

Electromagnetic Fields caused by Electrical Transients

"How does the noise on electrical wiring get onto my body?"

By understanding how electrical transients are generated and propagated, we can then understand how these phenomenon cause invisible fields that surround everything in their vicinity to varying levels of intensity.

What are transient voltages?

"Transients", are actually "Transient Voltages". More familiar terms may be "surges" or "spikes". Basically, transients are momentary changes in voltage or current that occur over a short period of time.

Where do Transient voltages come from?

Transients can be generated internally, or they can come into a facility from external sources. The least common of the two are externally generated transients. They've been described as "electronic rust".

External sources:

Lightning is the most well known of the externally generated transients. Most lightning transients are not actually the result of direct lightning strikes....they are most often "induced" onto conductors as lightning strikes near the power line. The large electric fields generated during a discharge can couple into the power system, creating induced transients. A cloud-to-cloud discharge can generate a 70 Volts per meter electric field. On a 1/2-mile length of transmission line this is equal to a 56,000-volt transient, and it didn't even touch the power line wires!

Poor or loose connections in the distribution system can also generate transients. They may be caused by high winds, which can blow one power line into another or blow tree limbs into the lines causing arcing.

Another common source, not well known, is neighbouring businesses or residences. If you share a transformer with other users, any transient activity generated on his premises will be seen at your electrical main. Remember, you are both physically connected at the secondary side of the power distribution transformer.

Internal Sources:

The vast majority of transients are produced within your own facility or residence. The main culprits are device switching, static discharge, and arcing.

Each time you turn on, turn off, load, or unload an inductive device, you produce a transient. Inductive devices are those devices that use "magnetic mass" to function. Examples of inductive loads are motors, transformers, relays and power supplies, etc. The inductive "kick" from a small motor turning on can produce a transient in excess of 1,000 volts. A motor with a faulty winding, commutator, or other insulation fault can produce a continuous stream of transients exceeding 600 volts! Even transformers can produce a large transient, particularly when energizing. Interestingly enough, this isn't produced the way many people think (from the sudden load on the system), but is a result of the collapse of the magnetic field upon energizing the transformer.

Arcing can generate transients from a number of sources. Faulty contacts in breakers, switches, and contactors can produce an arc when voltage jumps the gap. When this gap is "jumped" the voltage rises suddenly and the most common effect is an oscillatory-ring-type transient. Faulty connections and grounds can produce arcing.

How Do Transients "Travel"?

The common aspect of all these internally generated voltages is your electrical distribution system. Your facility or home wiring is designed to transmit electricity with the least impedance possible so that maximum efficiency is maintained. This same efficiency works to transfer the transients produced throughout your facility with minimal obstruction.

All of the electric interfaces are physically bonded together via protective earth system. Transient activity "seen" at one interface is easily transmitted to all other interfaces within your system, dependent upon transient frequency and magnitude.

What are the effects of transient activity?

These rapidly changing transients set up fluctuating invisible electromagnetic fields that radiate from the electrical system and wiring. The larger the transient, the higher the strength and density of the surrounding fields. It is these fields that "induce" a charge into nearby bodies and surfaces of objects in their vicinity, and this induced charge is believed to be biologically harmful to living organisms.

What are Electromagnetic Fields?

There are two types of field that are set-up, the Electric field and magnetic field. These are two interrelated aspects of a single object, called the electro-magnetic field. They are generated by moving electron charge otherwise known as a flow of current. The energy, which is the rate of flow of current, in the transient is related to the strength of the field.

Electric Field

The term electric field is used for a single vector field, denoted E-field. In physics, the space surrounding an electric charge or in the presence of a time-varying magnetic field has a property called an electric field. This electric field exerts a force on other electrically charged objects.

The SI unit of electric field is newtons per coulomb (N/C⁻¹) or, equivalently, volts per metre (V/m⁻¹).

Magnetic Field

The term magnetic field is used for two different vector fields, denoted B-field and H-field, although there are many alternative names for both. To avoid confusion, we use B-field and H-field for these fields, and use magnetic field where either or both fields apply.

Magnetic Field Strength (H)

The strength of the field depends on the current and the area of the wire loop.

The SI unit of magnetic field strength is expressed as Amperes per metre (A/m).

Magnetic Flux Density (B)

The Magnetic Flux is the rate of flow of magnetic energy across or through an area or surface.

The SI unit of magnetic flux density is the Tesla, (T).

How Do We Reduce These Fields?

The best way to reduce the electromagnetic fields is by eliminating them at source. However, we can't stop external sources such as lightning strikes, and we wait while technology gradually improves emissions from internal sources from electrical devices. In the interim, we can eliminate many electrical transients using techniques such as filtering and shielding. Thus, if we reduce the electrical transient activity and the size of the individual transients, then we can effectively reduce the potentially harmful fields generated by them.

Micropulse filters located around the electrical system will effectively reduce transient activity.