SUPPLEMENTARY REPORT

FOR

HOSPITAL FACILITIES IMPROVEMENT PROJECT

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VOLUME 2

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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	Closs. of Work	Description	System	
f - Lo	Existing	Existing instal-lation	3 φ 4 W 127/220	127 1φ
f - Ln	New instal-lation	Lighting	3 " 4 " "	220 1φ
f - p	"	Power (including cool-ing 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 instal-lation	X-ray apparatus	3 " 4 " 220/380	220V 1φ

f - Xo To be selected from among feed-ing 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

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

f - Lank = f - Luk

(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 400-250	4P 225-100	4P 400-300	4P 225-100	4P(15×2) 600-600	3P 225-175	4P 600-400	4P 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
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	
Persea	4P 100- 75	" 100- 30	" 225-150	" 100- 50	4P 100- 60	3P 225-150	4P 100- 30	4P 100- 60	
Stanter	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-Lunk 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

*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
Kondano	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
Pare Pare	88.4	114	**105	219	4	215	"
Rantpao	*150			135	1.0	134	No
Palopo	*150			135	0.5	130	"
Bantaeng	*150			135	2.5	132.5	20kw in reserve
Medan	247.1	305	**147	452	74.5	377.5	Yes
Tartung	91.4	114	**105	219	14	205	"
Poosea	*150			135	0.5	130	No
Binanter	127	135	**105	240	30	210	Yes
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	Currently no supply	

4-3 Calculation Sheet for PLN Transformers and Contract Power

a. Explanation

b. Calculation Table

(a) 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%).

(b) 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
Tarttung	154	"	123	39	30		91.4	100	100
Por Sea	87.8	"	70	30	25		56.6÷3+25=44		*150
Bianter	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

4-4 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 Kotamobagu,
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:

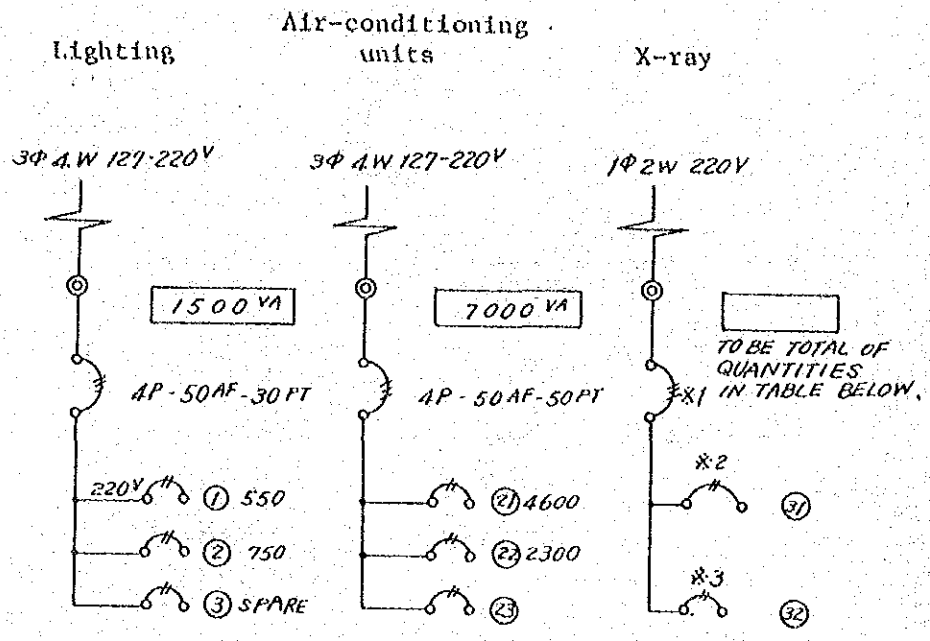
		L=Length (m) I=Calculated current $I_1 = \frac{P \times 10^3}{3} \div 127$ $I_2 = \frac{P \times 10^3}{I_3 \cdot 200}$	e=Voltage drop e_1 = 2V e_2 = 4V e_3 = 8V $I_3 = \frac{P \times 10^3}{0.5} \div 200$
①	f-Lo	$\frac{17.8 \times L \times I_1}{1000 \times e_2}$	or $0.009 \cdot L \cdot I_1$
②	f-Ln f-La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

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 FL10-1 LETTERS: PHOTOGRAPHING
	LAMP
o	LOCAL SWITCH 250V/0A
ND	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	50kW	30kW	25kW	3kVA	3 ∿ 2	3φ 3kVA 1φ 7kA
Lighting and Plug Socket	1,500			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 come 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.

3.7 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.

3.8 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).

1.4.2 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 fer 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 (1).

(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 diatribution 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

(1) 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	
Other 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

5) 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".

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.

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

5.1 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
200	500	500	550	3.2	2.0	2.0

(2) The following should be provided.

(i) 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.

6. 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

7.1 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. Tools

The tools of generator should be as mentioned below.

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

Inspection and test of machinery and equipment

.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.

.2 Test

(a) The AC generator should be tested 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,

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

(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.

(5) 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 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 (Ground 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.

(6) 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.

(7) 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%.

(6) 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.

(1) 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.

Execution of Work

Installation

Earthquake-proof treatment.

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

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.

Generator and prime mover

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, center line, bending of the crank shaft, etc. should be inspected and correct.