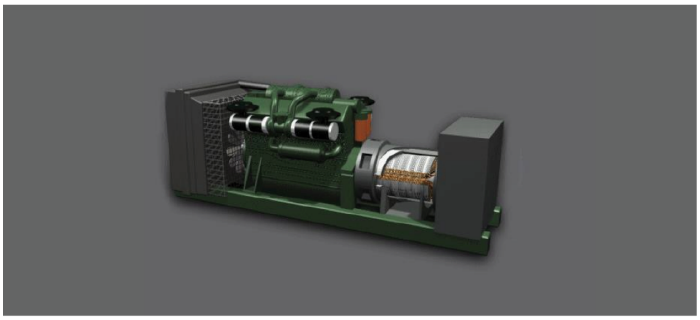
GENERATOR SELECTION AND SYNCHRONISATION

DEFINITION AND CLASSIFICATION OF GENERATOR; WHAT IS A GENERATOR?

In a few words, a generator is an electromechanical device that converts mechanical energy to electrical energy.



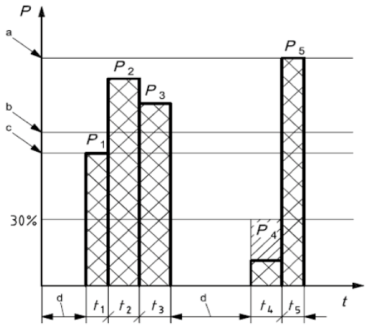
Classification of Generators

By their areas of use
Primary Energy Resource (Island Mode), Auxiliary Energy Resource

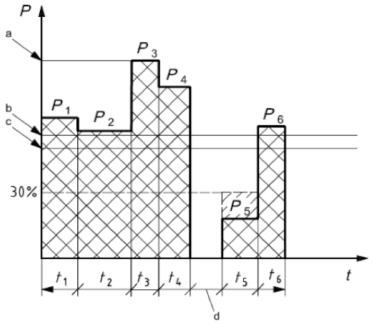
By their operating mode
ESP (Emergency Standby Power), PRP (Prime Power), COP (Continuous Power)

By their fuels
Fossil Fuel (Diesel, Gasoline, Natural Gas, Biogas)
Oil/ LPG Natural Gas / Biogas
Dual fuel (e.g. Diesel-Gas)

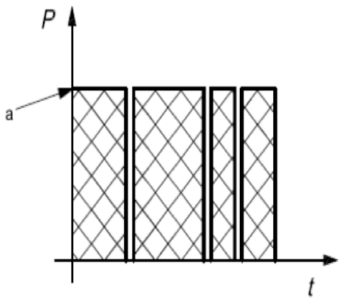
Classification by operating mode
ESP – Emergency Standby Power
- *It is capable of operating for 200 hours for a year. T=200h*
- *The load must be varying.*
- *The average load factor must be c=70%. Overloading isn't allowed.*



Classification by operating mode
PRP – Prime power
- *It is capable of operating for an unlimited-hour usage for a year.*
- *T = Unlimited.*
- *The load must be varying.*
- *The average load factor must be c=70%.*



Classification by operating mode
COP – Continuous Power
- *It is capable of operating for an unlimited-hour usage for a year.*
- *T = Unlimited.*
- *The average load factor may be a=100%.*
- *Overloading isn't allowed.*
- *Ts time indicates the shutdown period for maintenance.*



The Criteria for Selection of Generators
- *The voltage, frequency and phase number of generator,*
- *The geographical and physical conditions under which generator will be used.*
- *The permitted step voltage and frequency decrease*
- *Load characteristics*
- *The control modes of generators according to their areas of use*

Altitude and Temperature Factor

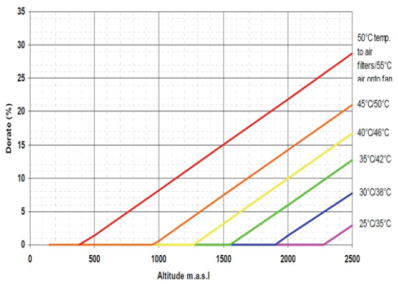


Table-1 A sample table for power decrease of a diesel motor

Ortam Sıcaklığı (°C)	30	35	40	45	50	55	
K1 Faktörü	1,04	1	1	0,96	0,93	0,9	
Güç Faktörü (Cos ϕ)	1	0,8	0,7	0,6	0,5	0,3	0
K2 Faktör	1	1	0,93	0,88	0,84	0,82	0,8
Yükseklik (m)	< 1000	< 1500	< 2000	< 2500	< 3000		
K3 Faktör	1	0,96	0,93	0,9	0,86		
∑K=K1xK2xK3							

Table-2 A sample table for power decrease of an alternator

SYNCHRONISATION

What is synchronisation?

Synchronisations means two or more electrical resources are in the same time slot, the same voltage amplitude, the same frequency rating and the same phases, and also the difference between their phase angles is 0°

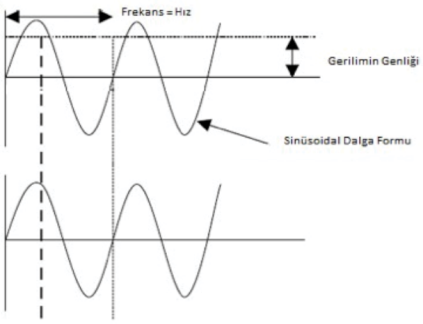
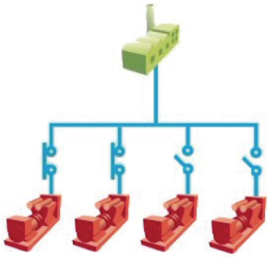


Table 3 Synchronisation

TYPES OF SYNCHRONISATION

Generator –Generator Synchronisation

Two or more generator sets feed the loads synchronously and continuously and these loads are shared in proportion to the power of generator sets. The generator sets are activated and deactivated according to the load level of operation so as to allow for economic use.



Generator– Mains Synchronisation

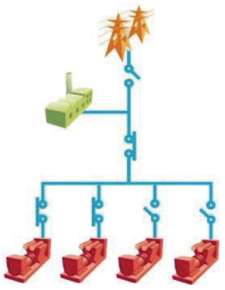
- **Smooth transition**

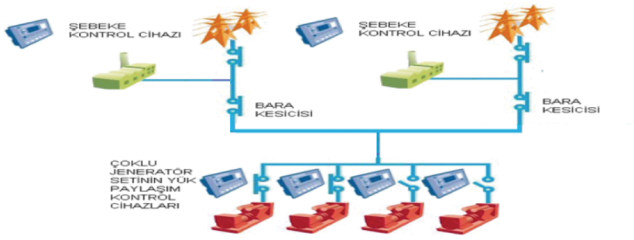
As it is known, when the mains power is cut, the emergency generators feed the load thanks to the transfer system established between the mains and generator. When the mains power is energised again, the operation has a power-cut again and takes the system to the mains position. In black start applications of hospitals, production facilities and power plants where it is not wanted to see a power cut twice, the generator group or groups prevent the system from being de-energized by being synchronous with the mains.

Generator– Mains Synchronisation

- *Peak lopping synchronisation*

The peak lopping synchronisation means operation of the mains and the generator by the defined energy amount in parallel.





The Advantages of Generator Synchronisation

- *The cost of the first set-up is low. That is because the area where the internal-combustion motors with high power will be used is limited and their production quantity is restricted. Since the diesel motors with a power up to 600kW are used in the applications such as heavy machines, cranes, generators and fire pumps, they are produced in mass production line. Therefore, since their production costs are low, the generator prices are cheaper than those of the generators with high power.*
- *Synchronisation provides fuel saving by power optimization. In case of no need for power, it takes the unnecessary generators out of the load and hence provides effective use of generators.*
- *Synchronisation keeps the mechanical life of generator groups the same according to the operating hours and hence ensures longer and more efficient energy consumption.*
- *When there is a single generator group, the whole enterprise is de-energized in case of failure of this group. However, in case of failure of either of generator groups, the synchronisation system may restrict the loads and feed the system partially. Thus, it is ensured that the generator groups are backed up partially.*

Unit kVA Cost Table

As it is seen in Table 4, the optimum installation cost (in kVA) of the power produced by generator is in the range of 200 and 715kVA.

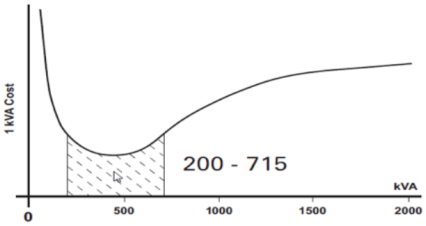


Table 4 Unit kVA- cost table

The Disadvantages of Generator Synchronisation

- *Due to the standards related to placement, more space is needed for the placement of generators in the synchronisation systems.*
- *Considering the maintenance materials used and workmanship, the conjugate of annual costs of synchronous systems is more than that of a single generator by 1.2 times.*
- *A more complex electrical panel and power distribution is needed.*
- *When the primary electrical resource is cut, the activation time may be longer by 20-50% depending on the synchronisation system.*

REFERENCES

- *TS ISO 8528-1 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 1: Application, ratings and performance
- *TS ISO 8528-2 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 2: Engines
- *TS ISO 8528-3 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 3: Alternating current generators for generating sets
- *TS ISO 8528-4 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 4: Controlgear and switchgear
- *TS ISO 8528-6 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 6: Test methods
- *TS ISO 8528-7 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 7: Technical declarations for specification and design
- *TS ISO 8528-8 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 8: Requirements and tests for low-power generating sets
- *TS ISO 8528-9 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 9: Measurement and evaluation of mechanical vibration
- *TS ISO 8528-10 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 10: Measurement of airborne noise by the enveloping surface method
- *TS ISO 8528-12 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 12: Emergency power supply to safety services
- *TS ISO 8528-9/T1 Reciprocating internal combustion engine driven alternating current generating sets*
  Part 9: Measurement and evaluation of mechanical vibration
- *ISO 3046 (International Standardization Organization) Internal Combustion Motors.*
- *The nominal power of diesel motor (according to ISO 3046-1) is defined in accordance with the following conditions:*
  - Total barometric pressure, pr: 100 kPa (1000 mbar)
  - Air temperature, Tr: 298 K (25°C)
  - Relative humidity, r: 30%
  - Temperature of cooling air (ambient temperature), Tcr: 298 K (25°C)
- *The nominal power of alternator (according to IEC 60034-1 and ISO 8528-3) is defined in accordance with the following conditions:*
  - Temperature of cooling air: below 313 K (40°C)
  - Temperature of cooler at the inlet of cooling gear: below 298 K (25°C)
  - Altitude level: above the sea level up to 1000m
- *The rated power of controlgear and switchgear (according to IEC60298, IEC60439-1 and IEC 60439-2) is defined in accordance with the following conditions:*
  - Ambient temperature: varying, maximum: 313 K (40°C)
  - Relative humidity: 50% in 313 K (40°C)
  - Altitude level: above the sea level up to 2000m