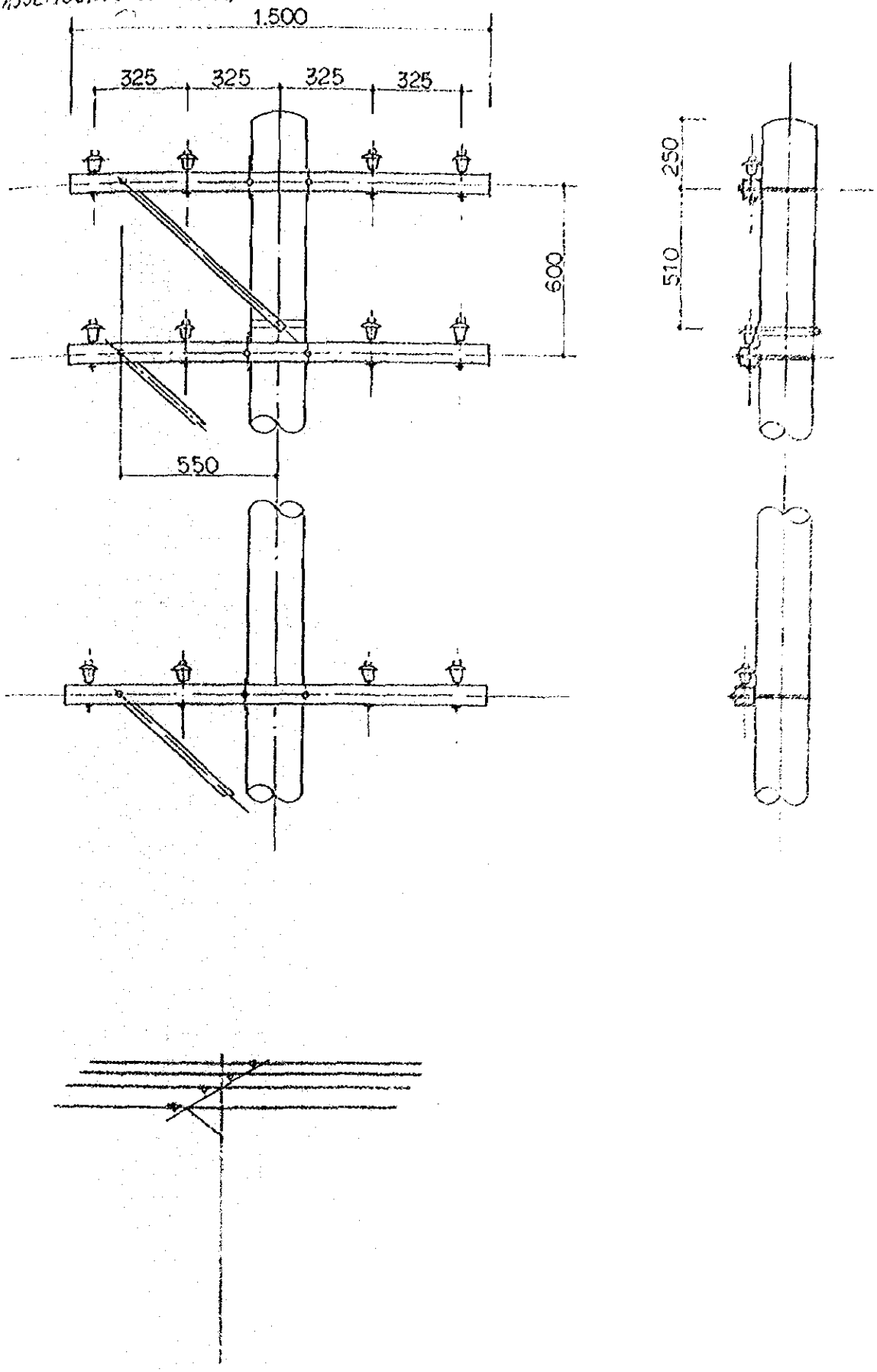
Notes

Mark	Name	Remarks
	Proposed building's site	
	Concrete pole	
	stay (usually, Y-stay)	
	stay (common, horizontal)	
	pole brace	
	aerial wiring	
	cable rack wiring	
	OW wire	
	600 V CV cable	
	main line system	
	principal name of buildings	
	name of basic assembling drawings	

Standard Drawing


POWER SOURCE FEED CONSTRUCTION
WORKS DRAWING
800
1000
2000
1500
3000
1500
SWITCH BOARD
CABLE RACK
800
1000
2000
CV CABLE
CABLE RACK
SWITCH BOARD
GL

Ⓐ ASSEMBLING DRAWING



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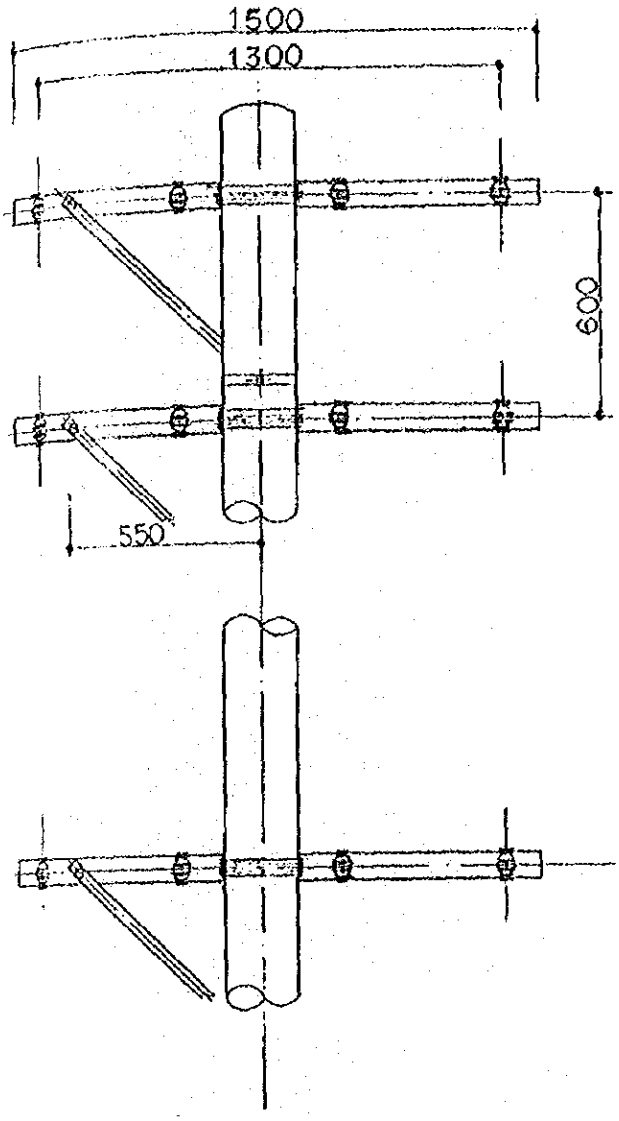
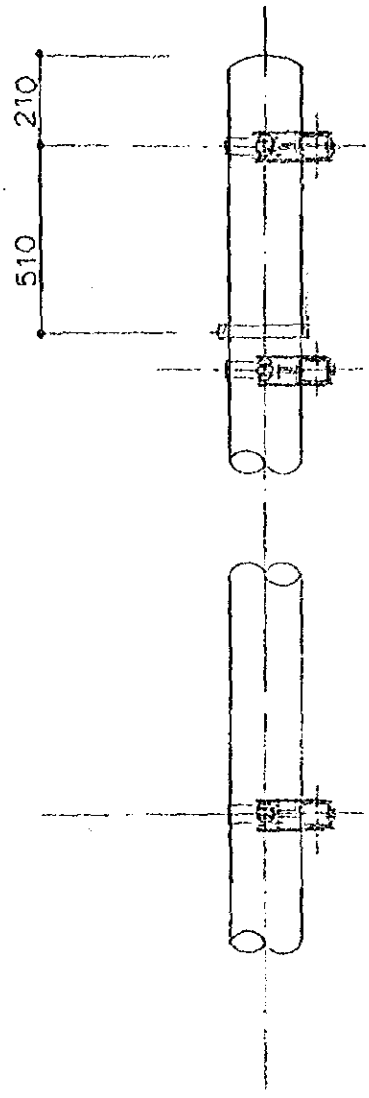
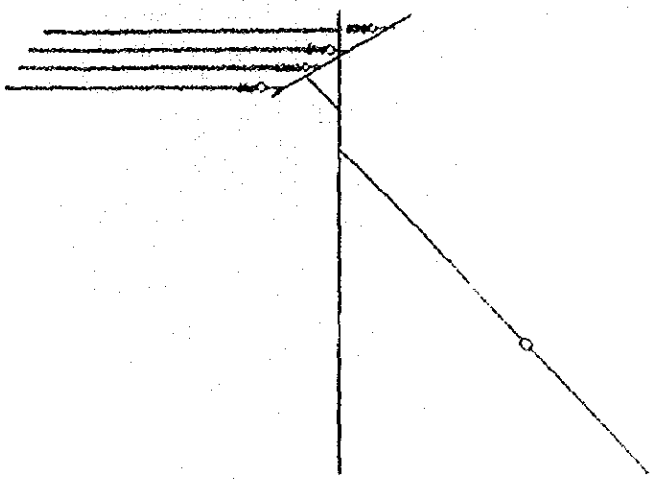
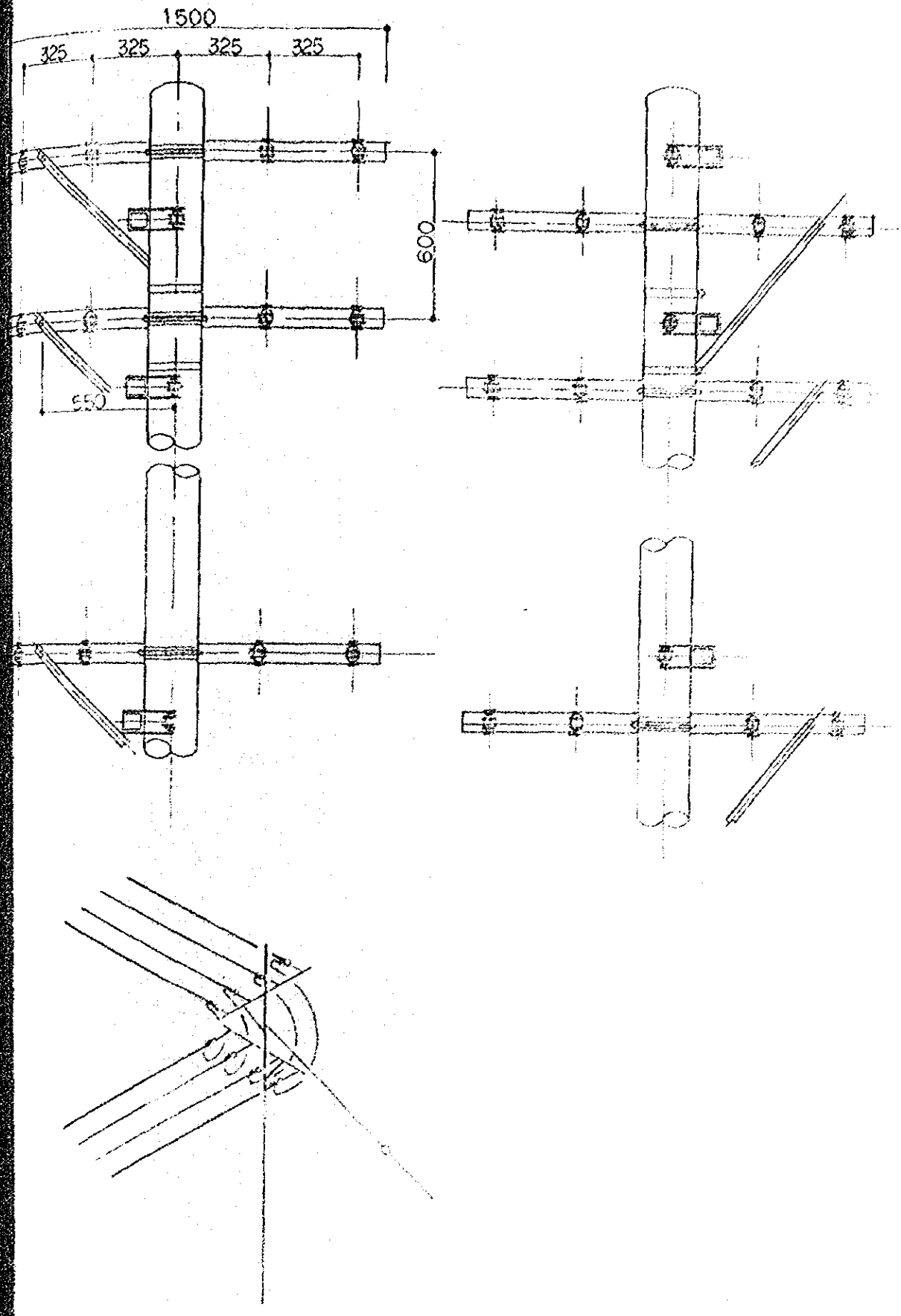






© ASSEMBLING DRAWING



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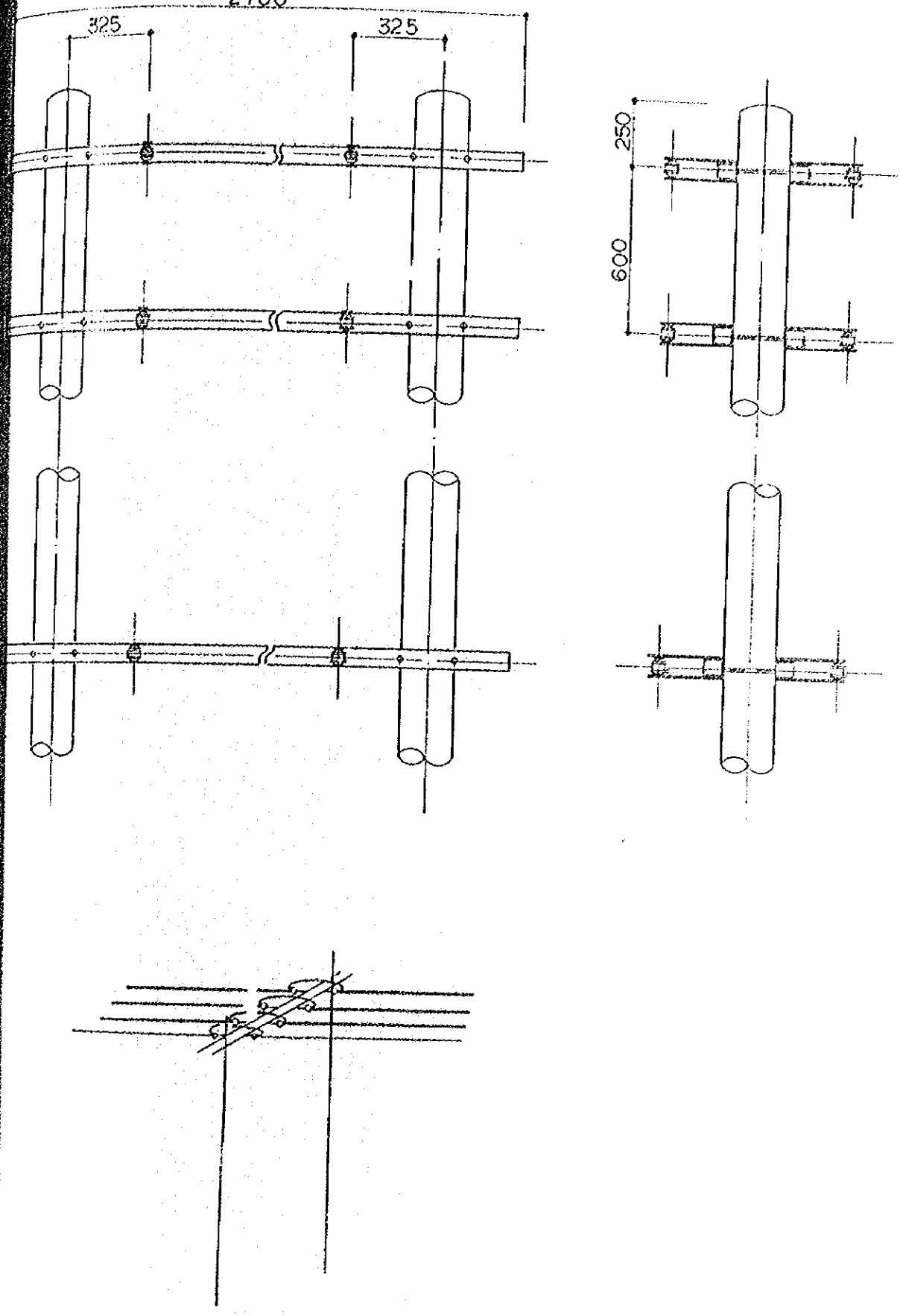

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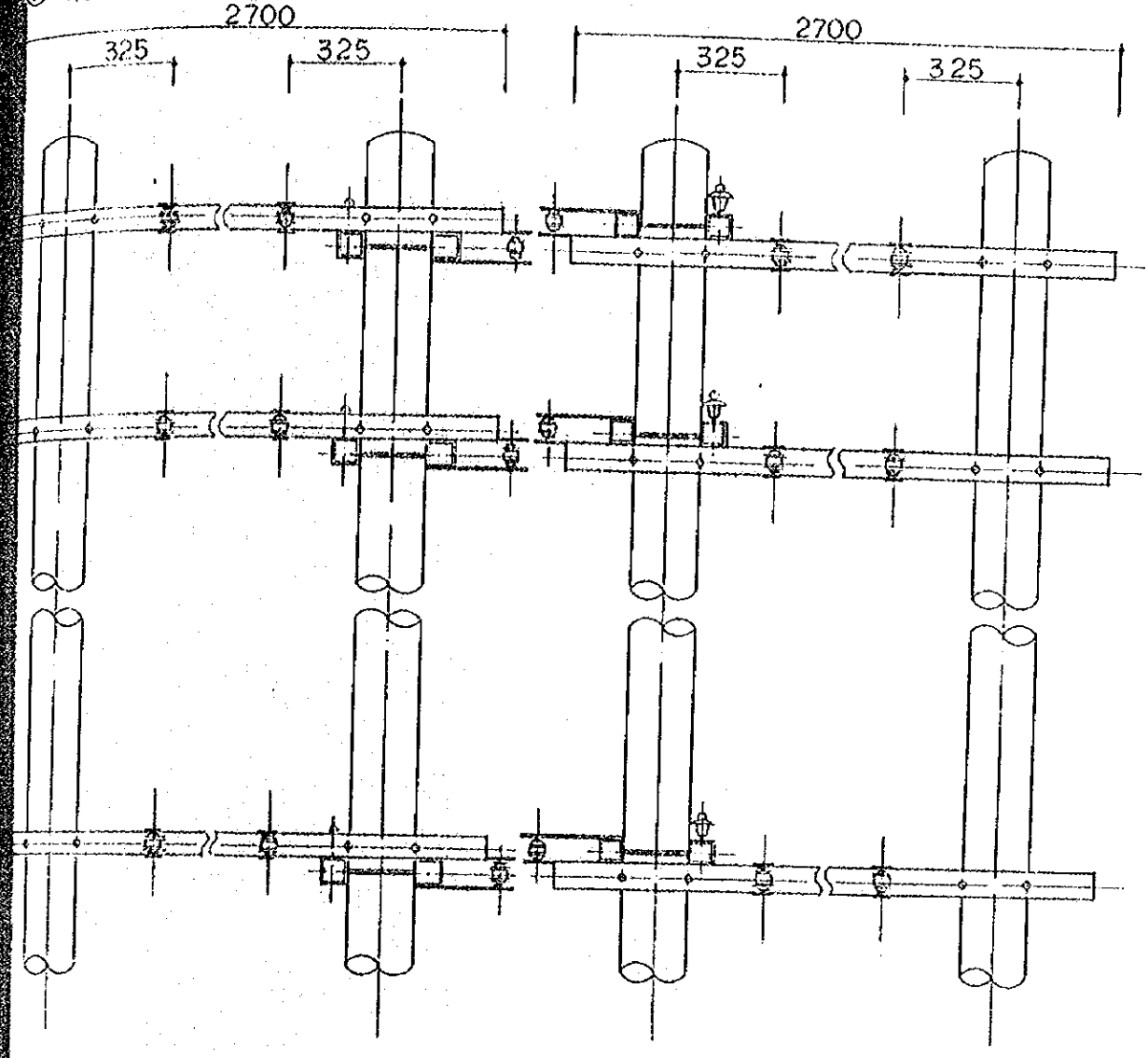
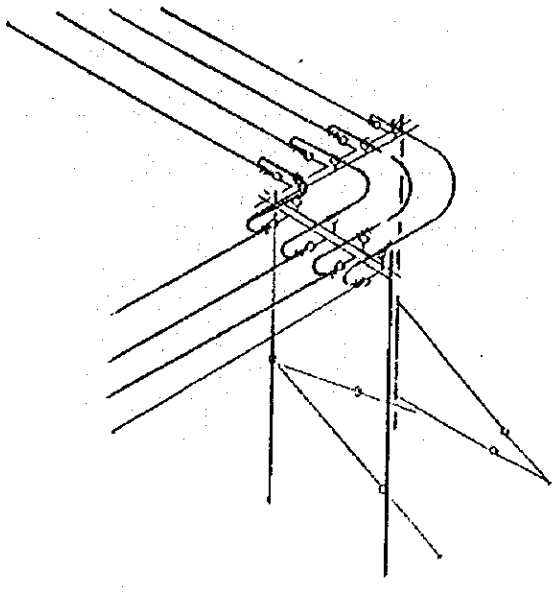
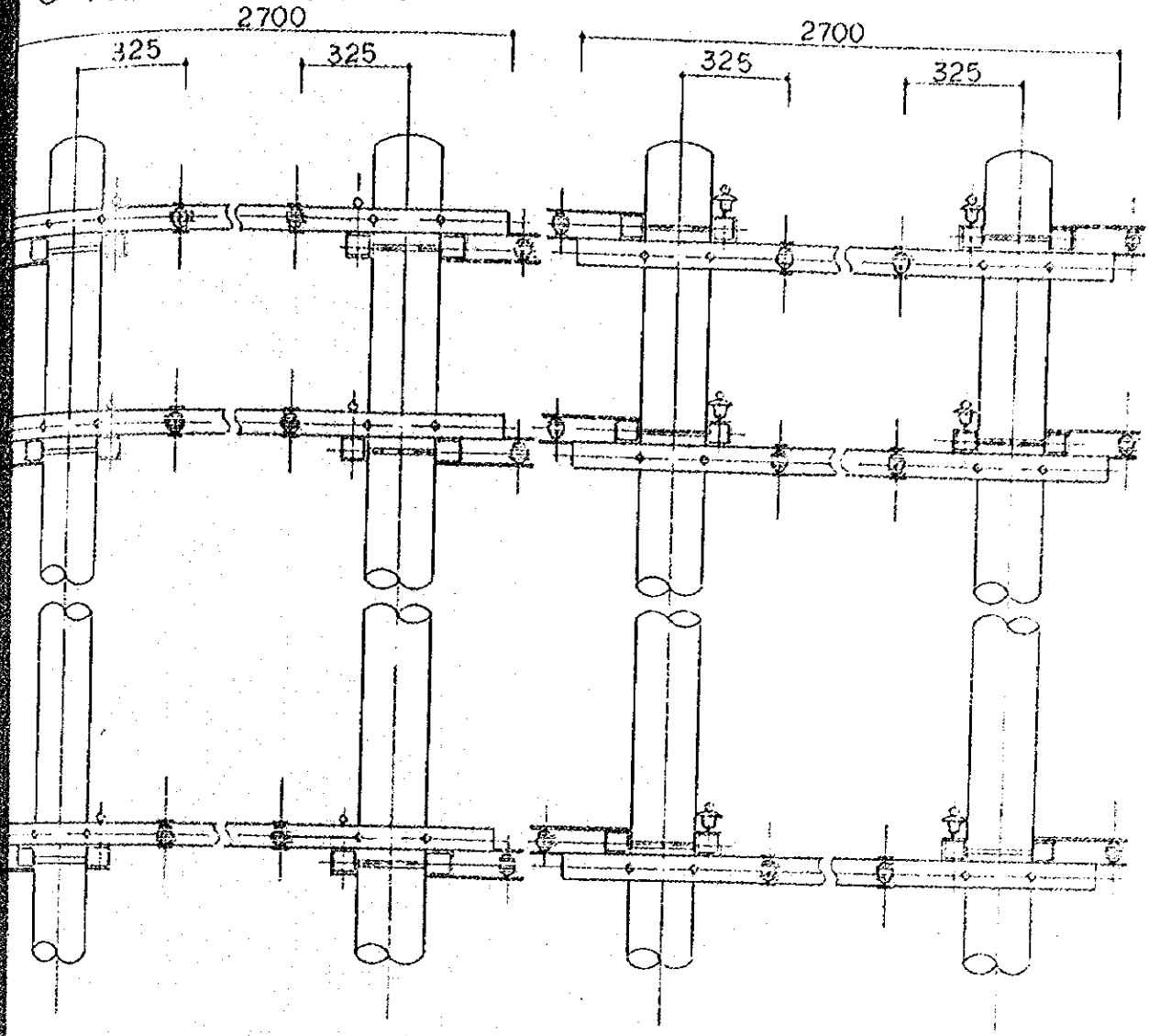
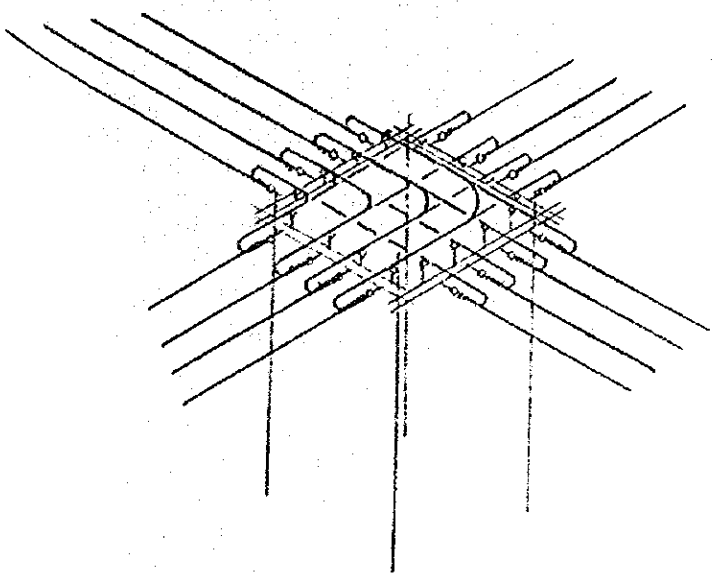




Ⓕ ASSEMBLING DRAWING





List of Material Package's Number, Outside Line Construction Works

	Pole		Fitting		Wires		Cable Rack	
	m^3	ton	m^3	ton	m^3	ton	m^3	ton
Gunung Wenang	88	52.03	75	45	135	75	0.8	0.5
Tondano	43	25.68	21	13	14	8	0.8	0.5
Kotamobagv	18	10.7	10	6	8	5	0.8	0.5
Gorontalo	22	12.84	12	8	12	7	0.8	0.5
Lim Kendage	22	12.86	9	6	12	7	0.8	0.5
Sub-total	193	114.49	127	78	183	102	4.0	2.5
Ujung Pandang	84	50.29	29	18	87	48	1.2	0.8
Watan pone	29	17.12	19	12	16	9	0.8	0.5
Soppeng	31	18.19	30	18	16	9	0.8	1.0
Pare Pare	45	26.75	18	11	21	12	0.8	0.5
Elm Rantpao	31	18.19	14	9	11	6	0.8	0.5
Palopo	24	13.91	13	8	10	6	0.8	0.5
Bantaeng	25	14.98	13	8	16	9	0.8	0.5
Sub-total	269	159.43	136	84	177	99	6.0	4.3
Medan	134	80.25	62	38	117	65	2.0	1.0
Tartung	70	41.73	19	12	41	23	1.2	0.8
Porsea	33	19.26	23	14	10	6	0.8	0.5
Pematang Sienter	66	39.59	20	12	59	33	1.2	0.8
Tebing Tinggi	22	12.84	14	9	15	9	0.8	0.5
Tanjung Balai	25	14.98	8	5	10	6	0.8	0.5
Kisaran	29	17.12	11	7	26	15	0.8	0.5
Rantau Prapat	40	23.54	17	10	16	9	0.8	0.5
Sub-total	419	249.31	174	107	294	166	8.4	5.1
Total	881	523.23	437	269	654	367	18.4	11.9

An example of cable wire strength computation

Wire safety factor = $\frac{\text{Wire strength}}{\text{Load on the wire}}$ $\frac{kg/mm^2}{kg/mm^2}$

(T_0)

$\frac{\text{Tensile load on the wire}}{\text{Maximum tensile force of the wire}}$ $\frac{kg\ mm^2}{kg.mm^2}$

(T_1)

(To of hard-drawn copper wire is 41.6 kg/mm^2.)

$T_1' = \frac{T_0}{F}$ $kg.mm^2$ where F = 2.2

Load Tare of the wire kg/m

Wind pressure load Wb: 50 kg/m^2 per projected area of wire outer diameter

When dϕ (mm) stands for the designed outer diameter,

$(\frac{d}{1000} \times m) \times 50 = 0.05d$ kg/m

Composite load $W = \sqrt{Wa^2 + Wb^2}$ kg/m

$T_1 = \frac{WS^2}{8D}$ (kg)

W	Composite load	kg/m
S	Span	(m)
D	Dip	(m)

$T_2 = \frac{WS^2}{8D} + W \times D$ (kg)

OW 150^A $T_1 = \frac{6000\ kg}{2.2} = 2727$ $41.6 \times 150mm^2 = 6000$ kg

d = 18mm

Wa = 1.5 kg/m

Wb = 0.05 18 = 0.9 kg/m

$$W = \sqrt{1.5^2 + 0.9^2} = \sqrt{2.25 + 0.81} = 1.75 \text{ kg/m}$$

S 30m

D 0.26m

$$T_2 = \frac{1.75 \times 30^2}{8 \times 0.26} + 1.75 \times 0.26$$

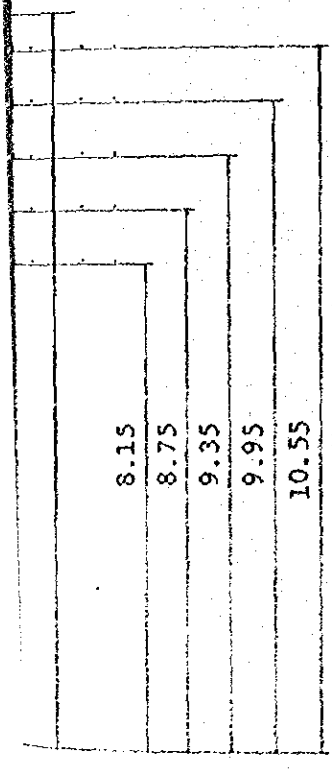
$$= 757 + 0.455 = 757 \text{ kg} \qquad < T_1' = 2727 \text{ OK}$$

$$F = \frac{2727}{757} = 3.6 > 2.2 \quad \text{OK}$$

Support Wind pressure load 80 kg/m^2

13mm pole $80 \times (0.3 \times 13 - 2.2) = 259.2$ kg

Tensile load of 150A wire 757 kg/wire



MW

Wind pressure load on two kinds of we's is 50 kg/m^2

$P\Sigma wedh = S_0 \times \Sigma wedh$ $\quad S_0 = \frac{S_1+S_2}{2}$ (m)

	Wire outer diameter d (mm)		Number of wires	we	Wedh	$\frac{\Sigma wedh}{1000}$	$\frac{P\Sigma wedh}{1000}$
150^A OW	18mm	10.55	4	50	37980		
		9.95	4	50	35.820		
		9.35	4	50	33.660		
		8.75	4	50	31.500		
		8.15	4	50	29.340		
						$\Sigma 168.3$	$\frac{30 \times 168.3}{5049}$

Moment by the design load When RC is 13m-500kg,

$$Mcr = 500\ kg \times (13-2.2 + 0.25) = 5275\ (kg-m)$$

Bending moment due to wind pressure on the pole

$$Mcp = 0.01\ KH^2\ (40D_0 - 35.5H)$$

$$= 0.01 \times 0.5 \times 10.8^2\ (40 \times 33.4 - 35.5 \times 10.8)$$

$$= 555\ (kg-m)$$

$H = 10.8$ m

$D_0 = 33.4$ cm

$K = 1$

$K = 0.5$

Span 30m

Mw = 5049 (From above table) (kg)

Mcp + Mw 555 + 5049 = 5604 kg-m

Decision Mcr > Mcp + Mw OK

5275 < 5604 kg-m (except when the wind pressure is 40 kg; then 5275 > 4594 (kg-m) OK)

Larger moment should be taken over by a stay.

4-9 Drawing of Outside Line

Others 127~220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
	G-b290	3	3φ4w127~220	7.8	1.0	1.3	10	2	2	①	38
		G-b									
f-Lo	G-a234	10-3=7		18.3			24			76.6=50.5+26.1	80
150	E-b226	3		7.9			10			26.1	38
		E-b									
	E-a190	10-3=7		18.3			24			76.6=50.5+26.1	80
	F-a140	50		131			170			214	125~2-4
	D-b	G-a+E-a+			1.0	1.3		2	2	①	125~3-4
	D-a	F-a									
	D-a	Same as									"
f-Lo		D-b									
	C-b162	3		7.8			10			14.5	
		C-b									
	C-a126	15-3=12		31.5			40			59=45.3+14.5	60
	B-b138	15		39			51			63	80
	B-a	D-a+C-a+			1.0	1.3		2	2	①	125~4-4
f-Lo		B-b									
	H-a152	50		131			170			232	125~2-4
	A	B-a+H-a									125~6-4

Calculation Sheet R.S Gunung Wenag System X ray 220-380V
Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
	G-b290	5		14.5	1.0	1.3	18.7	2	4	② 41.2	50
		G-b									
f-Ln	G-a234	15-5=10		29			37			107=65+41.2	100
	F-a140	10		29			37			65	
	D-b	G-a+F-a								172	100~2-4
		D-b									
	B-a96	35-25=10		29			37			198=26.9+172	100~2-4
f-Ln 55	H-a152 A	20 B-a+H-a		59	1.0	1.3	75	2	4	② 86.6 284	100-4 150~2-4
	G-b270	57.4		165	1.0	1.3	215	2	4	② 441	150~3-4
	B-a	Same as G-b									"
f-m 65.4	H-a152 A	18 B-a+H-a		52			67			77	80-4 150~4-4
		(3.5×2)									
	F-a140	30	1ø3w 220-380	150	1.0	-	150	4	8	③ 94.5	100-3
f-Xo 33	B-a	Same as F-a									" -3
	H-a152 A	3 B-a+H-a	1ø2w220 3ø4w 220-380	30	1.0		30	"	"	20.5	22-2 125-4

Calculation Sheet R.S Gunung Wenang System X ray 220-380V
Others 127-220V

Factor symbol	Length reel length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	G-a234	15	1ø2w 220	150	1.0	-	150	4	8	③ 94.5	100-3
T-Xn 65	B-a	Same as G-a									
	B-a152	50	2ø4w 220-380	500			500			342	125-3-4
	A	B-a+B-a	3ø4w 220-380							499	150-3-4
T-La	B-a152	30	3ø4w 127-220	86.7	1.0		112	4	8	② 129	125-4
	G-b290	117	3ø4w 127-220							$\frac{30.6 \times 351 \times 290}{6000}$	150-4-4
T-LoaN 117	B-a	Same as G-b		338	1.0	1.3	439× 0.8 =351	3	6	515	
	A	Same as B-a									
	G-b290	19.2	3ø3w 220	56			56				
T-? 38.4	B-a	Same as G-b			1.0	-		2	4	② 128	125 "
	B-a152	19.2		56			56			65	80
	A	B-a+B-a								123+65=188	100-2-3

Calculation Sheet R.S Tondano System X ray 220-380 TV Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	C-f126	2	3ϕ4w 127-220	5.2	1.0	1.3	6.8	2	2	① 7.7	14
f-Le	C-e180	2	"	"	"	"	"	"	"	" 11.0	14
	C-d120	2	"	"	"	"	"	"	"	" 7.3	14
	C-b -	4								7.3+7.7=15	22
	C-c90	1	"	2.6	"	"	3.4	"	"	" 2.7	14
	C-a--	5									
f-Ld	B-d146	3	"	7.8	"	"	10	"	"	2.7+15=17.7	22
	B-c	"								" 13.1	14
	B-e133	2	"	5.2	"	"	6.8	"	"	"	14
	B-b -	5								" 8.1	14
										13.1+8.1=21.2	22
f-Lc	B-a -	"								"	22
	A -	10								17.7+21.2=38.9	50
	C-e180	6	"	17	"	"	23	2	4	② 31.5	38
	C-d120	12	"	34	"	"	45	"	"	" 41	50
f-Lb	C-b -	"								"	50
	C-c90	2	"	5.7	"	"	7.5	"	"	" 5.1	14
	C-a -	14								41+5.1=46.1	50

Calculation Sheet R.S Tondano System X ray 220-380 TV
Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Ln	B-d146	9	3ϕ4w 127-220	26	1.0	1.3	34	2	4	② 37.7	38
	B-c -	"									"
	B-a -	"									
	A -	23								46.1+37.7=81.1	100
f-La	B-c126	20	"	58	"	"	75	"	"	" 71.8	80
fm	B-c126	15	"	43	"	"	56	"	"	" 53.6	60
	C-d120	27.5	"	79	"	"	103	"	"	" 93.8	100
	A -									53.6+93.9+147	150
f-Xn	C-c90	32	1ϕ3w 220	300	1.0	-	300	4	8	③ 121.5	125
f-Xo	C-c90	5	1ϕ3w 220	50	1.0	-	50	"	"	" 20.3	22
	B-c133	3	"	30			30	"	"	" 17.9	22
	A -	8	1ϕ3w								
f-LanK	C-e180	10.3	3ϕ4w 127-220	30	1.0	-	30	2	4	② 41	50

Calculation Sheet R.S Tondano System X ray 220-380 TV
Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	C-e180	3	3ϕ3w 220	8.6	1.0	-	8.6	2	4	② 11.8	14
f-P	C-d120	7.7-3 =4.8	"	14	"	-	14	"	"	" 12.7	14
	C-a -	12.6								11.8+12.7=24.5	30
	B-c126	4.8	"	14	"	-	14	"	"	" 13.4	14
	A -									24.5+13.4=37.9	38

Calculation Sheet Kotamobagu X ray 220/380V Others 220/380V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	174	12	3φ4w 220/380	20	1.0	1.3	26	2	4	$\frac{17.8\times26\times174}{1000\times4}=20$	22
f-La	138	15	3φ4w 220/380	25	1.0	1.3	33	2	4	$\frac{17.8\times33\times138}{1000\times4}=20$	22
f-Xo	48	330.5	1φ220	30	1.0	-	30	4	8	$\frac{35.6\times30\times48}{1000\times8}=6.4$	14
f-Xm	48	2330.5	1φ220	250	1.0	-	250	4	8	$\frac{35.6\times250\times48}{1000\times8}=53.4$	60
f-Lm	B-a 18	2	3φ4w 220/380	3.3	1.0	1.3	4.4	2	4	$\frac{17.8\times4.4\times48}{1000\times4}=3.0$	14
	C-d 174	16.3	"	27.5	1.0	1.3	36	2	4	$\frac{17.8\times36\times174}{1000\times4}=27$	30
	B-e 90	6	3φ4w 220/380	10	1.0	1.3	13	2	4	$\frac{17.8\times13\times90}{4000}=5.2$	14
	C-m									-27+5.2=32	38
	A-e									1+32=38	38

Calculation Sheet Kotamobagu X ray 220/380V
Others 220/380V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalanced check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	C-d174	47.5	3ø4w 220/380	70	1.0	1.3	91	2	4	$\frac{17.8\times91\times174}{1000\times4}=70$	80
	R-a58	8KVA	3ø3w220	23	1.0	-	23	2	4	$\frac{30.6\times23\times48}{1000\times4}=8$	14
f-P	C-d174	9.6KVA	3ø3w220	27.7	1.0		27.7	2	4	$\frac{30.6\times28\times174}{1000\times4}=37$	38
	A-a									8+37=45	30
f-Lamk	D-a90	10.3	3ø4w 127/220	30	1.0	-	30	2	4	$\frac{30.6\times30\times90}{1000\times4}=20.6$	22

Calculation Sheet R.S Gorontalo System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	132	42.5	3ϕ4w	122	1.0	1.3	159	2	4	$\frac{30.6\times159\times132}{1000\times4}$ =160	150.4
f-La	132	20	3ϕ4w 127-220	58	1.0	1.3	75	2	4	$\frac{30.6\times75\times132}{1000\times4}$ =74	80
	B-n50	2	3ϕ4w 127-220	5.7	1.0	1.3	7.4	2	4	$\frac{30.6\times7.4\times50}{1000\times4}$ =3	14
f-La	A-a C-c132	15	"	43	1.0	1.3	56	2	4	3+71=74 $\frac{30.6\times56\times132}{1000\times4}$ =56	80 60
	C-c	6	3ϕ4w 127-220	17	1.0	1.3	22	2	4	$\frac{30.6\times22\times90}{1000\times4}$ =15	22
	C-c									56+15=71	80

Calculation Sheet R.S Gorontalo System X ray 220-380 TV
Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-P	B-a50	8	3ϕ3w220	22.5	1.0	-	29.2	2	4	$\frac{30.6\times29\times50}{1000\times4}=84$	14
	C-c132	20.8-8 =12.8	3ϕ3w220	37	10	-	37	2	4	$\frac{30.6\times37\times132}{1000\times4}=37$	38
	A-a									8.4+37=45.4	50
f-Lo	96	13	3ϕ4w 127-220	34	1.0	1.3	45	2	2	$\frac{17.8\times45\times96}{1000\times2}=38$	38
f-Xo	50	3	1ϕ2w 220V	$\frac{3}{0.5}\times10^3\div200$ 30A	1.0	-	30	4	8	$\frac{35.6\times30\times50}{1000\times2}=6.6$	14
f-Xn	50	32	1ϕ3w 220V	$\frac{30}{0.5}\times10^3\div200$ 300A	1.0	-	300	4	8	$\frac{35.6\times300\times50}{1000\times8}=6.6$	80

Calculation Sheet: R.S Gerontalo System — X ray 220-380 TV; Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
C-Lamp	C-090	10.3	3φ4w	30	1.0	-	30	2	4	$\frac{30.6\times30\times90}{1000\times4}=20.6$	22

Calculation Sheet R.S Kendage System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	A-d 114	22.3	3φ4w 127-220	64	1.0	1.3	83	2	4	$\frac{30.6\times83\times114}{1000\times4}$ =72	80
c-ka	108	10	3φ4w 127-220	29	1.0	1.3	37.5	2	4	$\frac{30.6\times37.5\times108}{1000\times4}$ =30.9	38
	A-b108	2	3φ4w 127-220	5.8	1.0	1.3	7.5	2	4	$\frac{30.6\times7.5\times108}{1000\times4}$ =6.1	14
[illegible]	A-d114	10.5	"	3.0	1.0	1.3	40	2	4	$\frac{30.6\times40\times114}{1000\times4}$ =34	38
	[illegible]-a78	5	"	14.5	1.0	1.3	10	2	4	$\frac{30.6\times18\times78}{1000\times4}$ =10.7	14
	A-b A-c									34+10.7×6= 0.7 6+34=40	60 50

Calculation Sheet R.S Kendage System X ray } 220-380 TV
Others } 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-P	A-b108	8	3ϕ4w220	23.1	1.0	-	23.1	2	4	$\frac{30.6\times23.1\times108}{1000\times4}=19$	22
	A-d	7.2	3ϕ3w220	21	1.0	-	21	2	4	$\frac{30.6\times21\times114}{1000\times4}=18\ 2$	22
	A-a									19+18.2=37.2	38
f-Lo	108	12	3ϕ4w 127-220	31.5	1.0	1.3	41	2	2	$\frac{17.8\times41\times108}{1000\times2}=39.4$	50
f-Xo	108	3	1ϕ2w220	$\frac{3}{0.5}\times10^3\div200$ 30A	1.0	-	30	4	8	$\frac{35.6\times30\times108}{1000\times8}=14.4$	22
f-Xn	108	32	3ϕ3ϕ220	$\frac{30}{0.5}\times10^3\div200$ 300	1.0	-	300	4	8	$\frac{35.6\times30\times108}{1000\times8}=144$	150

Calculation sheet R.S Kendage System X-ray } 220-380 TV
Others } 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-LauK	B-a78	8.7	3φ4w 127-220	25	1.0	-	25	2	4	$\frac{30.6\times25\times78}{1000\times4}=14.9$	22

Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression	Decided size (mm^2)
f-Lc	D-a84	2	3φ4w 127-220	5.2	1.0	1.3	6.8	2	2	① 5.1	38
	A-e252	5		13	"	"	17	2	2	38	38
	A-d216	12-5=7		18.3	"	"	24	"	"	84.6=46.6+38	100
	A-c186	5		13			17			28.5	38
	A-b144	-	A-d+A-c							38+28.5+46.6 =113.1	125
"	A-a108	A-b 37-27 =10		26			34			① 146=33+113.1	150
	B-f360	3		7.8			10.2			33	38
	B-e312	B-f 7-3-4		10.4			13.6			71.2=38.2+33	80
	B-d192	B-e 11-4-7		18.3			24			112.6=41.4+39.2 +33	125
	B-c168	B-d 32-11 =21		55			72			107+112.6=220	125 2

Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
	B-b126	Same as B-c								① 220KV	125-2-4
	B-a84	C-a+B-b								110.6+220=330	150-2-4
I-Ic	C-d282	3 C-d		7.8			10.2			330×0.8=264 26	38
	C-c216	6-3-3 C-c		7.8			10.2			45.8-19.8+26	50
	C-b180	10-3=7 C-b		18.3			24			84.7=38.8+45.8	100
	C-a144	10-10-6 8%		13.7			20			③ 110.6-25.9+84.7	100
	A-a[illegible]	A-a[illegible]						2	2	330+146=476×0.8=380	125-3-4

C-14

Calculation Sheet R.S Ujung Pandang System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
	A-e252	10		29			38	2	4	② 72.7	80
	A-d216	Same as A-e								"	80
f-Ln	A-b144	20-10=10 (20)		29			38			114=41.5+72.7	125
	A-a108	Same as A-b								"	"
	C-d282	15		43			56			120	125
	C-a144	Same as C-d								② "	125
"	B-b126	15 (30)		43			56			53.6	60
	B-a84	C-a+B-b								120+53.6=173.6 173.6×0.9×150	150
	A-o	(50) A-a+B-a								114+173.6=287	150~2-4

Calculation Sheet R.S Ujung Pandang System

X ray 220-380V
Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression	Decided size (mm²)
	A-b144	22.7 A-b		65			85			② 93	100
f-m	A-a108	27.7-23.7=5		1.5			19			108=15.6+93	100
	C-e144	21 C-e		60			79			89.9	100
	B-A84	47.7-21 =26.7 A 75.4		77	1.0	1.3	100			153=63.8+89.9	150
	A-c	A-a+B-a			1.0	1.3				108+153=261	150×2=4
	D-e84	22.1		64	1.0	-	64			② 41	50
	A-e186	9.6		28			28			39.5	50
	A-a108	Same as A-c									50
	B-e84	Same as C-e									100
	[illegible]-e60	9.6		28			28			12.7	38
	A-c	A-a+B-a+B-e84+B-e									
-	C-e 144	76.3		76	1.0	-	76	2	4	41+39.5+12.7+83 =176	100 × 2=3 100
										89	

Calculation Sheet R.S Ujung Pandang System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing ×1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-LauK	A-e252	15.1	3ϕ4w 127-220	44	1.0	1.3	57	2	4	② 109	125
	A-a108	Same as A-e								"	"
	C-d282	95		274	0.8	1.0	219	3	6	$\frac{30.6\times219\times282}{1000\times6}$	125~3-4
	C-a=B-a	Same as C-d								314 "	
	A-o	A-a+C-a								109+336=444	150~3-4
f-La	B-a84	30		86.7	1.0		112	2	4	② 71.5	80
f-Xo	E-a60	46 (35) X7.5	1ϕ2w220 3ϕ4w	350	1.0	-	350	4	8	③ 94.5	100
	A-b144	C7.5 15	220-380	97.8	1.0	-	98	"	"	" 63.5	80
	A-a108	Same as A-b								"	
	A-o	A-a+E-a								94.5+63.5=150	150
f-Xn	E-a60	(50) 58	1ϕ3w	500	1.0	-	500	4	8	③ 135	150

Calculation Sheet R.S Watanpone System (Tereawar) X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	B-a156	22.3	3φ4w 127-220	64	1.0	1.3	84	2	4	$\frac{30.6\times84\times156}{1000\times4}=100$	100
f-La	156	10	3φ4w 127-220	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times156}{1000\times4}=44$	50
f-1a	C-c222	5	3φ4w 127-220	14	1.0	1.3	18	2	4	$\frac{30.6\times18\times222}{1000\times4}=30$	30
	A-d156	4	"	12	1.0	1.3	15	2	4	A-d=17.9	22
	156	9	3φ4w 127-220	26	1.0	1.3	34	2	4	$\frac{30.6\times34\times156}{1000\times4}=40.8$	50
	A-c									30+17.9+40.8=88.7	100
f-P	B-a156	13	3φ3w220	37.5	1.0	-	37.5	2	4	$\frac{30.6\times37.5\times156}{1000\times4}=45$	50
	A-d145	20	"	57.8	1.0	-	58	2	4	$\frac{30.6\times58\times156}{1000\times4}=69$	80
	A-c									$69+45\times\frac{8}{13}=96$	100

Calculation Sheet R.S Watanpone System (Tereawar) X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	A-d156	4	3ϕ4w 127-220	11	1.0	1.3	13.6	2	2	$\frac{17.8\times13.6\times156}{1000\times4}$ =18	22
	156	9	3ϕ4w 127-220	23.6	1.0	1.3	31	2	2	$\frac{17.8\times31\times156}{1000\times2}$ =43	50
	C-b192	3	"	7.8	1.0	1.3	10	2	2	$\frac{17.8\times10\times192}{1000\times2}$ =17	22
f-Xo	132	3	1ϕ2w220	$\frac{3}{0.5}\times1.0^3 \div 200$ 30A	1.0	-	30	4	8	$\frac{35.6\times30\times132}{1000\times8}$ =17.6	22
f-Xn	132	32	1ϕ2w220	$\frac{300}{0.5}\times1.0^3 \div 200$ 30A	1.0	-	300	4	8	$\frac{35.6\times300\times132}{1000\times8}$ =176	100×2
f-LauK	C-c222	8.7	3ϕ 3ϕ4w	25	1.0	-	25	2	4	$\frac{30.6\times25\times222}{1000\times4}$ =42	50

Calculation Sheet A.C Soppon System Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	A-d140	28.3	3φ4w	81	1.0	1.3	106	2	4	$\frac{30.6\times81\times140}{1000\times4}=86$	100
f-La	140	10	3φ4w 127-220	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times140}{1000\times4}=39$	50
f-Ln	A-d140	12	3φ4w	34	1.0	1.3	45	2	4	$\frac{30.6\times45\times40}{1000\times4}=48$	50
	B-b138	5	3φ4w	" 14	1.0	1.3	19	2	4	$\frac{30.6\times19\times188}{1000\times4}=20$	22
	A-b									48+20=68	80
f-P	A-d140	13	3φ3w220	37.5	1.0	-	38	2	4	$\frac{30.6\times38\times140}{1000\times4}=40$	50
	B-c132	7.5	" 220	21	1.0	-	21	2	4	$\frac{30.6\times21\times132}{1000\times4}=21$	22
	A-b									21+40=61	60

Calculation Sheet R.S Soppen System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	A-f216	2	3φ4w 127-220	5.2	1	1.3	6.8	2	2	$\frac{17.8\times6.8\times216}{1000\times2}=13$	14
	A-e186	10	"	26	1	1.3	34	2	2	$\frac{17.8\times34\times186}{1000\times2}=56$	13+56=80
	B-b138	2	"	5.2	1	1.3	6.8	2	2	$\frac{17.8\times6.8\times138}{1000\times2}=8.3$	14
f-Xo	140	3	1φ2w220	$\frac{3}{0.5}\times10^3$ 200 30	1	-	20	4	8	$\frac{35.6\times30\times140}{1000\times8}=18.7$	22
f-Xn	140	32	3φ3w220	$\frac{30}{0.5}\times10^3$ 200	1	-	300	4	8	$\frac{35.6\times300\times140}{1000\times8}=187$	100×2
f-LauK	B-b138	8.7	3φ4w	25	1.0	-	25	2	4	$\frac{30.6\ 25\ 138}{1000\ 4}=26$	30

Connection sheet K-S Fare Fare System X-ray 220-380V
Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lc	C-c177	10	3φ4w 127-220	26.2	1.0	1.3	34	2	2	① 45.7	50
	C-c211	2 (C-e)		5.2			6.8			10.9	14
	C-d153	17-2=15		40			51			70.2=59+10.9	80
	C-b94	27	C-d+C-c							70.2+45.7=115	125
	B-b117	6		15.6			20			17.8	22
f-Lc 33	B-a64 A	Same as B-b (B-a+ C-a)								17.8+115=133	150
f-Ln 22.5	C-c177	5	3φ4w 127-220	14.5	1.0	1.3	19	2	4	② 25.5	30
	C-d153	11		32			41			47.6	50
	C-b16	(C-c+ C-d)								25.5+47.6=73.1	80
	B-b117	65		19			25			22.2	22
	B-a	Same as B-b									
f-Ln	A	(B-a+ C-a)								22.2+73.1=95.3	100

Calculation Sheet R.S Pare Pare System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	C-d153	15	3φ4w 127-220	43	1.0	1.3	56	2	4	② 65.1	80
	C-b94	42.5-15 =27.5		79			103			138-73.5+65.1	150
	C-a – A	Same as C-a									
f-La	B-b117	20	"	58	1.0	1.3	75	2	4	② 66.6	80
f-Xo	C-d153	3	1φ 1φ2w220	30	1.0	-	30	4	8	③ 20.6	22
f-Xn	C-b94	32	1φ3w220	300	1.0	-	300	4	8	127	125
f-LauK	C-c177	8.7	3φ4w 127-220	25	1.0	1.3	33	2	4	② 44.4	50
f-P (21.5)	C-c211	7.5	3φ3w220	22	1.0	-	22	2	4	② 35.2	38
	C-b94	15.5-7.5 -8		23			23			51=16.4+35.2	50
	B-b117 A	6 (C-b+ B-b)		17			17			15 15+50=65	22 80

Calculation Sheet R-S Rantcpao System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	B-a67	18.3	3φ4w 127-220	52.8	1.0	1.3	68.3	2	4	$\frac{30.6\times68.3\times67}{1000\times4}$ =35	38
	A-e189	10	3φ4w 127-220	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times189}{1000\times4}$ =53	60
	A-a									25+53=88	100
f-La	189	10	3φ4w 127-220	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times189}{1000\times4}$ =55	60
f-Ln	B-a67	305	3φ4w 127-220	10	1.0	1.3	13	2	4	$\frac{30.6\times13\times67}{1000\times4}$ =6.6	14
	A-e189	13	"	37	1.0	1.3	49	2	4	$\frac{30.6\times49\times189}{1000\times4}$ =70.8	80
	A-a									6.6+70.8=77.4	80
f-P	A-f189	5	3φ3w220	14.3	1.0	-	14.3	2	4	$\frac{30.6\times14.3\times189}{1000\times4}$ =21	22
	B-a97	12.2	3φ3w220	35	1.0	-	35	2	4	$\frac{30.6\times35\times97}{1000\times4}$ =25.9	30
	A-a									21+25.9=46.9	50

Calculation Sheet R.S Rantepao System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	149	7	3φ4w 127-220	18.3	1.0	1.3	24	2	2	$\frac{17.8\times24\times149}{1000\times2}=31.8$	38
f-Xo	82	3	1φ2w220	$\frac{3}{0.5}\times10^3 \div 200$ 30A	1.0	-	30	4	8	$\frac{35.6\times30\times82}{1000\times8}=10.9$	14
f-Xn	82	32 30 0.5		$\frac{30}{0.5}\times10^3 \div 200$ 300	1.0	-	300	4	8	$\frac{35.6\times300\times82}{1000\times8}=10.9$	100
f-LauK	A-c92	8.7	3φ4w 127-220	25	1.0	1.3	32	2	4	$\frac{30.6\times32\times92}{1000\times4}=22.5$	30

Calculation Sheet R.S Palopo System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	A-d138	28.3	3ϕ4w	81	1.0	1.3	106	2	4	$\frac{30.6\times106\times138}{1000\times4}$ =100	100
f-La	A-d138	10	3ϕ4w 127-220	28.9	1.0	1.3	37.5	2	4	$\frac{30.6\times37.5\times138}{1000\times4}$ =39.5	50
f-Ln	B-b146	5	3ϕ4w 127-220	14.5	1.0	1.3	19	2	4	$\frac{30.6\times19\times146}{1000\times4}$ =21	22
	A-d138	11.6	"	33	1.0	1.3	43	2	4	$\frac{30.6\times43\times138}{1000\times4}$ =45	50
	A-c	16.6								21+45=66	80
f-P	B-b146	7.5	3ϕ3w220	21	1.0	-	21	2	4	$\frac{30.6\times21\times146}{1000\times4}$ =23.4	30
	A-d138	5	"	14.5	1.0	-	14.5	2	4	$\frac{30.5\times14.5\times138}{1000\times4}$ =15.3	22

Others) 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-P	A-c90 ΣA-c	8 20.5	3φ3w220	23	1.0	-	23	2	4	$\frac{30.6\times23\times90}{1000\times4}=15.8$ 23.4+15.3+15.8 =54.5	22 60
f-Lo	138	7	3φ4w 127-220	18.3	1.0	1.3	23.8	2	2	$\frac{17.8\times23.8\times138}{1000\times2}=29$	30
f-Xo	70	3	1φ2w	$\frac{3}{0.5}\times10^3\div200$ 30	1.0	-	30	4	8	$\frac{35.6\times30\times70}{1000\times8}=9.4$	14
f-Xn	70	32	3φ3w	$\frac{30}{0.5}\times10^3\div200$ 300	1.0	-	300	4	8	$\frac{35.6\times300\times70}{1000\times8}=94$	100
f-LauK	B-b 146	8.7	3φ4w 3φ	25	1.0	-	35	2	4	$\frac{30.6\times25\times146}{1000\times4}=27.9$	30

Calculation Sheet R-S Bancaeng System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	C-a72	28.3	3ϕ4w 127-220	81	1.0	1.3	10.5	2	4	$\frac{30.6\times105\times72}{1000\times4}$ =57.8	60
f-La	C-a72	10	3ϕ4w	29	1.0	1.3	37	2	4	$\frac{30.6\times29\times72}{1000\times4}$ =15.9	22
f-Ln	S-c84	2	3ϕ4w 127-220	5.8	1.0	1.3	7.5	2	4	$\frac{30.6\times7.5\times84}{1000\times4}$ =4.8	14
	C-a72	11.6	"	" 33	1.0	1.3	44	2	4	$\frac{30.6\times44\times72}{1000\times4}$ =24	30
	B-b96	5	"	"14.5	1.0	1.3	19	2	4	$\frac{30.6\times19\times96}{1000\times4}$ =14	14
	A-b	18.6								4.8+24+14=42.0	50

Calculation Sheet R.S Bantaeng System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-P	A-c84	8	3ϕ3w220	23	1.0	-	23	2	4	$\frac{30.6\times23\times84}{1000\times4}$ =14.8	22
	C-a72	5	"	14.5	1.0	-	14.5	2	4	$\frac{30.6\times14.5\times72}{1000\times4}$=7.9	14
	B-c147	7.5	"	22	1.0		22	2	4	$\frac{30.6\times22\times147}{1000\times4}$=24.7	30
	A-b	20.5								14.7+7.9+24.7 =47.3	50
f-Lo	A-c84	2	3ϕ4w 127-220	5.2	1.0	1.3	6.8	2	2	$\frac{17.8\times6.8\times84}{1000\times2}$ =5	14
	C-a72	S-2=6	3ϕ4w 127-220	16	"	"	21	"	"	$\frac{17.8\times21\times72}{1000\times2}$ =13.5	13.5+5=22
	B-b96	4	3ϕ4w 127-220	10.4	"	"	13.6	"	"	$\frac{17.8\times13.6\times96}{1000\times2}$ =	
	A-b	10								=11.6 13.5+11.6=25.1	14 30

Calculation Sheet R.S Bantaeng System X ray / Others } 127-220

Factor symbol	Length real rength at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Xo	A-c84	3	1ø2w220	$\frac{3}{0.5}\times10^3$ 200 30	1.0	-	30	4	8	$\frac{35.6\times30\times84}{1000\times8}$ =11.2	14
f-Xn	A-c84	25	1ø2w220	$\frac{25}{0.5}\times10^3$ 200 250	1.0	-	250	4	8	$\frac{35.6\times250\times84}{1000\times8}$ =93.4	100
f-LauK	B-b96	8.7	3ø4w 3ø	25	1.0	-	25	2	4	$\frac{30.6\times25\times96}{1000\times4}$ =18.4	22

Calculation Sheet R.S Medan System X ray } 220-380V
Others } 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	D-b164	10	3φ4w 127-220	26	1.0	1.3	34	2	2	① 50.1	50
	D-a									"	
f-Lo 110	C-d218	20		52			68			100.2	100
		C-d									
	C-c156	35-20=15		39			51			=71+100.2	100~2-4
	C-b	"									
	B-a	D-a+C-b								171.2+50.1=222	125~2-4
40	A-a	"			1.0	1.3		2	2	①	
	F-c194	20		52			68			118	125
f-Lo	F-d265	20		"			"			162×0.9=146	150
	F-b	F-C+F-d								118+146=264	150~2-4
	F-e										50-4
	H-d275	5		13	1.0	1.3	17	2	2	① 42	50
	H-c238	7		18			24			51	50
f-Lo	H-b226	2		5.2			6.8			13.8	14
	H-a	H-d+H-e+ H-b								42+51+13.8=107	100
	G-b178	30-17=13		34			45			179=72+107	100~2-4

Calculation Sheet R.S Medan System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Lo 70	G-a	Same as G-b			1.0	1.3		2	2		
	F-a	G-a+F-b								179+264	150~3-4
	A-b	Same as F-a									
f-Ln 55	C-d218	10	3ϕ4w 127-220	29	1.0	1.3	37	2	4	② 61.3	60
	C-c156	16-10=6		17			22			87=26+61.3	100
	C-b	Same as C-c									
	D-a142	8		23			30			32	38
	B-a	C-b+D-a								87+32=119	125
f-Ln 24	A-a	Same as B-a			1.0	1.3		2	4	②	
	F-d265	20		57.8			75			151	150
	F b	Same as F-d									
	H-d275	5		15			19			39.7	50
	H-c	Same as H-d									

Calculation Sheet R.S Medan System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Ln	H-b238 H-a G-b G-a F-a	6 H-c+H-b Same as H-a " F-b+G-a		17	1.0	1.3	22	2	4	② 39.7 79=39.7+39.7 151+79=230	50 80 " 125~2-4
31 f-Ln	A-b	Same as F-a									"
f-Lo	G-a95	30	3ϕ4w 127-220	87	1.0	1.3	112	2	4	② 80.8	80
f-m 90 36	H-d275 H-a G-a F-a A-b	36 " " " "	3ϕ4w 127-220	104	1.0	1.3	135	2	4	② 281	150~2-4
f-m 54	C-d218 C-c C-b A-a	54 " " "	"	156	1.0	1.3	202	2	4	② 334×0.9=300	150~2-4

Calculation Sheet R.S Medan System X ray 220-380V
Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	C-c'156	59.5	3ϕ4w 220-380	250	1.0	-	250	4	8	③ 175	100~2-4
T-Xc	C-b	max25 Same as C-c									
39.5	D-b'64 D-a	5 Same as D-b	1ϕ2w	50			50			36.9	38-2
	B-a	Same as C-b									
	A-a	Same as B-a									
T-Xc											
	C-c'136	68	3ϕ4w 220-380	300	1.0	-	300	4	8	③ 351	150-2-4
C-Xc	C-b	max30 Same as C-c									
38	B-a	"									
	A-a	"									

Calculation Sheet R.S Medan System X ray 220-380V Others 127-220V

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-LauK 141.6	D-a142	119	3ϕ4w 127-220	343	1.0	1.3	447	2	4	② 482×0.9=430	150~3-4
	B-a	Same as D-a									
	A-a	"	"								
	H-b226	22.6		65			85			145.9	150
	H-a	Same as H-b									
22.6	G-b	"	(F-b+ G-a)								
	G-a	"									
	F-a	"									
	A-b	"									
f-F	G-b178	37	3ϕ3w220	106	1.0	-	106	2	4	② 143	150-3
	G-a	Same as G-b									
	F-a	"	F-b								
	A-b	"									
	C-d218	23	3ϕ3w220	66	1.0	-	66	2	4	109	125-3
	C-c	Same as C-a									
	C-b	"									
	B-a	"									
	A-a	"									

Calculation Sheet R.S Tarutung System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	C-g334	3	3φ4w 127-220	7.8	1.0	1.3	10	2	2	① 30	30
	C-h294	3	"	"			"			" 26.5	30
	C-e										C-e 60
	C-f241	5	"	13			17			" 36.9	38
	C-d211									30+26.5+36.9 =93.4	
	C-i270	3	"	7.8			10			" 24.3	C-d 100 30
f-Lo	C-c162										
	C-b126	25-14 =11	"	29			37			24.3+93.4=117.7	125
	C-a90									" 41.9	41.9+117.7=159 →150
	B-g261	3	"	7.8			10				150
	B-d171	2	"	5.2			6.8			" 23.5	30
										" 10.5	14
f-Lo	B-f261	5	"	13			17			" 39.9	50
	B-e201									23.5+39.9=63.4	80
	B-c144	10	"							10.5+63.4=73.9	80
	B-a99	13-10 =3	"	7.8			10			" 8.91	73.9+8.9=82.8 →100
	A										150-2

Calculation Sheet R.S Tarutung System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Ln	C-b126	15	3φ4w	43			56	2	4	② 53.6	60
	C-a90	38.5-15 =23.5	127 220	68			88			" 60.1	60.1+53.6=125
	B-f261	14		40			52			" 103	100
	B-e201	16-14=2		5.8			7.5			" 11.4	103+11.4=125
	B-c144	16								103+11.5=114.4	125
f-m	C-a90 90	36.5	"	105	1.0	1.3	137	2	4	② 93.7	100
f-Xo	C-b126	5	1φ3w	50	1.0	-	50	4	8	$\frac{35.6\times126\times50}{1000\times8}$ =28	30
	B-e201	2		20	1.0	-	20	"	"	$\frac{35.6\times201\times20}{1000\times8}$ =17.9	22
	A									28+17.9=45.9	50
f-Xn	B-e201	32	1φ3w	300	1.0	-	300	4	8	$\frac{35.6\times300\times201}{1000\times8}$ =268	150~2

Calculation Sheet R.S Tarotsug System X ray 220-380
Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	C-h294	11.1	3ϕ3w	32	1.0	-	32	2	4	③ 24.8	30
	C-h126	15.9-		13.8	1.0	-	14	"	"	" 13.4+24.8	50
		11.1-4.8									
	C-a90	20.7-		13.8	1.0	-	14	"	"	" 9.5+13.4+24.8	50
		15.9-4.8									
	A-C-a										50
C-La	C-a90	20	3ϕ4w	57.8	1.0	1.3	75	2	4	② 51.3	60
C-LauK	B-C263	10.3	3ϕ4w	29	1.0	-	29	2	4	② 57.5	60

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Calculation Sheet R.S Porsen System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	A-e131	22.3	3φ4w 127-220	64	1.0	1.3	83	2	4	$\frac{30.6\times83\times131}{1000\times4}=83$	100
f-Le	A-e131	8	"	13.6	"	"	17.7	2	2	$\frac{17.8\times17.9\times131}{1000\times2}=20.6$	22
	A-e A-d143	A-f4A-e 7 2	"	5.2	"	"	6.8	2	2	$\frac{17.8\times6.8\times143}{1000\times2}=8.6$	S.4+20=30 14
f-Lp	A-e131	17.6	3φ4w 127-220	50	1.0	1.3	66	2	4	$\frac{30.6\times66\times131}{1000\times4}=66$	80
	A-f144	14.9	3φ3w220	43	1.0	-	43	2	4	$\frac{30.6\times43\times144}{1000\times4}=47$	50
f-p	A-e131	2.4	"	7	1.0	-	7	2	4	$\frac{30.6\times7\times131}{1000\times4}=7$	14
	A-e	17.3								47+7=54	60
f-Lq	131	10	3φ4w 127-220	28	1.0	1.3	36	2	4	$\frac{30.6\times36\times131}{1000\times4}=36$	38

Calculation Sheet R.S Forsen System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Xc	87	5	1ø2w 220	$\frac{5}{0.5}\times10^3 \div 200$ 50	1.0	-	50	4	8	$\frac{35.6\times50\times87}{1000\times8}$ =19.4	22
f-Xn	87	25	1ø2w 220	$\frac{25}{0.5}\times10^3 \times 200$ 250	1.0	-	250	4	8	$\frac{35.6\times250\times87}{1000\times8}$ =97.5	100
f-LauK	A-c114	8.7	3ϕ4w 127-220	25	1.0	1.3	33	2	4	$\frac{30.6\times33\times114}{1000\times4}$ =28.7	30

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Calculation Sheet R.S Siamter System X ray 220-380 TV Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Lo	C-c180	7.7	3φ4w 127-220	20	1.0	1.3	26	2	2	① 4.2	50
	C-b108	27.7-7.7=20	"	28			37			77.9=35.9+42	80
	C-a72	Same as C-b		-			-			77.9	"
44.7	B-b156	7.6		20			26			36.5	38
	B-a72	Same as B-b								"	"
f-Lo	D-c156	5		13			17			23.8	30
	D-b240	5		13			17			36.7	38
	D-a48	(D-c+D-b)		-			-			23.8+36.7=60.5	60
	A	B+C+D								175	100~2-4
f-Ln	B-b156	7.6		20	1.0	1.3	26	2	4	② 30.8	30
	B-a72	Same as B-b								"	"
	C-c180	12		35			45			61.5	80
	C-b108	C-c 24-12=12		35			45			98=36.9+61.5	100
	C-a72	Same as C-b									"

Calculation Sheet R.S Slanter System X ray 220-380 TV Others 127-220 TV

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Ln	A	B+C								30.8+98=128	125
f-m	C-c180 C-a72	65.5 Same as C-c		189	1.0	1.3	246	2	4	② 336	150~2-4
f-Xo	C-b108 C-a72	18 Same as C-b	1ø3w220	150	1.0	-	150	4	8	③ 72.9	80-3
f-Xn	C-c180	32	1ø3w220	300	1.0		300	4	8	③ 243	125~2-3
f-La	C-c180	30		87			113			② 154	150
f-LauK	B-b156 B-a72	14.85 Same as B-b		42.9			56			② 66.4	80
f-P	C-c180 C-a72	24 Same as C-c		69	1.0	-	69	2	4	② 94	
	D-c564	22.1		63	1.0	-	63.1	3	6	$\frac{30.6\times564\times63}{1000\times6}$ = 181	
	D-a48 A	Same as D-c								94+181=275	150~2-3

Calculation Sheet R-S T. Tings System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	A-d180	28.3	3φ4w 127-220	81	1.0	1.3	106	2	4	$\frac{30.6\times106\times180}{1000\times4}$ =45	150
f-La	A-d180	10	3φ4w	28.5	1.0	1.3	37	2	4	$\frac{30.6\times37\times180}{1000\times4}$ =50.9	60
f-Ln	A-e150	5	3φ4w 127-220	14.5	1.0	1.3	19	2	4	$\frac{30.6\times19\times150}{1000\times4}$ =21.8	22
	A-d180	11.6	3φ4w 127-220	33	1.0	1.3	43	2	4	$\frac{30.6\times43\times180}{1000\times4}$ =59	60
	A-C									21.2+59=80	80
f-P	A-d180	13	3φ3w220	37	1.0	-	37	2	4	$\frac{30.6\times37\times180}{1000\times4}$ =53	60
f-Lo	C-b180	11	3φ4w 127-220	28.8	1.0	1.3	37	2	2	$\frac{17.8\times37\times180}{1000\times2}$ =59	60

Calculation Sheet R.S T. Tinga System X ray Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Xo	72	3	1ϕ2w220	$\frac{3}{0.5}\times10^3 \div 200$ 30A	1.0	-	30	4	8	$\frac{35.6\times30\times72}{1000\times8}=10.0$	14
f-Xn	72	32	3ϕ3w220	$\frac{30}{0.5}\times10^3 \div 200$ 300A	1.0	-	300	4	8	$\frac{35.6\times300\times72}{1000\times8}=100$	100
f-Bank	A-e150	87	3ϕ4w 127-220	25	1.0	-	25	2	4	$\frac{30.6\times25\times150}{1000\times4}=28$	30

Calculation Sheet R.S T. Barai System X ray Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	A-b96	28.3	3φ4w 127-220	81	1.0	1.3	105	2	4	$\frac{30.6\times105\times96}{1000\times4}=60$	60
f-La	90	10	3φ4w 127-220	28.9	1.0	1.3	37	2	4	$\frac{30.6\times37\times90}{1000\times4}=25$	30
f-Ln	B-a90	2	3φ4w 127-220	5.8	1.0	1.3	7.5	2	4	$\frac{30.6\times7.5\times90}{1000\times4}=5.1$	14
	C-a60	10.6	3φ4w 127-220	31	"	"	39	2	4	$\frac{30.6\times39\times66}{1000\times4}=17.9$	22
	A-e194	2	"	5.8	"	"	7.5	2	4	$\frac{36.6\times7.5\times194}{1000\times4}=11.1$	14
	A-c144	3	"	8.6	"	1.3	11	2	4	$\frac{30.6\times11\times144}{1000\times4}=12.1$	14
	ΣA-c	7.0								5.1+11.1+12.1=28	30
	A-a									5.1+17.9+28=51	60

Calculation Sheet K.S T. Boral System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	B-a90	5	3ϕ3w	14.5	1.0	-	14.5	2	4	$\frac{30.6\times14.5\times90}{1000\times4}=10$	14
f-P	C-a60	8	"	23	1.0	-	23	2	4	$\frac{30.6\times23\times60}{1000\times4}=10.5$	14
	A-b96	3	"	8.6	"	-	8.6	2	4	$\frac{30.6\times8.6\times96}{1000\times4}=6.3$	14
	A-a									10+10.5+6.3=26.8	30
	A-a264	3	3ϕ4w 127-220	7.8	1.0	1.3	10	2	2	$\frac{17.8\times10\times264}{1000\times2}=23$	30
	A-c194	10	"	25	1.0	1.3	33	2	2	$\frac{17.8\times33\times194}{1000\times2}=57$	60
f-Ko	⑦ 174	2	"	5.2	1.0	1.3	6	2	2	$\frac{17.8\times6\times174}{1000\times2}=9.2$	14
	A-b A-c A-a									57+9.2=66.2	80
f-Xo	60	10-3×3	1ϕ2w220	$\frac{5}{0.8}\times10^3$ =200 50A	1.0	-	50	4	8	$\frac{35.6\times50\times60}{1000\times8}=13.3$	14 2 30

Calculation Sheet R.S T. Barai System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Xn	60	25	1ø2w220	$\frac{25}{0.5}\times10^3 \div 200$ 250A	1.0	-	250	4	8	$\frac{35.6\times250\times60}{1000\times8}=66.5$	80
f-LauK	⑦ 174	7	3ø3w 127-220	20	1.0	1.3	26	2	4	$\frac{30.6\times26\times174}{1000\times4}=34$	38
	A-c144	1.7	"	5	1.0	1.3	6.5	2	4	$\frac{30.6\times6.5\times144}{1000\times4}=7.1$	14
	ΣA-c	8.7								34÷7.1=41.1	50

Calculation Sheet R.S Kisaran System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-m	A-c137	42.5	3φ4w 127-220	122	1.0	1.3	159	2	4	$\frac{30.6\times59\times137}{1000\times4}=166$ 166×0.9=149	150
f-La	B-a162	20	3φ4w 127-220	58	1.0	1.3	75	2	4	$\frac{30.6\times75\times162}{1000\times4}=92$	100
	A-g282	4	3φ4w 127-220	11	1.0	1.3	15	2	4	$\frac{30.6\times15\times282}{1000\times4}=32$	38
	A-f247	10-4=6	"	17	1.0	1.3	23	2	4	$\frac{30.6\times23\times247}{1000\times4}=43$	38+43=80
f-Lm	B-a162	5	"	14	"	"	18.7	"	"	$\frac{30.6\times18.7\times162}{1000\times4}=23$	22
	A-c137	10	"	28	"	"	39	"	"	$\frac{30.6\times39\times137}{1000\times4}=40.8$	40.8+80=120.8
	ΣA-c A-b	Σ20 Σ25								125+23=148	125 150

Calculation Sheet R.S Kisaran System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check facto	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-P	B-a162	6	3ϕ3w220	15.7	1.0	-	15.7	2	4	$\frac{30.6\times15.7\times162}{1000\times4}$ =19.4	22
	A-c137	9.6	"	27.7	1.0	-	27.7	2	4	$\frac{30.6\times27.7\times137}{1000\times4}$ =29	30
	A-b	Σ15.6								19.4+29=48.4	60
f-Xo	54	6	1ϕ2w220	$\frac{6}{0.5}\times10^3\div200$ 60	1.0	-	60	4	8	$\frac{35.6\times60\times54}{1000\times8}$ =14.4	22
f-Lo	A-g282	4	3ϕ4w 127-220	10	1.0	1.3	13	2	2	$\frac{17.8\times13\times282}{1000\times2}$ =32	38
	A-f247	10-4=6	"	15.7	"	"	20	"	"	$\frac{17.8\times20\times247}{1000\times2}$ =44	38+44=82
	A-d172	20-10=10	"	26	"	"	34	"	"	$\frac{17.8\times34\times172}{1000\times2}$ =52	80÷52-150
	B-a162	5	"	13	"	"	15.7	2	2	$\frac{17.8\times15.7\times166}{1000\times2}$ =22	22
	A-b72	30-25=5	"	13	"	"	15.7	2	2	$\frac{17.8\times15.7\times72}{1000\times2}$ =10	32+44+52+22+10 =160→150

Calculation Sheet R.S Kisaran System X ray 220-380 Others 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-Xn	54	62	1ø3w220	$\frac{30}{0.5}\times10^3 \div 200$ 300	1.0	-	300	4	8	$\frac{35.6\times300\times54}{1000\times8}=72$	80
f-LnuK	A-g282	8.7	2ø4w	25	1.0	1.3	33	2	4	$\frac{30.6\times33\times282}{1000\times4}=71$	80

Calculation Sheet R-S Rantau Prapat System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
f-m	A-f180	28.3	3φ4w	81	1.0	1.3	106	2	4	$\frac{30.6\times106\times180}{1000\times4}=145$	150
	B-b108	3	"	8.6	1.0	1.3	12	2	4	$\frac{30.6\times108\times12}{1000\times4}=9.9$	14
f-La	A-f180	10	3φ4w	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times180}{1000\times4}=50.9$	50
f-Ln	A-f180	10	3φ4w 127-220	29	1.0	1.3	37	2	4	$\frac{30.6\times37\times180}{1000\times4}=50$	50
	C-b234	2	3φ4w 127-220	6	1.0	1.3	7	2	"	$\frac{30.6\times7\times234}{1000\times4}=12.5$	14
	A-d	12								50+12.5=62.5	60
	B-b108	5	3φ4w 127-220	14	1.0	1.3	18	2	4	$\frac{30.6\times18\times108}{1000\times4}=14.8$	22
	A-a	17								62.5+14=76.5	80

Calculation Sheet R.S Rantau Prapat System X ray / Others } 127-220

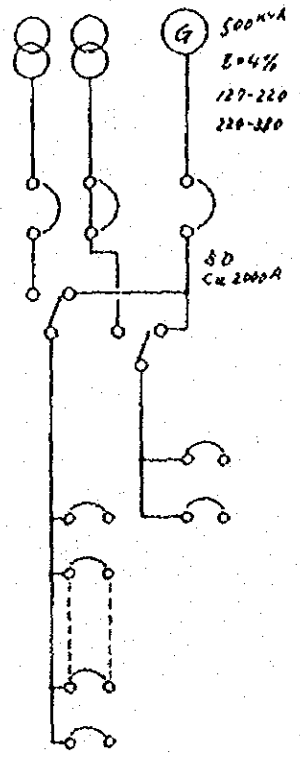
Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm²)	Decided size
	A-f180	6	3ϕ3ϕ220	17	1.0	-	17	2	4	$\frac{30.6\times17\times180}{1000\times4}$ =24	30
f-P	(10) 354	15	"	15×0.6 =26	1.0	-	26	3	6	$\frac{30.6\times26\times180}{1000\times4}$ =46.9	50
	A-d	21								24+46.9=70.9	80
	A-f180	5	3ϕ4w 127-220	13	1.0	1.3	17	2	2	$\frac{17.8\times17\times180}{1000\times2}$ =27	30
f-Lo	C-b236	5	"	"	"	"	"	"	"	$27\times\frac{216}{180}$=32	38
	B-b108	5	"	13	"	"	"	"	"	$\frac{17.8\times17\times108}{1000\times2}$ =16.3	16.3+22=75.3→80
	A-a	Σ15								27+32+22	80
	A-d	10								27+32=59	60
f-Xo	72	3	1ϕ2w220	$\frac{3}{0.5}\times10^3$ ÷200 = 30	1.0	-	30	4	8	$\frac{35.6\times30\times72}{1000\times8}$ =9.6	14

Calculation Sheet R.S Rantau Prapat System X ray / Others } 127-220

Factor symbol	Length real length at drawing × 1.2 (m)	Load capacity (KVA)	System	Current (A)	Demand ratio	Unbalance check factor	Calculated current (A)	Voltage drop F (%)	Voltage drop F (V)	Calculation expression (mm^2)	Decided size
f-Xn	72	32	3ϕ3w220	$\frac{30}{0.5}\times10^3 \div 200$ 300	1.0	–	300	4	8	$\frac{35.6\times300\times72}{1000\times8}=96$	100
f-LauK	B-b108	8.7	3ϕ4w 127-220	25	1.0	1.3	32	2	4	$\frac{30.6\times32\times108}{1000\times4}=26.4$	30

Computation of Short-circuit Capacitance

Assuming condition: It is assumable that the independent power supply is higher than Tr (commercial power supply)



1) Generator %Z 4% 500KVA

X_1 = 1000KVA

Base PU reactance = $\frac{4}{100} \times \frac{100\Omega}{500}$ = 0.08Ω

Generating load

2) From generator to board

2000A ~ 1500A BD ℓ = 15m 50Hz

Reactance 0.0015Ω

X_2 = 1000KVA

Base PU reactance $0.0015 \times \frac{1}{(0.127)^2}$ = 0.094Ω

3) From low tension feeder to site board

150mm² (75)

ℓ = 10m is assumed on the safety fuse side

Reactance 0.0013Ω

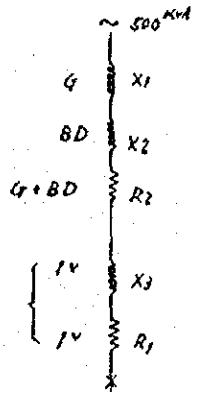
X_3 = 1000KVA

Base reactance = $0.0013 \times \frac{1}{(0.127)^2}$ = 0.08Ω

4) ΣX = PV 1000KVA

Base reactance = 0.08 0.094 + 0.08

= 0.254



5) Resistance Decided to be only in the portion where wires are used.

$150mm^2$ ℓ = 10m

Resistance 0.0012Ω

R_1 = 1000KVA Converted PU resistance

$$0.0012 \times \frac{1}{(0.127)^2} = 0.074$$

6) Resistance in other portions

$$R_2 = \frac{\Sigma X - X_3}{4} \qquad \frac{0.254 - 0.08}{4} = 0.044\Omega$$

7) $\Sigma R = R_1 + R_2$ $\therefore \Sigma R = 0.074 + 0.044$

$= 0.118$

8) Composite impedance $Z_0 = \sqrt{\Sigma R^2 + \Sigma X^2}$

$\therefore = \sqrt{0.118^2 + 0.254^2}$

$= \sqrt{0.014 + 0.065}$

$= 0.28$

9) Symmetrical short-circuit capacitance

$$= \frac{500KVA}{0.28} = 1786KVA$$

10) Symmetrical short-circuit capacitance

$$= \frac{500KVA}{0.28 \times \sqrt{3} \times 0.127} = 8.125A$$