CATERPILLAR®

ENGINE DATA SHEET

EDS 70.0.2
Date 10-90

Generator Characteristics — Terminology

The Technical Marketing Information (TMI) contains a great amount of data relating to Caterpillar Generators. Information is arranged by sales model of engine using the specific generator rating and arrangement number. This data sheet explains the data in the Technical Marketing Information and, where possible, its use by professional engineers or others who calculate performance or predict reactions to various loads.

Generator information includes:

- Efficiency
- Excitation
- Ratings
- Resistance
- Reactance
- Time Constants
- Regulation
- Short Circuit Ratio
- Winding Pitch
- Motor Starting Capability
- Temperature Rise
- Decrement Curves
- Heat Dissipation
- Component Weights
- Center of Gravity
- Temperature Rise
- Air Flow
- Insulation Class

AU Caterpillar Generators are identified by an arrangement number within the Caterpillar parts system. The part number identifies the machine by type and primary design voltage at a specified frequency (50 *Hz or* 60 Hz). Generators with 12 leads can be connected in delta configuration. Parts service items can be found in the appropriate engine parts book. Every generator has the original part number and the serial number stamped into the generator frame. The data plate also lists the generator part number and serial number. The serial number must be used when locating specific service parts in a parts book.

Hz (Frequency)

Data listed relates directly to the generator operating frequency. Parts books also list the generator frequency

Frame Number

This information is primarily a factory design control number. It has no relation to the frame numbering system of NEMA design electric motors. Larger frame numbers indicate a larger generator. The first two digits relate to the diameter of the generator stator. The last digit relates to the length of the stator iron core.

kW

The electrical rating of the generator. All data in the electrical and mechanical listing is identified as P *(prime power)* and S *(standby power)* and follow the various NEMA requirements.

At prime power, the generator itself is rated on a continuous (24 *hours per day)* duty basis. The rating is expressed in kilowatts at 0.8 power factor. The figures appearing in the data sheet are kW. A common ratio, kW divided by 0.8 permits calculation of kV•A on all Caterpillar Generators.

Rated Volts, Line Leads, Wires Per Lead

All SR 4 Generators have 4, 6, 10, or 12 line leads. These can be connected into a *low voltage Y* configuration *(coils parallel)* or into a *high voltage Y* configuration *(coils in series).* Generators with 12 leads can be connected in delta configuration. Larger generators use more than one wire per line lead. This feature eases the problem of forming very heavy conductors inside a limited space for terminal connections.

All leads are identified. If more than one wire is used per line lead, each of these wires is identified by a line lead number. Thus, on smaller generators, there would be only one wire marked T_1. However, on larger generators, there will be two or more wires marked T_1. These are to be connected together to form one lead. The first voltage listed is the line-to-line voltage at the specified frequency when the generator leads are connected for the low voltage. The second voltage listed is the line-to-line voltage at the specified frequency when the

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Supersedes LEHQ8061

reconnectable line leads are series connected for high voltage.

Line-to-neutral voltages for wye-connected generators can be calculated by dividing the listed voltage by √3 *(square root of 3 and equal to 1.732).* Example: Line-to-line voltages (listed voltages) are 240 or 480. Line-to-neutral voltages become 138.5 or 277. Generators have a voltage level adjustment at least equal to the listed percentage (±) of the listed voltages.

Voltage Regulation

Two figures are listed. One concerns the maximum steady-state voltage change that will occur if the engine speed change that will occur if the engine speed under load moves 3% from nominal speed. Assume the generator is correctly adjusted at 1854 rpm (61.8 Hz) and 1800 rpm (60 Hz). The generator voltage will not change more than 2% if the load changes move the speed between 1800 rpm and 1854 rpm.

The other figure concerns an engine with an isochronous *(speed recovery)* governor. In this instance, load changes do not result in permanent speed changes. The regulator will hold the generator voltage to ±1% of nominal voltage.

Rated Amperes

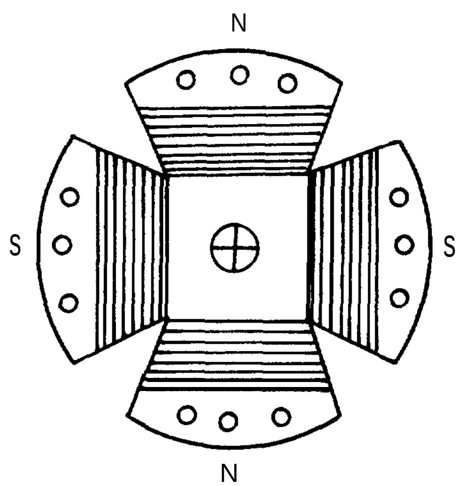
Two values are listed for all SR 4 Generators. The larger number describes the line ampere *(current)* rating when the generator is connected for the listed low voltage *(coils are parallel connected). The* smaller ampere figure describes the line ampere rating when the generator is connected for the listed high voltage. Line ampere ratings generally limit the kV•A rating of a generator. The product of the listed line amperes, the related line-to-line voltage, and 1.732 equals the kV•A. Exceeding the line ampere rating can reduce generator life because of excessive winding temperature. Heat input of the generator armature increases approximately with the square of the current. Doubling the current will result in about four times the heat input.

As a general rule, the listed line ampere rating should not be exceeded to gain the listed kV•A rating when the voltage level is reduced to its minimum adjustment. It is not necessary to reduce the line ampere load to keep within the kV•A limit when the voltage level is at maximum adjustment.

Generator set kilowatt rating will be exceeded before the line ampere rating is reached when supplying a resistive load *(power factor approximately equal to 1.0).* Line ammeters are the most important monitoring devices on the generator set.

Number of Poles/Synchronous Speed

All SR 4 Generators are four-or six-pole machines. *Pole* relates to the number of magnetic poles developed in the rotating field. Magnetic poles in a four-pole generator are arranged north-south-north-south around the circumference of the rotor. Magnetic poles in a six-pole generator are arranged north-south-north-south-north-south. The number of poles *(north-south-north-south)* and the desired frequency *(cycles per second or hertz)* determine the synchronous speed in revolutions per minute *(rpm):*



$$\text{rpm} = \frac{120 \times f}{\text{number of poles}}$$

If 50 Hz is desired from a four-pole generator, the generator must be driven at 1500 rpm. If a six-pole generator is driven at 1000 rpm:

$$1000 \text{ rpm} = \frac{120 \times f}{6} \quad f = 50$$

The generated frequency of a specific machine is entirely a function of the driven speed.

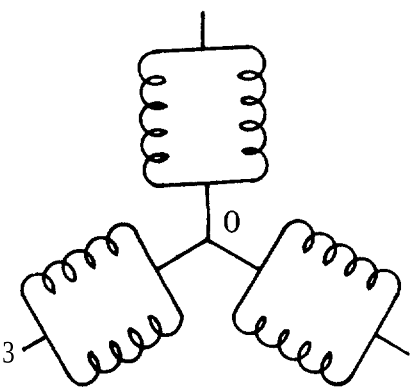
Overspeed Capability — Percent

All Caterpillar Generators have a 150% overspeed capability above 60 Hz synchronous speeds and a 180% overspeed capability above 50 Hz synchronous speeds. Overspeed protection controls on the engine are generally adjusted to function at a speed 18% to 20% above the generator synchronous speed; the engine overspeed safety shutdown device on a four-pole, 50 Hz generator set should be adjusted to function at 1770 rpm ±20 rpm.

Electronic overspeed controls have a built-in test feature that permits complete check of the system without overspeeding the engine and generator. Mechanical overspeed controls should be removed from the engine for testing. The units should be driven from a variable speed source. On-engine full -speed testing of mechanical overspeed units should be kept to a minimum. Mechanical contractors can be driven through a 1:2 speed increasing tachometer drive directly from the engine.

Stator Resistance

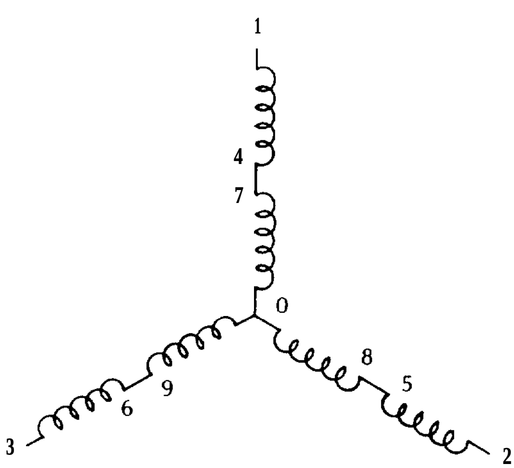
Figures quotes are coil resistance in Ohms with the stator temperature at 25°C. The following diagrams show the points at which the listed resistance value or a multiple of it applies:



- For resistance of 1-2, 2-3, or 3-1 *(line to line),* listed value applies.

  Note that the generator coils arc connected in parallel for low voltage.

  For resistance of 1-0, 2-0, or 3-0 *(line to neutral),* divide the listed figure by 2.



- If the generator coils are connected in series for high voltage:

  for resistance of 1-2, 2-3, 3-1 *(line-to-line),* multiply the listed figure by 4.

  For resistance of 1-4, 2-5, 3-6, 7-0, 8-0, 9-0 *(individual coil resistance),* use the listed figure.

  For resistance of 1-0, 2-0, and 3-0, multiply the listed value by 2.

Resistance measurements will be valid only if made with instruments capable of measuring very low resistance. Do not attempt to use an Ohmeter. The inaccuracy is too great to have any value.

The resistance values apply only at 25°C (77°F). Correction must be applied at other temperatures. For temperatures other than 25°C, multiply the listed value by 0.00393 and by the total temperature difference between 25°C and the existing temperature. Add the result to the listed value if the temperature is higher. Subtract the result if the temperature is lower.

Example: Stator resistance at 25°C is 0.0077 Ohms. At 75°C the resistance will increase by 50 x 0.00393 x 0.0077 = 0.0015. This value must be added to the listed value: 0.0077 + 0.0015 = 0.0082 Ohms at 75°C.

At 4°C the resistance will decrease by (25 - 4)x 0.00393 x 0.0077= 0.0006. This value must be subtracted from the listed value: 0.0077 = 0.0006= 0.0071 Ohms.

Internal temperature of generator coils can be found by a reverse process. The generator stator resistance must be accurately measured.

By comparison with the established 25°C resistance, the average winding temperature can be found: resistance was measured as 0.0108 Ohms. At 25°C this generator has a stator resistance of 0.0077 Ohms. The increase due to temperature is 0.0108- 0.0077 = 0.0031 Ohms. Then 0.0031 = (25+ T) x (0.0077 x 0.00393).

$$0.0031 = 0.00075653 + 0.00003026T$$

$$0.00325 = 0.00003026T$$

$$T = 77.6°$$

Insulation Resistance

This value is the minimum insulation resistance of the generator stator. It is measured according to NEMA procedure using two times the rated voltage plus 1000 volts. Insulation of the rotor is also within this minimum. The rotor resistance is measured at 1500 volts. Caution must be exercised in these measurements. All test circuits must be clear of any connections, including terminal boards or leads to control panels. High voltage testing is not recommended for periodic inspection as each application severely stresses insulation. Low voltage testing is permissible.

Transient Reactance

Note: This expression will be used to explain reactance values in general and to show some of the related arithmetic and uses of the five listed reactance values.

The term "transient reactance" is usually expressed by the symbol X'_d. It is one of the five reactance figures frequently used by engineers when comparing generator capability with load requirement, or when comparing one generator with another. ***Reactance figures are always used with the related kV•A rating (called Base KV•A), the refuted ampere rating (called Base Amperes), and the related voltage (called Base Voltage).*** The listed figures are "per unit" values *(abbreviated, P.U. or p.u.).* "Per unit" is a decimal fraction of some whole value. "Twenty percent" (20%) indicates part of some whole value but could also be written as 0.20. "Per unit" is a *pure number.* It has ***no*** label such as volts, amperes, or Ohms. Reactance are also expressed in percent (100% x *per unit.).*

The five listed reactance *per unit* values describe the *line-to-neutral* value at the kV•A and ampere condition (or volt condition) listed in the same price list reference number and rating. These line-to-neutral reactance per unit values can be directly converted to a line-to-neutral ohmic value by use Ohm's law and the per unit value: divide the *line-to-neutral* rated voltage by the rated line amperes. The result will be Ohms. Multiply the result by the per unit value. The result is Ohms reactance.

Example: Transient reactance = 0.2490 per unit. The base voltage is 480, base ampere is 263. Generator voltage listed is *line-to-line. This* must be converted to line-to-neutral voltage: 480 divided by the √3 equals 277 volts, which is the "base voltage".

$$\text{Transient Reactance, ohms} = \frac{277}{263} \times 0.2490 = 0.262 \text{ Ohms}$$

Most engineers prefer a presentation in the following order: line-to-line voltage, prime power kV•A, line amperes *(at the listed line-to-line voltage),* and the line-to-neutral reactance in the per unit value.

Various ratings on a specific generator do not change the reactance. However, the *per unit* value reactance *do* change directly with the rating. Example: Determine the *per unit* value of transient reactance of a generator at a 180 base kV•A at 480 volts. At 219 kV•A, 480 volts, the reactance is 0.2490 P.U. Per unit values change directly with the base kV•A.

$$\frac{180}{219} \times 0.2490 = 0.2046 \text{ per unit}$$

The reactance in ohms has not changed because at 180 kV•A, the line ampere rating would be 216 amperes. The calculation shows:

$$\frac{277 \text{ volts}}{216 \text{ amperes}} \times 0.2046 = 0.262 \text{ Ohms}$$

Per unit reactance changes inversely *(volts down, reactance up) with the* square of the voltage ratio if the kV•A rating remains the same. Example: At 480 volts the listed transient reactance is 0.2490. The *base voltage* is to be decreased from 480 volts to 416 volts. The kV•A is to remain the same. The *per unit* transient reactance at the lower voltage is:

$$(480/416)^2 \times 0.2490 = 0.3310 \text{ per unit}$$

The ohmic line-to-neutral transient reactance has not changed. Line-to-neutral voltage is now:

$$\frac{416}{\sqrt{3}} = 240 \text{ volts}$$

Since the kV•A rating is to remain at 219 kV•A, the line ampere rating is:

$$\frac{219 \text{ kV•A} \times 1000}{\sqrt{3} \times 416} = 303$$

Transient reactance in ohms is:

$$\frac{240 \text{ volts} \times 0.3310}{303 \text{ amperes}} = 0.262 \text{ Ohms}$$

Other terms relating to reactance:

Direct — All of the figures quoted in the TMI are "direct axis" reactance per unit values. Occasionally, engineers will ask for *quad axis* figures. Quadrature axis figures are supplied when appropriate.

Saturated — Where applicable, figures are calculated at magnetic saturation. Occasionally, engineers will ask for the *unsaturated* value of a reactance. Where applicable, this can be supplied upon specific request.

Transient reactance *(per unit)* figures are used to approximate the current at the time a circuit breaker opens under three-phase, short-circuit conditions. A circuit breaker will probably open at 7 cycles (0.13 *seconds at* 60 Hz), which is within the time transient reactance values apply *(about* 6 *cycles to 5 seconds),* The calculation requires two values — base amperes and the transient reactance. For a generator at 60 Hz, 480 volts, divide the base amperes by the transient reactance per unit value:

Example: Generator base amps = 263A
Transient reactance = 0.2490

$$\frac{263 \text{ amperes}}{0.2490} = 1056 \text{ amperes}$$

Transient reactance is also used by some engineers to determine the approximate voltage dip on a generator when starting large motors.

SR 4 Generators have transient reactance per unit values ranging from 0.16 to 0.45.

Subtransient Reactance

This term is usually expressed as X''_d and for SR *4* Generators has a per unit (P. U.) value of 0.1 to 0.3. Engineers frequently request the *percent subtransient reactance.* Per unit values are directly convertible to percent: 0.1 becomes 10%, 0.3 becomes 30%. Engineers also request the subtransient impedance. This implies the Ohmic line-to-neutral reactance since the stator resistance is less than 2% of the line-to-neutral impedance. Calculate the subtransient line-to-neutral reactance as:

$$\frac{\text{volts, line-neutral}}{\text{base amperes}} \times X''_d$$

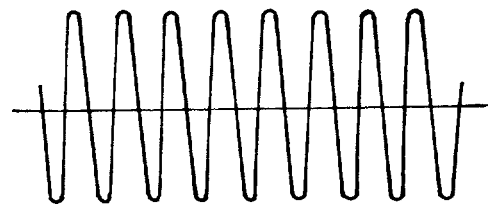
For a generator at 60 Hz, 219 kV•A, with X''_d = 0.120 and base amperes of 263:

$$\frac{480 \text{ Volts}}{\sqrt{3}} = 277 \text{ volts, line-neutral}$$

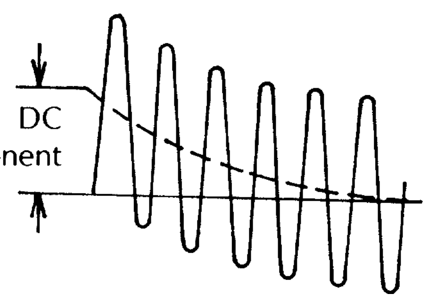
$$\frac{277}{263 \text{ Amperes}} \times 0.1201 = 0.1265 \text{ Ohm}$$

The subtransient reactance applies to a time period ranging from zero to five cycles. The per unit value is often used to determine the maximum current in event of a short circuit. The RMS* symmetrical current will be the rated amperes divided by the subtransient reactance per unit value. Under three-phase short circuit, this generator can produce:

$$\frac{263}{0.1201} = 2190 \text{ amperes RMS}$$



Asymmetrical refers to a current which is not centered, or symmetrical, to a fixed reference axis.



The point in time at which the short circuit occurs determines if the resultant current is initially symmetrical or asymmetrical or a combination of each. If the fault occurred the instant the voltage is crossing the zero line, the current will be asymmetrical. The resulting value is known as *maximum asymmetrical* current. If the fault occurred when the voltage is at a positive or negative peak, the resultant current will be symmetrical. A fault occurring at any point in time between zero crossing, and the positive or negative peak will produce a lesser value of asymmetrical current.

In time — within one to five cycles — the asymmetrical current declines to a very low value. From that time forward, the symmetrical current is the only significant current.

* *RMS means root mean square and is the value indicated by the more common electric measuring equipment — ammeters, voltmeters. Symmetrical refers to a current that remains centered about a fixed reference axis.*

The asymmetrical current is also known as the "DC *(direct current)* component".

The maximum asymmetrical short circuit RMS current can be found by multiplying the RMS symmetrical value by 1.732 (square root of 3). In the above example, the generator will produce 2190 x √ 3 = 3793 *RMS amperes, asymmetrical.*

Calculations involving circuit breakers normally require *peak* currents. Symmetrical and asymmetrical currents from an SR 4 Generator can be converted to *peak* values by multiplying either value by the square root of 2 (1.414). In the above example, the generator will produce:

2190 x √ 2 = 3096 peak symmetrical amperes

or

3793 x √2 = 5363 aeak asymmetrical amperes

Note that a smaller subtransient reactance per unit value results in higher *available* short-circuit current. Available short-circuit current is sometimes expressed as a multiplier (called available current ratio), which is the reciprocal of the per unit subtransient reactance. For this generator,

1 ÷ .1201 = 8.326.

Rated current times that multiplier equals RMS symmetrical current:

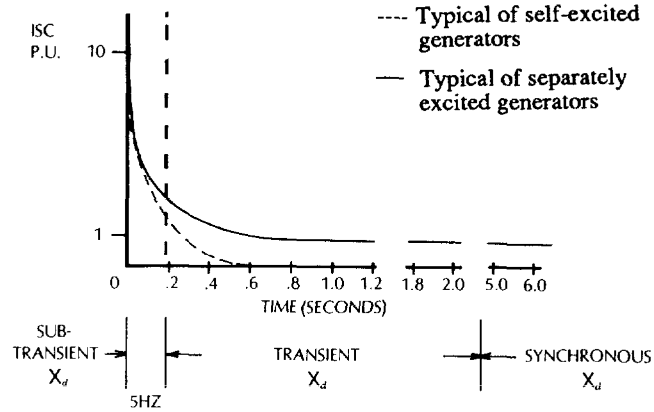
263 Amperes x 8.326= 2190

Per unit subtransient reactance values of SR 4 Generators are about one-half the transient reactance per unit value.

Synchronous Reactance

This term is identified by the symbol X_d and has a per unit value of 2.0 to 3.9 in SR 4 Generators. This factor is used to determine the steady-state fault current capability of a separately excited generator. *(The short-circuit* current *which would be produced after five seconds.)* Self-excited generators, such as the SR 4, lose excitation before five seconds. Hence, the synchronous reactance factor cannot be used to determine the actual steady-state fault current. The factor does, however, give a comparison with other generators by considering the probable performance if excited from a separate source.

The following diagram indicates the current available at various periods of time:



Negative Sequence Reactance

This factor has a symbol X_2 and a per unit value that approximates the value of the subtransient per unit reactance value. Engineers use this figure when calculating probable fault currents in event of a line-to-line short circuit from a particular generator. Calculation is very similar to that used for subtransient short circuits. For a generator at 60 Hz, 219 kV•A, 263 amperes, and X_2 of 0.1543:

$$\text{amperes, RMS}_{SC} = \frac{\text{rated amperes} \times \sqrt{3}}{X''_d + X_2}$$

$$\frac{236 \times \sqrt{3}}{0.1201 + 0.1543} - \frac{263 \times \sqrt{3}}{0.2744}$$

= 1660 amperes, the RMS effective symmetrical current. The peak symmetrical value is found by multiplying the above result by √2.

1660 x 1.414= 2347 amperes

RMS asymmetrical value is determined from:

$$\text{RMS} \times \sqrt{3} = 1660 \times 1.732 = 2875$$

The peak asymmetrical value is the RMS asymmetrical value multiplied by 1.414, which equals 4065 amperes.

Zero Sequence Reactance

This reactance factor has the symbol X_0 and a per unit value of 0.03 to 0.13 or approximately one-third the value of the subtransient per unit reactance figure. The factor is used to determine probable value of line-to-neutral, short-circuit currents and possible line-to-ground currents in the event the neutral is grounded and a line-to-ground fault occurs. Fault current calculation is similar to those of line-to-line calculation:

$$\text{anperes, RMS} = \frac{\text{rated amperes} \times 3}{X''_d + X_2 + X_0}$$

For a generator at 60 Hz, 219 kV•A, 263 amperes and X_0 of 0.0450:

$$\frac{263 \times 3}{0.1201 + 0.1543 + 0.0450} = \frac{263 \times 3}{0.3194}$$

= 2470 amperes, RMS, symmetrical

The peak value can be found by multiplying the RMS value by $\sqrt{2}$:

2470 x $\sqrt{2}$ = 3493 amperes, peak, symmetrical

RMS asymmetrical value can be found by multiplying the RMS symmetrical value by $\sqrt{3}$.

Note: Available currents resulting from different type of faults are different. The line-to-neutral short circuit is often the highest value and the most likely to occur.

Open Circuit Time Constant

Figure listed are in seconds. These are determined from a test performed as follows. The generator is operating at normal rated voltage with no load. The main rotating field is supplied from a separate source, usually a battery. The rotating field input is short circuited and the voltage across the generator output terminals will reduce. Time, in seconds, for the generator terminal voltage to reach 36.8% of its original value is recorded as the *open circuit time constant.* The figure is primarily used in the design of voltage regulators. Some engineers use the open circuit time constant along with another factor called *generator time constant*, which can be supplied upon request. Individual y and together, these two time constants provide switchgear and distribution designers with information needed to study the possible voltage changes resulting from severe load changes.

Generator Time Constant is a measure of the magnetic inertia in a generator and gives an indication of machine performance under short circuit conditions. The factor is determined by actual running tests where the generator output is short circuited and the reaction is recorded. The time elapsed between short circuit application and voltage decline to 36.8% of normal is the generator time constant. The symbol is *TD-SC* and it has a value in seconds approximately equal to 10% of the open circuit time constant.

Exciter Field Resistance -- Ohms, Exciter Voltage No Load, Rated Load and Exciter Amperes No Load, Rated Load

The preceding three factors are closely related and are very helpful when troubleshooting: a difficulty involving the field circuit breaker of art SR 4 Generator.

1. Exciter field resistance is given in Ohms as measured at the lead terminals of the exciter field. The actual resistance is more easily determined by measuring any applied voltage and the resulting current. Ohm's law applies: R = E/I. If E = 6.0 volts, I = 2.5 amperes, the exciter field has a resistance of 2.4 Ohms.

2. Exciter voltage is also measured at the input leads to the exciter-field. Input voltage is lowest when there is no load on the generator and rises by a factor of about there under load. Exciter field current is also low at no load and will rise by a factor of three under full load.

   Generator main field voltage and current are not listed because they cannot be measured on an SR 4 Generator. There is no way of opening the circuit to insert instruments while the generator is operating. However, a static test can be performed with a variable source of DC voltage.

Derate Altitude (m)

Derate Temperature (°C)

These two factors relate directly to the density of the cooling air forced through the generator. Derating would not be required below 1000 m (3280 ft). NEMA design considerations require generator derating of 1 % per 100 m (330 ft) above 1000 m. A 100 kV•A generator operating at 2000 m (6,560 ft) altitude would be derated to 90 kV•A. NEMA design machinery derating is very similar to that of European design machinery as shown by this comparison:

Typical European DesignDerated to	Altitude Meters	NEMA Design Derated to
96%	1500	95%
91%	2000	90%
87%	2500	85%
83%	3000	80%

Air density decreases as cooling air temperature increases. At higher cooling air temperatures, derating of the generator maybe required. NEMA recommendations suggest that the *permissible* *temperature rise* of the machine be reduced 10°C (i.e., from 105°C to 95°C) when cooling air temperature is 40°C up to and including 50°C. NEMA also suggests permissible temperature rise of the machine be reduced 20°C (i.e., from 105°C to 85°C) when cooling air temperature is 50°C up to and including 60°C (140°F). These recommendations may affect the generator rating. Some Caterpillar Generators do not require a temperature rise decrease until the ambient cooling air temperature is 50°C. The generator may not require derating as its actual operating temperature rise could be considerably below the 105°C limit for prime power or 130°C at the standby rating. The following compares European practice of rating decrease with NEMA permissible temperature rise decrease using a typical SR 4 Generator.

Typical European Design Generator Percent of 40°C Ambient Rating	Cooling Air Temperature	Typical SR 4 Generator at Prime Power Percent o f40°C Ambient Rating
107%	25°C	100%
96%	45°C	100%
93%	50°C	100%
91%	55°C	95%
88%	60°C	92%

In most instances, altitude and temperature will cause derating of the engine and, therefore, limit the available power from the generator. Actual derating of the generator itself is normally not necessary.

See information on temperature rise.

Efficiency at 0.8 Power Factor

Efficiency data accounts for *all* losses in the generator. Losses include:

Loss	Approximate Percent of Input Power
Stator Resistance	1.3%
Cooling Air Power	1.3%
Mechanical Friction	1.3%
Excitation System Power	2.3%

The percentage figures are typical of a 400 kW, 60 Hz machine supplying 400 kW at 0.8 power factor. Excitation system power and stator resistance power loss would be less if the load was 1.0 power factor. Caterpillar Generators have the greatest efficiency near 3/4 full load.

Temperature Rise °C Stator/Rotor Insulation Temperature Class

Figures quoted are *will not exceed* temperatures. The actual temperature under the load conditions will probably be less than the listed figure. Figures have been determined by heat run tests.

Temperatures quoted for the insulation class (Class F is standard) are normally accepted operating temperatures for the materials involved.

Heat Dissipated Btu/min, kW Air Flow Required cfm/m^3/min

These two factors are directly related. All losses in the generator convert to heat which must be dissipated by radiation and by cooling air flow. To convert Btu to kcal/min, multiply by 0.0252 kcal/Btu. *Total* heat loss can also be calculated in either kW or Btu/min. For heat loss in kW, multiply the kW rating by (100 - efficiency).

For total loss in Btu/min, multiply the kW loss by 56.8 Btu/kW x minute.

To convert required air flow in m^3 to air flow in cu ft, multiply the listed figure by 35.31 cu ft/m3.

Air flow is calculated on an average air temperature rise of 11°C (20°F) as it passes through and around the generator. This volume of air must always be included in engine room ventilation requirements.

Rotor Weight

This figure indicates the total weight of the generator rotor. When used with the formula for inertia, the *flywheel effect* of the generator can be found. Engineers may use these figures when generator loads are sudden or cyclic.

Inertia Data

When the information is given to an engineer, it must be correctly identified.

These figures list the mass moment of inertia in System International units and English units. Other symbols used to designate inertia of rotating machinery are WK^2, WR^2, and GD^2. The Caterpillar inertia presentation of

	Force	x Distance	x Time^2
N•m sec^2 =	Newton	x meter	x Second^2
lb/in sec^2 =	lb	x in.	x Second^2

is recognized anywhere in the world and can be readily converted to other inertia designations.

To convert to moment of inertia (WK^2) in SI units, multiply N•m sec^2 by 9.803 m/sec^2. Multiply lb/in sec^2 by 2.683 to get inertia (WK^2) in lb/sq ft, the common English unit designation.

Inertia data is essential to studies of transient response, such as the effect of a larger generator with more rotor weight and greater mass moment of inertia.

Stator Weight

Figures in kilograms and pounds give an indication of the capacity of a generator. Engineers generally assume that a heavier stator contains more working copper and iron.

Total Weight

These figures are the sum of rotor weight and stator weight.

Center of Gravity

Listed information gives the location of the generator center of gravity in three planes. With the total generator weight, the information can be used to determine the center of gravity of an assembly consisting of engine, generator, radiator, and base. Combined calculations require reducing all values to moments *(lb/in or kg/mm). These* are summed algebraically in each plane of reference.

Mounting Flange Number

This relates to the engine flywheel housing the generator is mounted on.

Waveform Deviation Factor

This figure is an indication of the degree that a generated voltage differs from a perfect sine wave. Present standards require that the factor not exceed 10% of the line-to-line generated voltage at no load. SR 4 Generators do not exceed 5%. This characteristic is also known as *Wave-Shape Deviation Factor*. Deviation from a perfect sine wave is primarily the result of harmonics, generated as a field pole passes a conductor. There are many design techniques available to make the deviation factor very low. These may or may not have importance when the generator is under normal load.

Telephone Influence Factor

This factor is usually identified as *TIF*. European standards refer to it as Telephone Harmonic Factor or *THF*. *The* factor is an indication of the possible effect of generated harmonics on adjacent telephone circuits.

The factor relates to interference by magnetic induction. This is rarely a problem today as telephone lines are in conduit, shielded cable or buried. However, some engineers use this factor to predict the amount of electrical noise induced or conducted into control circuits that may trigger SCR devices.

Acceptable limits set by various standards groups relate to generator kV•A capacity. Up to 300 kV•A, the factor is 350; 300 to 600 kV•A, the factor is 250; and 700 to 5000 kV•A, the factor is 150. The actual values are always determined at rated frequency, rated voltage, but on open circuit. SR 4 Generators are well below the listed limits. These generators are limited in harmonics that might trigger an SCR system or device. This feature accounts for the very low wave form deviation factor.