

## THE ROLES OF VOLTAGE AND FREQUENCY IN THE TRANSMISSION OF ELECTRICITY

When next you switch on the electric light or television in your house, think for a moment of all the effort and work that went into generating electricity and sending it to your home.

Power stations all over South Africa are linked by overhead transmission lines. (Transmission is a word from the verb “to transmit” which means to send from one place to another.) The transmission lines are supported by towers called pylons and transport the electricity by means of thick aluminum and copper wires. The network of transmission lines is called the National Grid.

### Voltage

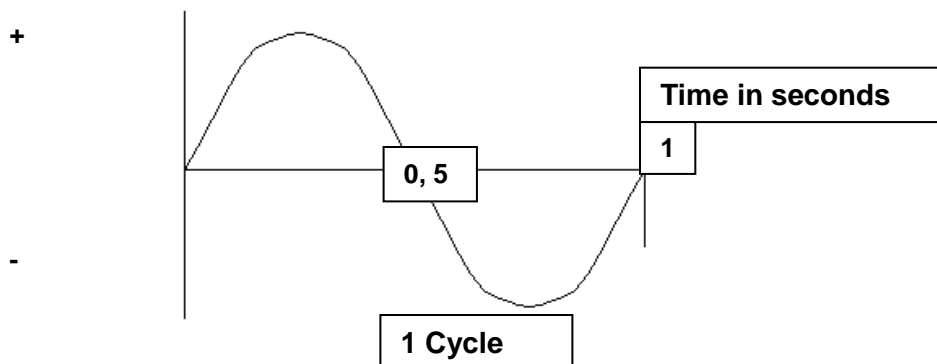
In order for the electricity to be transmitted safely and efficiently over long distances, it must be at a high voltage (pressure) and a low current (flow). This is because if the current is too high, the lines would heat up too much and even melt. If the voltage were too low, hardly any energy would be carried.

The generators in the power stations produce electricity at  $\pm 20\,000$  volts (20kV). This voltage is raised by transformers before it is sent out. The high voltage transmission system in Eskom comprises a 132 000, 275 000, 400 000 and 765 000 volt system. These very high voltages are necessary to “push” the required flow of electricity efficiently through the long distance lines. From the high voltage network, the electricity is transformed down, for example, to 11 000 volts for local distribution and then to 240/220 V for domestic use.

### Frequency

A further point to understand is that we generate and transmit **Alternating Current (AC)**. Eskom’s generators are synchronised to the National Grid at a frequency of 50 Hertz (Hz).

We could also say that frequency is the speed at which an electric current flows. This “speed” is measured in a sine wave as illustrated in the following diagram.



The standard frequency in South Africa is 50 Hertz, whereas in some other countries like the USA, the frequency is 60 Hz.

There is a definite relationship between the rotational speed of a generator and frequency. The rotor of a generator is in effect a huge electro-magnet with magnetic poles. Most generators within the Eskom system are classed as two pole generators with one North Pole and one South Pole, ie a pair. The typical rotational speed of these generators is 3 000 rpm. When a generator has one pair of poles and the rotational speed of 3 000 rpm is divided by 60 seconds, a frequency of 50Hz is obtained.

A slower rotating generator would need more pairs of magnetic poles in order to achieve the same 50 Hz frequency. For example, a machine rotating at 300 rpm would require 10 pairs of poles.

### **Monitoring supply and demand**

Frequency is also a "tell-tale", giving us an indication of what the demand for electricity is at any given moment. For a balanced frequency **supply must always meet demand!**

If the demand drops for any reason, the frequency will increase. The control systems at power stations must therefore ensure that the supply of electricity from the generators is reduced to bring the frequency back to 50 Hz. The opposite occurs when the demand increases. In this case the output from the generators must be increased to meet the new demand.

### **Effect of variations in frequency**

Every device with a motor or electronic circuit, and that means practically every tool or labour saving device we use, is designed to work at a standard frequency of alternating current.

*What would happen if the network frequency was allowed to run at a low frequency of 49 Hz?*

All electrically driven motors would run at slower speeds. This means that the work a motor is doing, driving a pump, for instance, would be "reduced" and the pump would run at a slower speed. This could have an effect on systems where flow rate is important. Another example is that your electric clock at home would lose time! This low frequency scenario could also be very damaging to motors and other electrical devices we use.

### **How the network is protected from low frequency incidents**

Should the frequency drop below a certain level, automatic load shedding will occur. To forestall this, Eskom performs controlled load shedding so that the network and subsequently all electrical devices and appliances connected to it are protected against "under-frequency". Controlled load shedding is a way of rotating the available electricity capacity between all customers when the demand is greater than supply.

By "shedding" some of the demand in a controlled manner, the balance between supply and demand is thus restored and the frequency maintained at a healthy level.

**Produced by:            Generation Communication  
                                 TD 0004 Revision 6 (November 2017)**

For more information on Eskom related topics see the Eskom website ([www.eskom.co.za](http://www.eskom.co.za)).  
Select the "About electricity" tab and "Facts and figures"