Chapter 1

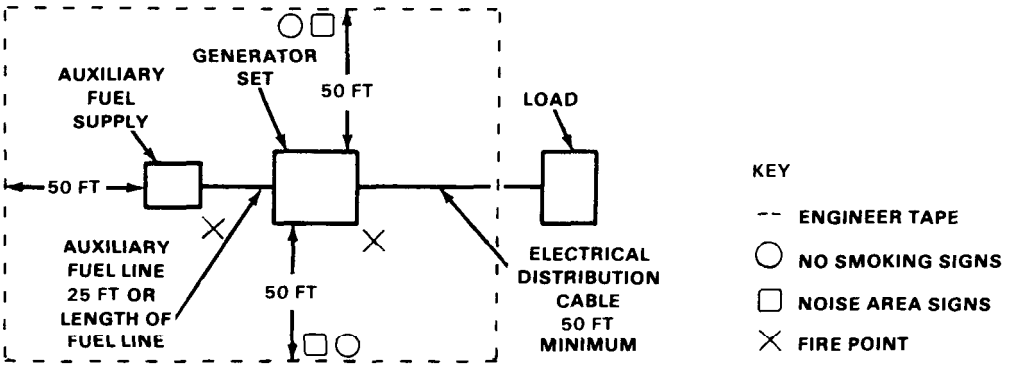
Electric Power Generation and Distribution Systems

The DOD uses a family of generator sets to produce the electric power needed by military field units. The family was developed in the 1960s to reduce the variety of generator sets and repair parts required by all services. Field Manual. 20–31 describes the generators in this family and provides instructions for their use.

The demands for electricity in military field operations are numerous and varied. Electricity powers equipment ranging from rock crushers to missile launchers. It services aircraft, ships, and land vehicles. Electricity is required for command and control operations, medical support, and other facilities. The mobile generator sets used by DOD to meet these demands are described in this chapter.

MOBILE GENERATOR SETS

A mobile electric generator set converts mechanical energy to electrical energy by using an engine to drive the generator. An internal fuel supply makes the set independent and mobile. When equipped with accessories such as an electrical distribution system, these sets can produce all the power needed by military forces in the field. The elements of an electric power generating site in the field are shown below.



TYPICAL ELECTRIC POWER GENERATING SITE

The generator models in the DOD inventory and their characteristics are listed in the table below. The kilowatts of power each model produces, their frequency rating (in cycles per second), and voltage (output) also are listed. The rated current of DC generators is shown in the output column. The characteristics in the table must match the requirements of the equipment to which the generator set is connected.

GENERATOR SET CHARACTERISTICS

MODEL	KILOWATT	FREQUENCY	OUTPUT
MEP-014A	0.5	60	120/240 volts (v), single-phase, three-wire
MEP-024A	0.5	DC	28v, 17 amperes (amps)
MEP-019A	0.5	400	120/240v, single-phase, three-wire
MEP-015A	1.5	60	120/240v, single-phase, three-wire
MEP-025A	1.5	DC	28v, 53 amps
MEP-016A	3	60	120v, three-phase 120/240v or 120/208v, three-phase, four-wire
MEP-021A	3	400	120v, three-phase 120/240v or 120/208v, three-phase, four-wire
MEP-026A	3	DC	28v, 103 amps
MEP-002A	5	60	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-017A	5	60	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-022A	5	400	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-018A	10	60	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-023A	10	400	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-003A	5	60	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-112A	10	400	120v, three-phase, three-wire 120/240v or 120/208v, three-phase, four-wire
MEP-004A	15	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-103A	15	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-113A	15	400	120/208v or 240/416v, three-phase, four-wire
MEP-005A	30	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-104A	30	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-114A	30	400	120/208v or 240/416v, three-phase, four-wire
MEP-006A	60	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-105A	60	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-115A	60	400	120/208v or 240/416v, three-phase, four-wire

GENERATOR SET CHARACTERISTICS (CONTINUED)			
MODEL	KILOWATT	FREQUENCY	OUTPUT
MEP-404B	60	400	120/208v or 240/416v, three-phase, four-wire
MEP-007A	100	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-007B	100	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-106A	100	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-116A	100	400	120/208v or 240/416v, three-phase, four-wire
MEP-009A	200	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-108A	200	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-029A	500	50/60	120/208v or 240/416v, three-phase, four-wire
MEP-029AHK	500	50/60	120/240v or 120/208v, three-phase, four-wire

The table below shows the generator models separated by the type of engine that drives the generator. This table-lists the application (use) for each model and the technical manual (TM) that provides additional information about it.

MOBILE ELECTRIC GENERATOR SETS				
MODEL	KILOWATT	APPLICATION	VOLTAGE	TECHNICAL MANUAL
GASOLINE ENGINE DRIVEN				
MEP-014A	0.5	Utility	AC	TM 5-6115-329-14
MEP-019A	0.5	Utility	AC	TM 5-6115-329-14
MEP-024A	0.5	Utility	DC	TM 5-6115-329-14
MEP-015A	1.5	Utility	AC	TM 5-6115-323-14
MEP-025A	1.5	Utility	DC	TM 5-6115-323-14
MEP-016A	3	Utility	AC	TM 5-6115-271-14
MEP-021A	3	Utility	AC	TM 5-6115-271-14
MEP-026A	3	Utility	DC	TM 5-6115-271-14
MEP-017A	5	Utility	AC	TM 5-6115-332-14
MEP-022A	5	Utility	AC	TM 5-6115-332-14
MEP-018A	10	Utility	AC	TM 5-6115-275-14
MEP-023A	10	Utility	AC	TM 5-6115-275-14
DIESEL ENGINE DRIVEN				
MEP-002A	5	Utility	AC	TM 5-6115-584-12
MEP-003A	10	Utility	AC	TM 5-6115-585-12
MEP-112A	10	Utility	AC	TM 5-6115-585-12
MEP-004A	15	Utility	AC	TM 5-6115-464-12
MEP-103A	15	Precise	AC	TM 5-6115-464-12
MEP-113A	15	Precise	AC	TM 5-6115-464-12
MEP-005A	30	Utility	AC	TM 5-6115-465-12
MEP-104A	30	Precise	AC	TM 5-6115-465-12
MEP-114A	30	Precise	AC	TM 5-6115-465-12
MEP-006A	60	Utility	AC	TM 5-6115-545-12
MEP-105A	60	Precise	AC	TM 5-6115-545-12
MEP-115A	60	Precise	AC	TM 5-6115-545-12

MOBILE ELECTRIC GENERATOR SETS (CONTINUED)				
MODEL	KILOWATT	APPLICATION	VOLTAGE	TECHNICAL MANUAL
DIESEL ENGINE DRIVEN				
MEP-007A	100	Utility	AC	TM 5-6115-457-12
MEP-007B	100	Precise	AC	TM 5-6115-457-12
MEP-106A	100	Precise	AC	TM 5-6115-457-12
MEP 116A	100	Precise	AC	TM 5-6115-457-12
MEP-009A	200	Utility	AC	TM 5-6115-458-12
MEP 108A	200	Precise	AC	TM 5-6115 458-12
MEP 029A	500	Utility	AC	TM 5-6115 593-12
MEP 029AHK	500	(with options)	AC	TM 5 6115 593-12
TURBINE ENGINE DRIVEN				
MEP 404B	60	Precise	AC	TM 5-6115 603-12

Electric generator sets are driven by gasoline, diesel, or gas turbine engines. The generators produce either alternating current (AC) or direct current (DC). Alternating current changes in value and reverses its direction of flow at regular intervals. Direct current is constant in value and flows only in one direction.

AC Generator Sets

The lighting and power loads of most field units require voltages and frequencies supplied by AC systems. While 60-cycle AC is used much of the time, loads with specific voltage, frequency, and power requirements must use 400–cycle AC. Radar, fire control sets, communication controls, and guided–missile systems are examples of equipment requiring 400-cycle AC. Some equipment can operate with either 60-cycle or 400–cycle AC.

Small AC generator sets are driven by gasoline engines and. produce from 0.5 kw to 1.5 kw of electricity. The output is delivered in 120 volts or 240 volts, with a single-phase distribution system, and at a frequency of 60 cycles. Sets that produce 0.5 kw are available at a frequency of 400 cycles, and those that produce 1.5 kw are available at a frequency of 60 cycles.

The 1.5-kw, 60-cycle generators are the most versatile and widely used small sets in the DOD inventory. They satisfy the communications and lighting needs of small field units.

Medium–sized AC generator sets are driven by gasoline or diesel engines and produce between 3 kw and 10 kw of electricity. These generator sets can deliver 60– or 400–cycle AC. A reconnection switch enables the operator to connect any of the following distribution systems at the rated kilowatt output:

- Single-phase, two–wire, 120 volts.
- Single–phase, two–wire, 240 volts.
- Three-phase, three-wire, 120 volts.
- Three-phase, four-wire, 120/208 volts.

Generator sets that produce 60–cycle AC are used for general power requirements because they are versatile and have a range of power outputs. Sets that produce 10 kw at 60 cycles are the most versatile because their outputs are adequate for small maintenance shops and other relatively large loads. These generators usually are mounted on skids to increase their mobility.

Large AC generators are driven by diesel engines and produce 15, 30, 60, 100, 200, or 500 kw of electricity. These generators can deliver 50/60- or 400-cycle AC. They can deliver three-phase, four-wire power at either 120/208 volts or 240/416 volts. An output delivered at 50 cycles Is 82 percent of the rated power. An output delivered at 60 cycles is 100 percent of the rated power.

Large generator sets produce electricity for lighting and power in buildings and other general loads. They can produce enough output to supply several kinds of loads simultaneously over a relatively wide area.

Standard frequency generator sets are rated at 50/60 cycles. High-frequency generator sets are rated at 400 cycles. The most common gas turbine engine–driven generator set produces 60 kw of electricity at 400-cycle AC.

The AC generator sets are designed to operate at various voltages, frequencies, and power levels. To meet a particular power demand, an operator must choose a set with the proper characteristics. If a large set is needed but is not available, several small sets, each located near the load to be supplied, may be used. Note that additional operators and maintenance personnel may be required if several small sets replace a large one.

Mobility is a factor in selecting generator sets for field use. Sets that produce 60 kw of electricity often are used in the field because they can be transported in 2 l/2-ton trucks. Sets that produce more than 60 kw of power must be transported in 5-ton trucks. Therefore, a field unit may make parallel connections between several 60–kw generator sets to produce an amount of power equivalent to one large set.

DC Generator Sets

The DC generator sets provide power for specific pieces of equipment. For example, DC generators are used to charge batteries, operate

communications equipment, and provide power to some missile equipment. Thus, the need for DC generator sets in the field Is less than the need for AC sets. The three DC sets listed in the tables on pages 2 and 3 are basic AC generators that use rectifiers to convert the AC voltage to DC voltage.

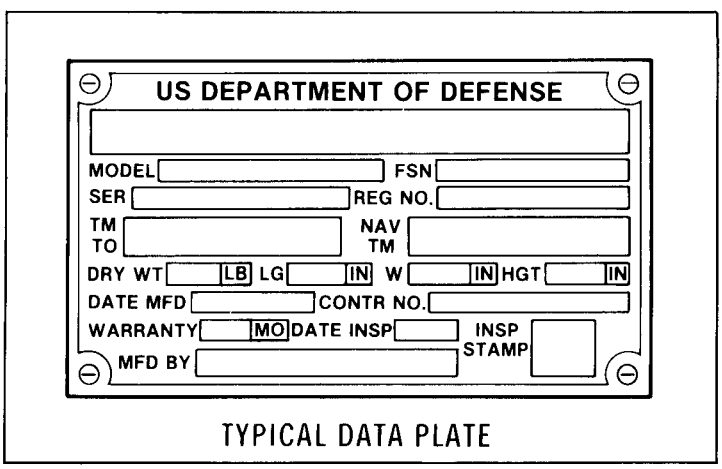
Data Plates

Three data plates provide information about the output from a generator set. These plates indicate all pertinent information about a generator set's capabilities and performance characteristics. Refer to the description and data section in the appropriate technical manual for information about a specific generator that is not on the plates.

Alternator data plate. Specifies the alternator ratings for 50-, 60-, and 400–cycle outputs. The plate also provides serial numbers, kilowatt ratings, DC excitation requirements, date of manufacture, voltage and ampere outputs, power factors, model numbers, and revolutions per minute (RPM). On most models the plate is attached to the main generator housing.

Engine identification plate. Specifies the engine model number, serial number, horsepower rating, date of manufacture, number and firing order of the cylinders, national stock number, and contract number. Sometimes the applicable technical manual number is shown. This plate usually is attached to the engine.

Starting and stopping instruction plate. Sometimes called the paralleling and synchronizing instruction plate, this plate specifies starting and stopping and/or paralleling and synchronizing procedures. Preliminary positioning of controls and procedures for using the dark lamp method of synchronizing and paralleling generators also may be shown. This plate is inside the main control panel cover.



TYPICAL DATA PLATE

ELECTRIC DISTRIBUTION SYSTEMS

A distribution system transfers electricity from its source in the generator to loads such as heaters, motors, or lights. A distribution system is identified by the number of phases, the number of wires, and the voltages between wires. Operators must check the data plates on the equipment before connecting a distribution system to the load. Any attempt to operate equipment at other than its rated frequency will damage it. The following distribution systems are used by military field units:

- Single-phase, two-wire.
- Single-phase, three-wire.
- Three-phase, three–wire.
- Three-phase, four–wire.

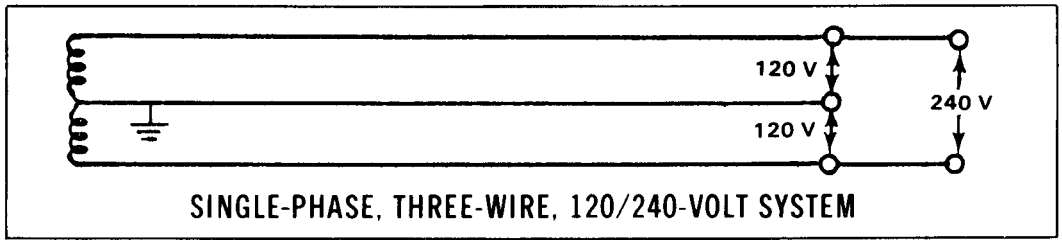
Single-Phase, Two-Wire

In a single-phase, two-wire distribution system, one of the two wires from the generator set is connected to the ground (neutral wire). The neutral wire is called the grounded wire or the grounded circuit conductor.

The second wire, called the live wire or ungrounded conductor, is connected to the load. Usually there is a difference of 120 volts between these two wires. Any single-phase, two–wire, 120-volt load can be connected to both the live wire and the grounded wire.

Single-Phase, Three-Wire

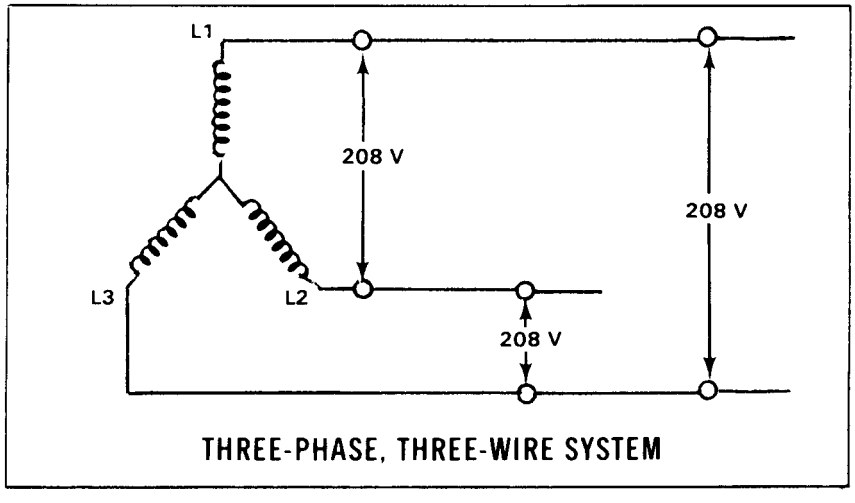
A single-phase, three–wire distribution system has one grounded wire and two live wires (figure at the top of page 8). It is called a single-phase system because there is no phase difference between the two available voltages. The difference in voltage between either of the two live wires and the grounded wire usually is 120 volts. The difference in voltage between the two live wires is 240 volts.



SINGLE-PHASE, THREE-WIRE, 120/240-VOLT SYSTEM

Three-Phase, Three-Wire

All three wires in a three-phase, three–wire system are live wires. Thus, a three-phase, three–wire, 120-volt load can be connected to all three wires. This system requires a generator set designed to produce three-phase voltage. Because only one magnitude of voltage is available from this kind of generator, the loads must require the same voltage.

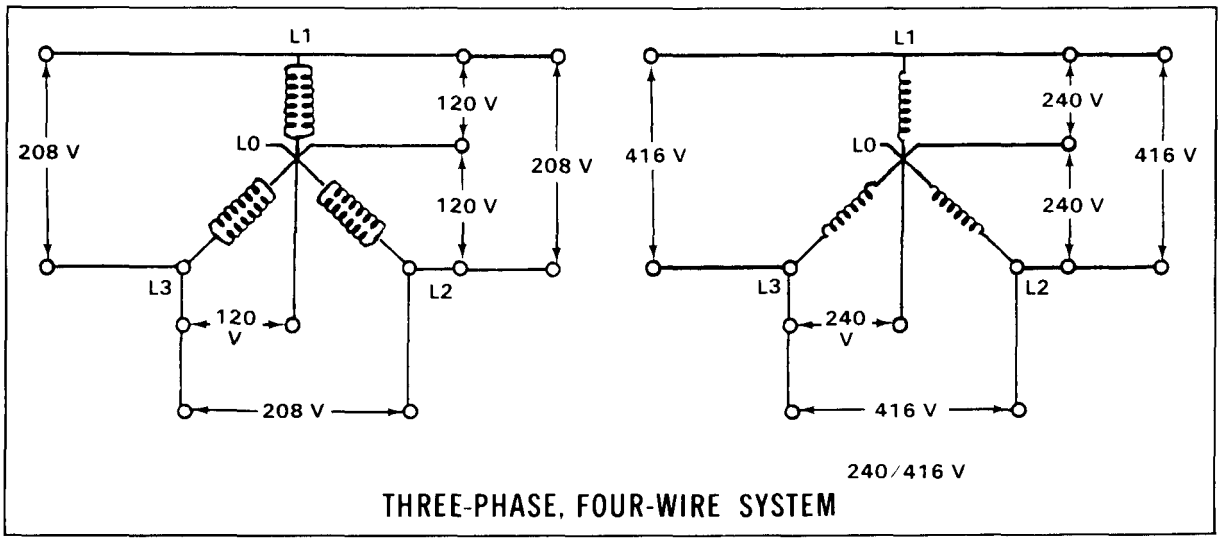


THREE-PHASE, THREE-WIRE SYSTEM

Three–Phase, Four-Wire

A three-phase, four-wire system is shown in the figure on page 9. A generator set with this system may be designed to produce single-phase or three-phase voltages. For example, the generator could produce 120 volts and 208 volts, or 240 volts and 416 volts. A 240/416 voltage connection is common on generator sets that produce from 15 kw through 500 kw of electricity.

Generator sets with three–wire or four–wire systems are designed so that the ratio of the higher (line) voltage to the lower phase (voltage) is always the same and cannot be changed (1.73 x phase voltage = line



THREE-PHASE, FOUR-WIRE SYSTEM

voltage). Thus, any single-phase, two-wire, 120-volt load can be fed power by making a connection between any live wire and the grounded wire. Any single–phase, two-wire, 208–volt load can be fed between any two live wires. A single-phase, three-wire, 120/208–volt load can be fed by making a connection to two live wires and the grounded wire. Any three-phase, four–wire, 120/208-volt load can be fed power by making a connection to all four wires. Any three–phase, three–wire, 240-volt load can be fed by repositioning the tap change board and the connection to the three live wires.

Distribution systems are classified according to the voltage used to carry the power from the power source to the distribution transformers or to the loads. The following distribution systems commonly are used in military field units:

- Single-phase, two-wire, 120–volt system. Supplies electricity for light bulbs, portable tools, and most equipment requiring low power.
- Single-phase, three-wire, 120/240–volt system. Supplies power directly to small loads such as lighting in barracks.
- Three-phase, four-wire, 120/208-volt system. Supplies power to structures that require substantial amounts of power and lighting, such as shops and hospitals. This system is more flexible than either of the systems discussed previously.
- Three–phase, three–wire, 240/416-volt system. Supplies power to loads in structures in which the three-phase power load is larger than the single–phase lighting load. The single-phase lighting load in such a structure is supplied either from a separate single phase service to the structure or by a stepdown transformer.