

Backup System

1.0 Generating Set

There are occasions when the TNB electricity supply fails and a building is left without electricity. In some buildings the risk of being totally without electricity is unacceptable and some provision must be made for an alternative supply to be used in such an emergency. Many consumers have installed standby generating sets in their building to maintain a supply for their essential loads.

The majority of small standby sets installed will be powered by diesel engines, as these are the most readily available prime movers, and most economic in capital costs, operation and maintenance. Most emergency sets can be started either manually or automatically. A manual start is simple, but it involves a substantial delay during which the building is without power. This delay can be minimized to about 10seconds by automatic starting, initiated by a sensing unit which detects a drop in the mains voltage.

The location of a generator room and the layout of generator set are important as they affect the performance of the equipment. Generator rooms should have as many external walls as possible. In any case, it is not advisable to have less than 2 external walls. Additionally the location of the room also affects the surrounding environment and persons. Therefore the DE shall apply noise reduction / acoustic treatment so that noise level is not more than 65dB(A) measured at receptor. This is in line with the requirements of Seksyen 23, Akta Kualiti Alam Sekeliling 1974. According to Peraturan 36 Peraturan Kualiti Alam Sekeliling (Udara Bersih) 1978, the approval from Jabatan Alam Sekitar (DOE) has to be obtained for generator sets that burn fuel at $\geq 15\text{kg/hr}$ (which has been equated to $\geq 60\text{kVA}$).

The minimum clearance height of the generator set room should be given careful consideration during planning stage. If the minimum clearance height is insufficient, the exhaust system may not be able to be properly installed resulting in high back pressure. This effects the performance of the generator set and increase the noise level as well. Generator set should be so installed such that the radiator can discharge the hot air through an external wall away from occupied areas. Air intake should preferably be from the opposite side of the wall through which the radiator discharges the hot air. If the construction of the room is such that the volume of intake air is insufficient, then forced air intake by means of electric blower fan has to be installed.

Some common terminologies associated with backup systems:

- a) Emergency load – back up supply from generator set only
- b) Essential load – critical loads which cannot afford any break in power supply hence will normally be backed up with supply from UPS equipment which in turn may or may not be connected to a generator.
- c) Uninterrupted Power Supply, UPS

1.1 Load Assessment and Sizing the Generator

It is necessary to determine to which loads one proposes to maintain a supply under emergency conditions. These loads may consist of static loads and motor loads.

The generator is sized with the main loads plus 20% on other power requirements such as lightings, small motors, etc.

Static load consist of lamps, communication equipment, etc. – items which do not involve rotating machinery. Static loads are expressed in kW.

Motor loads are those electrical motors which power such things as fireman lifts, pressurization fans and fire fighting equipment. These motor loads are also expressed in kW, but they also place an additional demand on the electric supply. This demand is the starting kVA (skVA). The starting kVA for a motor of 5 kW or more is 5.5 to 6 times the rated kVA and it is 8 to 10 times approximately in the case of one of 5 kW or lower.

At starting, the motor normally apply a fairly large load to the generator. Under the rated full load, most motors require about 1.4 kVA per kW. It is therefore easy to find out kVA values on the basis of output kW.

Thus to determine the total load,

- a) Add up the static loads in kW to establish the total static load.
- b) Identify the individual motor loads and compute their total kW value.
- c) Then individually calculate the starting kVA of each motor.

1.1.1 Some Notes on European Design Motors

The essential data is on the nameplate of European design motors. The motor capacity (output) may be expresses in horse-power (hp), or in kW; and there will be no code letters as in American Design Motors. If the name-plate includes hp, multiply this figure by 0.85 to determine the kW requirement (same process as with American design motors, refer 1.1.2). If the nameplate lists motor capacities in kW, multiply this mechanical kW figure by 1.15 to determine the electrical kW requirement from the generator set (1.15 is derived from the reciprocal of typical electric motor efficiency of 88% of $1/0.88 = 1.15$).

The nameplate may list the starting kVA (skVA) or may list a figure, LRA, which means 'Locked Rotor Amperes'. To arrive at the skVA, the following formula should be applied,

$$\text{skVA} = \frac{\text{LRA} \times \text{rated voltage} \times 1.732}{1000}$$

Establish the total kW demand: The static load kW should be added to the motor load kW. When this exercise is completed for all static and motor loads, the total figure is the minimum generator set capacity of the selected generator set.

1.1.2 Some Notes on American Design Motors

The motor hp and NEMA (National Electric Manufacturer's Association) code letter will be shown. These two items allow you to determine quickly the motor power requirement in kW and the starting requirement in kVA.

For kW requirement, multiply the nameplate hp by 0.85 (0.85 is derived from the conversion of 0.716 kW /hp divided by a typical motor efficiency of 0.88). The result closely approximates the motor kW demand at full load. For skVA – refer to the NEMA code letter in Table 1. Multiply the related skVA /hp figure by the motor nameplate hp.

Eg: A 100 hp Code F motor has a skVA of $100 \times 5.5 = 550$ kVA.

NEMA Code letter	skVA per horsepower (multiplier)
Motors with these code letters are usually Three Phase	
A	3.1
B	3.5
C	4.0
D	4.5
E	5.0
F	5.5
G	6.2
H	7.0
J	8.0
Motors with these code letters are usually Single Phase	
K	9.0
L	10.0
M	11.0
N	12.5
P	14.0
R	16.0
S	18.0
T	20.0
U	22.0
V	25.0

Table 1: Identification of code letters on typical US design 3 phase induction motors

Note: Wound rotor motors have no code letters.

1.3 Check for voltage dip

The next step is to establish if the generator set with the required kW capacity will be adequate to cope with the motor skVA needs. Manufacturers usually provide tables listing voltage dip versus skVA. Each motor is checked against the generator set skVA capacity for the probable voltage dip. This figure is compared with the acceptable voltage dip. If the expected dip exceeds the acceptable dip, the generator size will have to be increased or the starting requirement of motors will have to be reduced.

1.4 Dimension Guideline for Generator Set Installation

Table 2 shows some guideline of generator plinth size, room size and other requirement for the installation.

(Proposed to use Appendix 1 in Chapter 13 for reference)



TABLE 2 : RECOMMENDATION FOR GENERATOR ROOM AND PLINTH SIZES

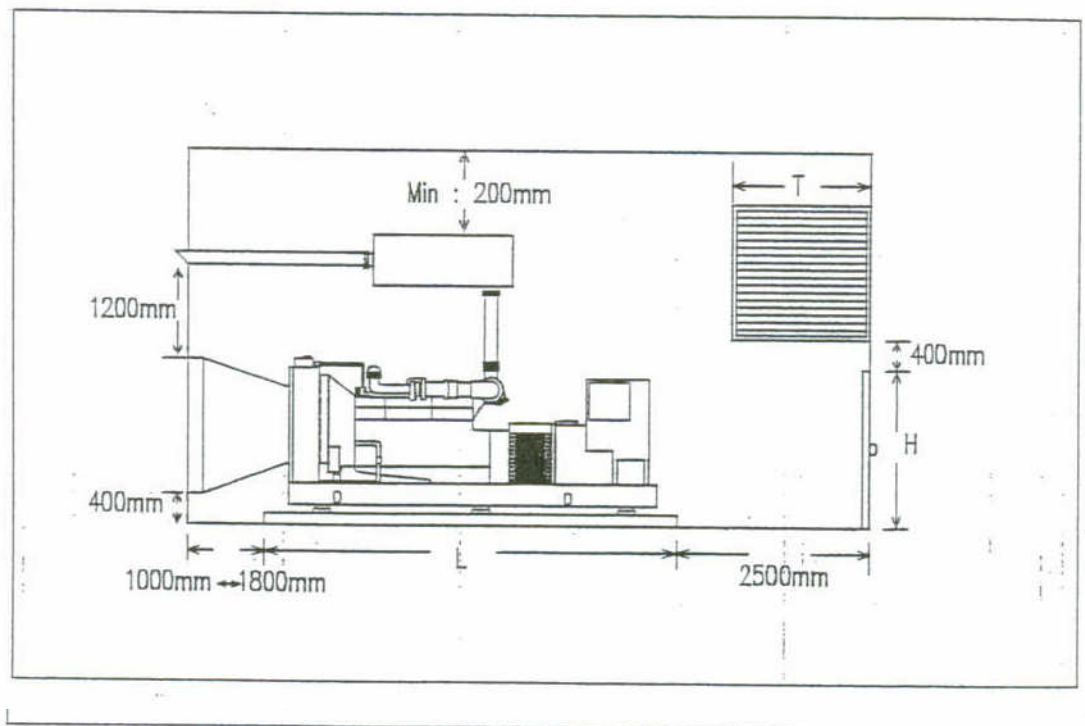
Generator Rated		Generator Physical Size (mm)			Generator Weight	Oil Tank Size	Generator Plinth Size	AIS Size (mm)	ADS Size (mm)	Recommended Room Size			Door Size
kW	kVA	L	W	H	KG	L x W x H (mm)	L x W x H (mm)	W x H x T	W x H x T	L	W	H	W x H x T
20	25	1408	556	900	600	1000 x 500 x 350	1400 x 550	900 x 600 x 900	900 x 600 x 900	3400	4000	4000	1800 x 2100 x 75
32	40	2149	710	1341	820	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
35.2	44	2149	710	1341	820	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
40	50	2149	710	1341	820	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
48	60	2149	710	1341	905	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
52	65	2149	710	1341	905	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
60	75	2149	710	1341	945	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
66	82.5	2149	710	1341	945	1000 x 500 x 350	2100 x 700	900 x 600 x 900	900 x 600 x 900	3900	4000	4000	1800 x 2100 x 75
80	100	2515	845	1545	1222	1000 x 500 x 500	2500 x 850	900 x 600 x 900	900 x 600 x 900	4400	4200	4000	1800 x 2100 x 75
88	110	2515	845	1545	1222	1000 x 500 x 500	2500 x 850	900 x 600 x 900	900 x 600 x 900	4400	4200	4000	1800 x 2100 x 75
108	135	2700	900	1545	1417	1000 x 500 x 600	2500 x 850	900 x 600 x 900	900 x 600 x 900	4400	4200	4000	1800 x 2100 x 75
120	150	2700	900	1545	1417	1000 x 500 x 600	2500 x 850	900 x 600 x 900	900 x 600 x 900	4400	4200	4000	1800 x 2100 x 75
128	160	2953	990	1717	2001	1000 x 600 x 600	3600 x 1500 x 510	900 x 600 x 900	900 x 600 x 900	5600	5000	4000	1800 x 2100 x 75
140	175	2953	990	1717	2001	1000 x 600 x 600	3600 x 1500 x 510	900 x 600 x 900	900 x 600 x 900	5600	5000	4000	1800 x 2100 x 75
144	180	2953	1020	1717	2001	1000 x 600 x 600	3600 x 1700 x 510	900 x 600 x 900	900 x 600 x 900	5600	5200	4000	1800 x 2100 x 75
160	200	2967	1020	1717	2043	1000 x 600 x 600	3600 x 1700 x 510	900 x 900 x 1200	900 x 900 x 1200	6200	5200	4000	1800 x 2100 x 75
176	220	2967	1020	1717	2043	1000 x 600 x 600	3600 x 1700 x 510	900 x 900 x 1200	900 x 900 x 1200	6200	5200	4000	1800 x 2100 x 75
184	230	2967	1020	1717	2107	1000 x 600 x 600	3600 x 1700 x 510	900 x 900 x 1200	900 x 900 x 1200	6200	5200	4000	1800 x 2100 x 75
200	250	2967	1020	1717	2107	1000 x 600 x 600	3600 x 1700 x 510	900 x 900 x 1200	900 x 900 x 1200	6200	5200	4000	1800 x 2100 x 75
220	275	3077	1020	1717	2150	1000 x 600 x 600	3600 x 1700 x 510	975 x 900 x 1200	900 x 900 x 1200	6200	5200	4000	1800 x 2100 x 75
240	300	3500	1219	1813	3090	1000 x 800 x 600	4000 x 1800 x 510	1500 x 1200 x 1200	1300 x 1300 x 1200	6600	5200	4000	1800 x 2100 x 75
280	350	3500	1219	1813	3180	1000 x 800 x 600	4000 x 1800 x 510	1500 x 1200 x 1200	1300 x 1300 x 1200	6600	5200	4000	1800 x 2100 x 75
300	375	3500	1219	1662	2350	1000 x 1000 x 1000	4000 x 1800 x 510	1500 x 1200 x 1200	1300 x 1300 x 1200	6600	5200	4000	1800 x 2100 x 75
320	400	3560	1430	2000	2350	1000 x 1000 x 1000	4200 x 1900 x 510	1500 x 1200 x 1200	1300 x 1300 x 1200	6800	5300	4500	1800 x 2100 x 75
360	450	3560	1430	2000	2530	1200 x 1000 x 1000	4200 x 1900 x 510			6800	5300	4500	1800 x 2100 x 75
400	500	3585	1520	2108	4738	1200 x 1000 x 1000	4200 x 1900 x 510	1950 x 1200 x 1500	1300 x 1300 x 1500	7200	5300	4500	1800 x 2100 x 75
440	550	3689	1520	2108	5100	1200 x 1000 x 1000	4200 x 1900 x 510	1950 x 1200 x 1500	1300 x 1300 x 1500	7200	5300	4500	1800 x 2100 x 75
520	650	4200	1800	2108	5200	1200 x 1000 x 1000	4600 x 2100 x 510	1950 x 1200 x 1500	1625 x 1625 x 1500	7600	5500	4500	1800 x 2100 x 75
600	750	4485	1800	2500	5700	1200 x 1200 x 1000	4800 x 2100 x 510	2275 x 1500 x 1500	1950 x 1950 x 1500	7800	5500	4500	1800 x 2100 x 75



680	850	4800	2000	2550	7000	1200 x 1200 x 1000	5000 x 2400 x 510			8300	5800	4500	1800 x 2100 x 75
728	910	4800	2100	2550	7500	1200 x 1200 x 1000	5000 x 2500 x 510			8300	5900	4500	1800 x 2100 x 75
800	1000	4800	2100	2800	9700	1200 x 1200 x 1200	5000 x 2500 x 510	3250 x 1500 x 1500	2100 x 2100 x 1800	8300	5900	5000	2400 x 2400 x 75
1000	1250	5306	2100	2800	10670	1500 x 1500 x 1200	5400 x 2500 x 510	3900 x 1500 x 1500	2400 x 2400 x 1800	8800	5900	5000	2400 x 2400 x 75
1080	1350	5306	2100	2800	10000	1500 x 1500 x 1200	5400 x 2500 x 510	3900 x 1500 x 1500	2400 x 2400 x 1800	8800	5900	5000	2400 x 2400 x 75
1200	1500	5500	2222	2800	11450	1500 x 1500 x 1200	5500 x 2600 x 510	3900 x 1500 x 1500	2400 x 2400 x 1800	9000	6000	5000	2400 x 2400 x 75
1400	1750	6500	2530	2920	14000	1500 x 1500 x 1500	5970 x 2700 x 510			10000	6200	5000	2400 x 2400 x 75
1460	1825	6500	2530	2920	15000	1500 x 1500 x 1500	5970 x 2700 x 510			10000	6200	5000	2400 x 2400 x 75
1600	2000	6500	2530	2920	15000	1500 x 1500 x 1500	5970 x 2700 x 510	4500 x 1800 x 1800	3000 x 3000 x 2100	10000	6200	5000	2400 x 2400 x 75
1800	2250	6500	2530	2920	15000	2000 x 1500 x 1200	5970 x 2700 x 510	4500 x 1800 x 2100	3000 x 3000 x 2100	10000	6200	5000	2400 x 2400 x 75

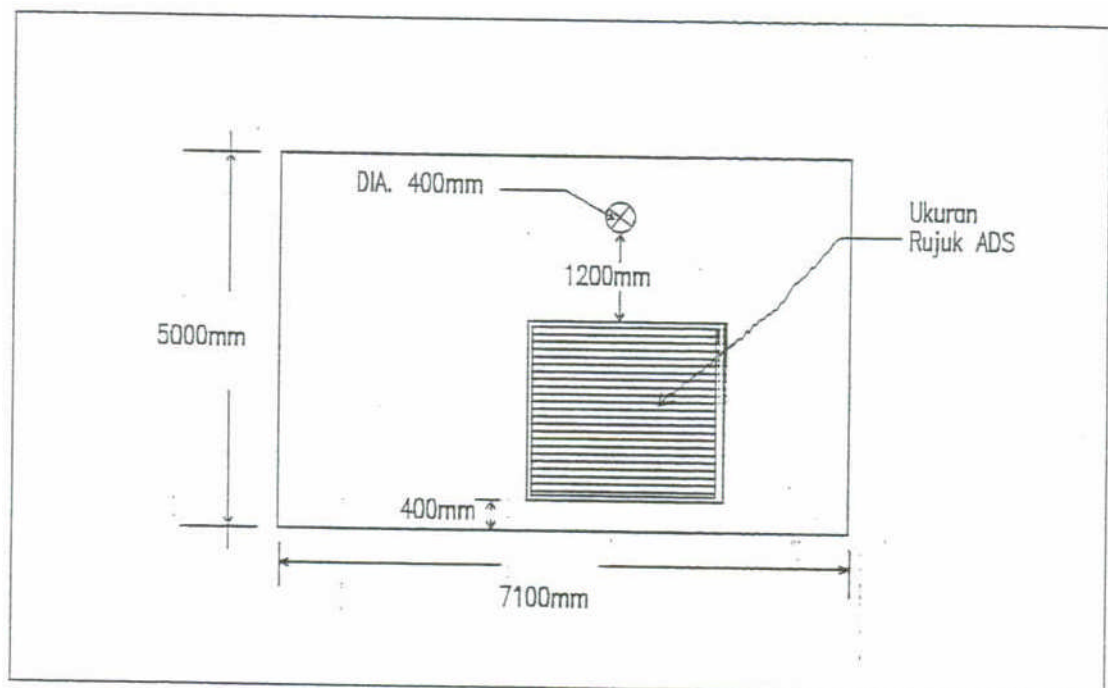
- Notes:
1. Data reference from Perkins and Caterpillar Engine Model
 2. AIS - Air Intake Silencer, ADS - Air Discharge Silencer
 3. L-Length, W-Width, H-Height, T-Thickness

- a) Susunatur tipikal Pandangan Tepi bagi janakuasa tunggu sedia.

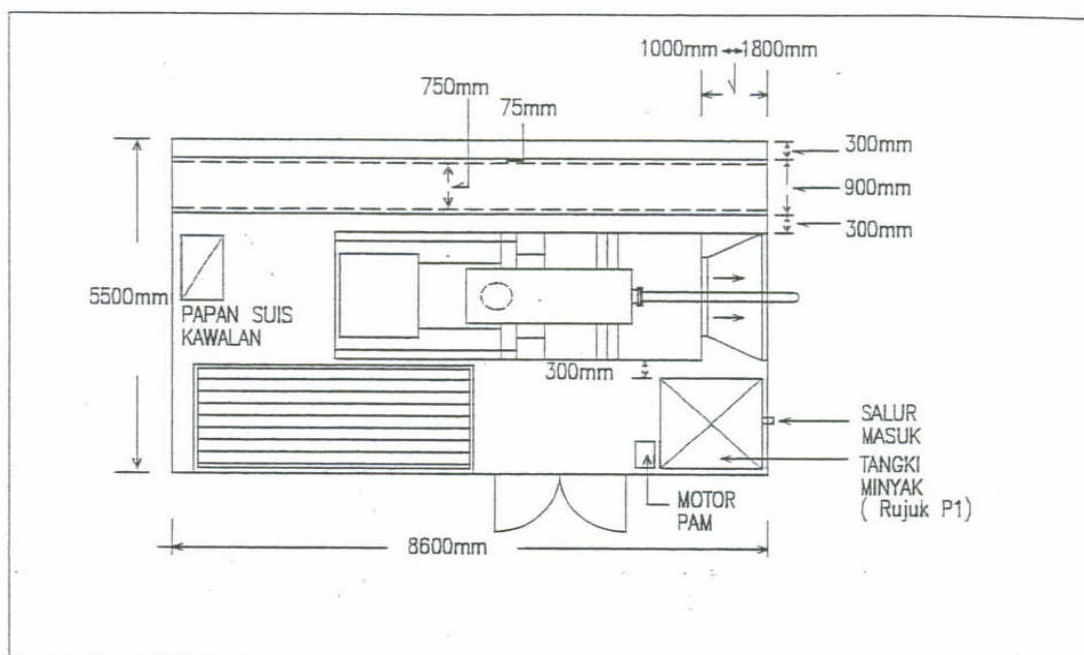


Nota: Dimensi adalah berdasarkan Janakuasa 1250kVA

- b) Susunatur tipikal Pandangan Belakang bagi janakuasa tunggu sedia.



c) Rajah Susunatur Alternatif untuk janakuasa tunggu sedia



Nota: Dimensi adalah berdasarkan Janakuasa 1250kVA

2.0 Uninterruptible Power Supply

Uninterruptible power supply equipment (UPS) shall be installed to provide emergency power supply to critical services. The UPS shall be of rotary/ dynamic type or static type:

- a) For the rotary/dynamic type UPS system with flywheel energy storage/kinetic machine energy storage module shall be of sufficient capacity for the present loads and with 20% spare capacity future extension.
- b) For the static type UPS system shall be complete with static bypass switch, minimum 12 pulse rectifier/charger, maintenance bypass switch, harmonic reduction facilities such as input harmonic filter trap, input transformer/choke etc. so as to reduce the harmonics generated in both the input circuit and output circuit.

The UPS equipment shall be completed with all necessary control, indication and alarm facilities, both local and remote. The status of the UPS equipment shall be continuously monitored by the plant monitoring system.

The static type UPS, including the battery, shall be of sufficient capacity for the present loads and with 20% spare capacity future extension. The battery capacity shall be **not less than 15 minutes** at the capacity of the UPS, including future extension. The battery shall be vented nickel cadmium type installed in a separate room adjacent to the UPS equipment.

The UPS shall be of the combination system whereby the UPS generator shall be in parallel with the standby generator set. The UPS rooms shall be 24 hours air-conditioned and the battery rooms shall be well ventilated.

In some cases of UPS installation, Isolation Transformer may be required to be installed for a purpose of avoiding high 'floating voltage' and relay tripping during changeover period.