

Power Surge

A sudden change in power flow caused by an unplanned event, such as the unexpected loss of power from a generating unit or a major transmission line.

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LOAD
SERVICE VOLTAGE
VOLT
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Electric power supply is generated in direct response to electric power demand. Under normal operating conditions, generation closely matches demand, and power flows at a steady state (without abrupt irregularities) through the transmission and distribution (T&D) system to customers.

Power surges, or sudden large changes in power flow, can result when a generating unit, major transmission line, or utility intertie (or interconnection) unexpectedly fails. When this happens, power within the transmission system is redistributed, and a power surge—normally accompanied by a high-voltage condition—results until system supply and demand are rebalanced. Power surges are usually contained within the transmission system, seldom affecting local distribution systems. Power surges do not occur frequently, and they usually do not last more than a few seconds.

Irregularities in voltage can also originate at the local distribution level, where voltage fluctuations are more noticeable to customers. Overvoltage disturbances include surges and swells and can be categorized by their duration and the magnitude of the irregularity.

- Voltage surges*, previously called *voltage spikes* or *impulses*, usually last less than 0.001 seconds and can jump to as much as 6,000 volts (V). Voltage surges are most commonly caused by lightning, but may also result from sudden switching of high-voltage utility equipment.
- Voltage swells*, previously called surges, usually last longer than 0.01 seconds and include voltages exceeding 110 percent of normal service voltage. Depending on the cause, voltage swells can peak to as much

as four to six times above normal for a very short period. Voltage swells may occur in response to power-flow changes, such as the switching on or off of various types of utility system equipment (utility switching), or in response to a sudden large reduction in load, such as switching off a very large motor.

Undervoltage irregularities include voltage notches, sags, and outages, and can also be characterized by their duration and magnitude.

- Voltage notches* usually last less than 0.01 seconds and are characterized by a momentary loss of power. Voltage notches can be caused by starting loads, utility switching, or equipment failure.
- Voltage sags* usually last longer than 0.01 seconds and are characterized by voltages up to 20 percent below the normal service voltage. Sags may be caused by system overload, starting very large loads, utility switching, equipment failure, or lightning.
- Outages* last longer than 0.01 seconds and are characterized by a total loss of power. Outages can result from natural disasters, accidents, equipment failure, or a short circuit in any part of an electrical system.

Electric utility systems are equipped with regulating devices such as voltage regulators that can detect certain undervoltage or overvoltage conditions and assist in maintaining the correct system operating voltage. Other electric equipment, such as capacitors, can be used to absorb surges or swells, or to alleviate voltage sag occurring in the distribution system. Utility systems are also equipped with protection devices such as surge

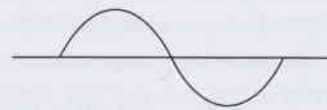
protectors, which operate to divert voltage surges caused by lightning.

Power-sensitive electric equipment such as computers can be protected from voltage irregularities by installing protective devices such as passive filters, surge suppressors, and line conditioners,

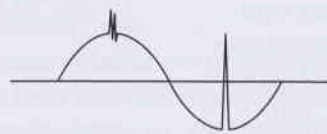
each of which smoothes the power supply to varying degrees. Another more complete power protection device is an uninterruptible power supply (UPS), which ensures a steady power supply for up to 15 minutes during an outage.

Voltage Irregularities*

IDEAL ALTERNATING CURRENT (ac) VOLTAGE



Surge



**Duration
(seconds)**

Less than 0.001

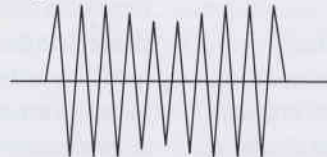
**Magnitude
(volts)**

50-6,000

**Possible Cause
of Voltage Irregularities**

Switching loads on or off
Normal computer operation
Utility switching
Lightning

Sag

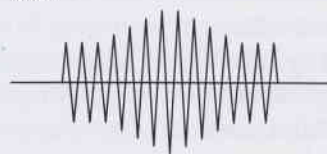


More than 0.01

Up to 20 percent
below service
voltage

Ground faults
Starting large loads
Inadequate power system
capacity
Utility switching
Utility equipment failure
Lightning

Swell

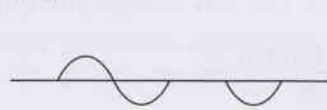


More than 0.01

More than
110 percent above
service voltage, but
not exceeding 600
percent

Rapid load reduction
Utility switching

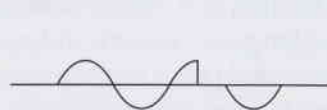
Outage



More than 0.01, 0
but otherwise
indefinite

Ground faults
Equipment failure
Accidents
Utility equipment failure
Lightning
Acts of nature

Notch



Less than 0.01 0

Starting loads
Utility switching
Equipment failure
Accidents

*Latest Institute of Electrical and Electronic Engineers (IEEE) nomenclature; surges were previously called spikes, and swells were previously called surges.

SOURCE: PG&E.