Reprinted from issue number 4, January 1994

SAFT INTERNATIONAL

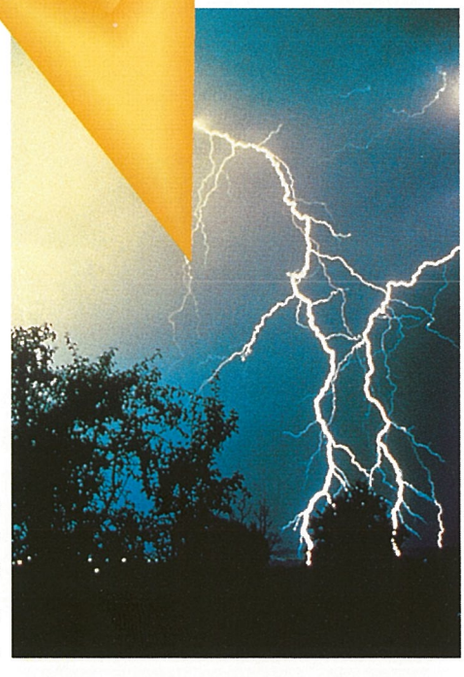
Electromagnetic compatibility: a growing problem

Electromagnetic com

Confronted with multiplying possibilities of electromagnetic disturbance, international and European standards are taking the situation in hand.

The fact that electrical currents, apparently the "cleanest" forms of energy, may cause, and be susceptible to, "pollution" may surprise many people familiar with more well-known types of environmental degradation.

Yet everyone has experienced "snow" on the TV screen when the neighbour switches on a vacuum cleaner, or the crackle on the radio as a motorcycle with a defective suppressor goes past. These are minor, though annoying, instances of electromagnetic pollution – in the first case, brought on largely by interference of the vacuum cleaner with the mains supply; in the second, by the electromagnetic field associated with electrical currents in the engine.



Gamma

Lightning is the most spectacular example of electromagnetic disturbance

The problem of electrical and electromagnetic pollution is far more widespread and damaging than these everyday examples would suggest. The electrical grid is at risk from uncontrolled emissions. Walkie-talkies used in factories can interfere with the operation of inadequately immunized machinery. Aircraft instrumentation is susceptible to disturbance by people using equipment like laptop computers or cellular phones. And so on.

Since the early 1980s, the problem of electromagnetic "pollution" has been compounded by two developments in particular. One of these is power conversion technology, whose characteristic high frequencies are liable to produce emissions if not adequately protected. The arrival on the market of new power semi-conductors, such as fast transistors, mosfets, and IGBTs, as well as the new ferrite magnetic circuits, has accelerated the development of this technology, reducing volume, weight and cost and improving efficiency. But these products are also liable to pose a greater threat to the electromagnetic environment if adequate precautions are not taken.

The other development is in information technology (IT), whose expansion during the past decade has seen microprocessors entering into every area of industry, commerce and daily life. The multiplication of these sensitive electronic circuits in our everyday environment has increased the possibilities of disturbance.

DUAL ASPECT: EMISSION AND IMMUNITY

Electromagnetic pollution of the environment has led to the on-going formulation of rules to eliminate or minimize its effects. The overall aim of ensuring the electromagnetic compatibility of various kinds of electrical and electronic equipment has two major aspects. On the one hand potentially disturbing emissions from equipment must be reduced to an environmentally accep-

patibility: a growing problem

table level; and on the other hand the immunity of equipment to electromagnetic disturbance needs to be optimized. Thus for any given piece of equipment there is the twin goal of rendering it non-polluting and of protecting it from pollution generated elsewhere.

At Saft, both of these aspects are an issue. In a telephone exchange, for example, using a Saft Nife power-switching supply system, emissions from the power supply must be reduced (Saft's concern), while the switchboard manufacturer also maximizes the immunity of his highly electronic product.

There are many different types of disturbance emitted and received by equipment. For emissions, a key distinction is made between frequencies below and above 30 MHz. Up to that frequency, conduction along electrical cables is the main problem, both "upstream" (ultimately into the power main) and "downstream" to any other connected equipment, along with the associated magnetic field. Above 30 MHz electromagnetic radiation through space becomes the concern, as the cables act like antennae (see illustration at right).

Power supply systems can, depending on their quality, be both the cause and remedy of mains pollution. The better-quality units clean up surges and sags in voltage and spikes in the characteristic sine-wave form of AC. This is obviously true of the UPS and is required for many chargers in telecom applications, where the input boost converter serves to regularize the sine wave. But disturbance emanating from the main source is only part of the problem. Users can also cause pollution. For example, fluorescent lighting produces spikes when switched on.

Switch-mode power supplies can cause another problem, flattening the voltage sine-wave. By drawing a high current only from around the peak of the wave, switch-mode equipment can feed back harmonic currents into the mains supply. This problem forces the electricity supplier to oversize the grid or other power generation. Other sources of pollution include computers, electric motors and welding equipment, all of which can cause sags in the sine wave. High power conversion units can also contribute to electromagnetic pollution or radio-frequency interference (RFI).

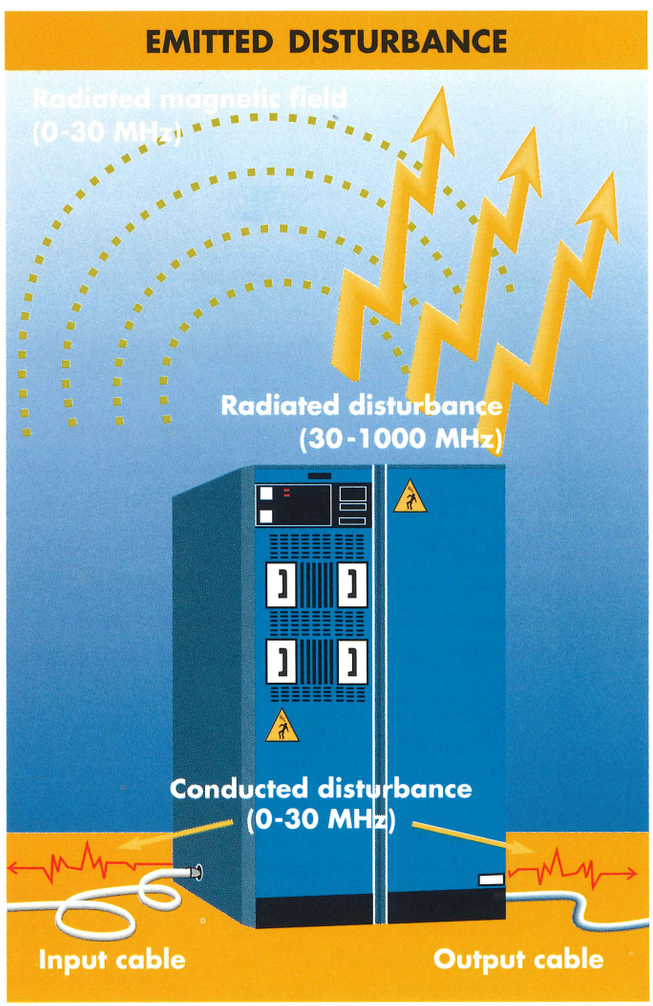
From the point of view of immunity, disturbance can be both man-made and natural. Power lines transmit shock waves resulting from lightning strikes, as well as irregularities in voltage and sine-wave deformation. Apart from cable-conducted pollution, problems are also caused by electrostatic discharge and by disturbances emitted from equipment like radar and radio installations and very high power supply equipment (see illustration on page 14).

EUROPEAN STANDARDS: A NEED TO HARMONIZE

The need for standards to regulate emissions and to ensure adequate immunity is now widely accepted, although until recently there has been little cooperation among countries.

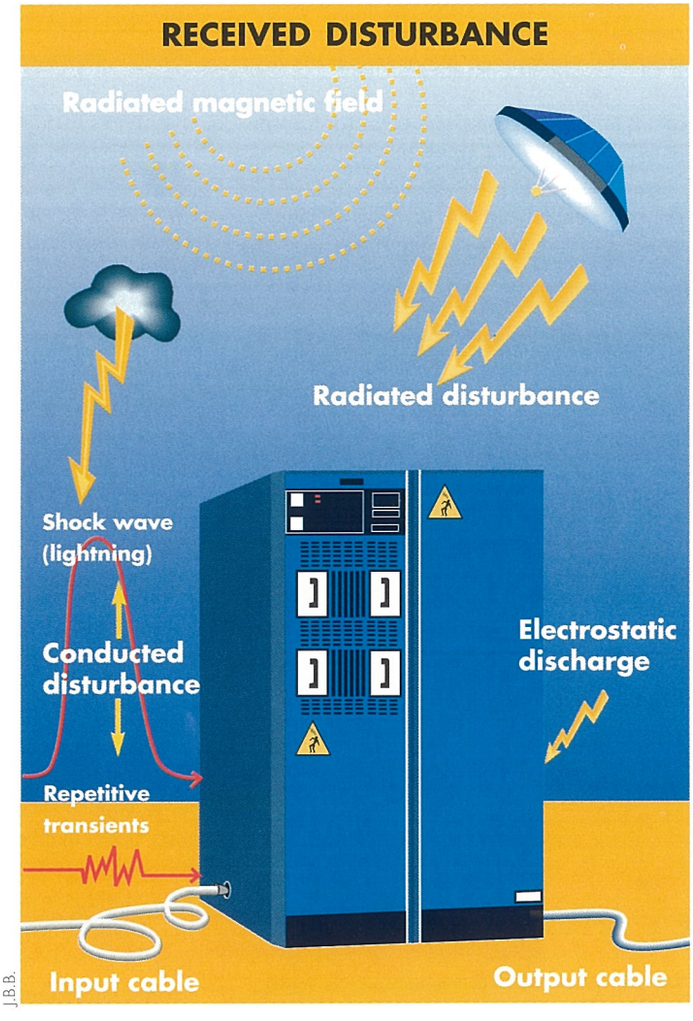
In general, each advanced industrial country has adopted its own approach and set its own limits and conventions. Germany – one of the first to recognize the necessity of regulation – the US, France, Britain and Japan all established their own regulations. The result is the jumble of different standards that exists today.

At present the correlation of standards is far from simple, and involves extensive testing, which only the largest companies can afford to carry out. Saft is in a position to perform such testing, and has developed products which respond to correlated limits for many applications, especially telecommunications systems, enabling it to provide power systems for telecom companies worldwide.



J.B.B.

The current inconsistency among standards is the reason for the move towards supra-national legislation and agreement. The chart on page 15 illustrates how the French limits, based on CISPR international limits for emissions in the ranges up to and higher than 30 MHz, differ from the standards applying in the US (FCC) and Germany (VDE). Work on common European standards for EMC has been underway since the mid-80s, and the EMC Directive has been in place since 1989 – it will become obligatory in January 1996. International standards which will be applicable the world over are also in the works – the International Electrotechnical Commission (IEC) has already established a certain number of standards, notably applying to immunity (see box on facing page).



J.B.B.

For European standards a distinction is made between domestic (which includes offices and light industry as well as households) and industrial environments. In general, standards pertaining to domestic use (Class B) are far stricter, since any disturbance on the 230/400V mains will affect other users drawing power through the same voltage stepdown substation. In the case of the industrial user (Class A), taking power from the 20,000 V grid, and stepping it down to 230 V/400 V on-site, the transformer acts as a barrier to the transmission of pollution to other users. It can therefore largely be left to the industrial user to ensure that emissions are minimized, since any disturbances will be confined uniquely to his own installations.

Three degrees of standards are distinguished: Basic, Generic, and Product. Basic Standards, the most general, apply to a specific type of phenomenon; they specify levels and describe methods of testing. Generic Standards define EMC levels, following the European EMC directive. Finally, Product Standards also define EMC, but in addition specify safety and performance. The most detailed of the standards, they have not yet been elaborated for all products – when they exist, however, they take precedence over the others.

EMC DIRECTIVE

As European standards become operational they will supersede existing national standards. For instance, EN 55011, the European EMC standard for industrial products, will harmonize national near-equivalents such as Germany's VDE and the UK's BS.

The EMC Directive 89/336/EEC is to become mandatory by January 1996. This

patibility: a growing problem

Directive is designed to reconcile and supersede existing standards of EC member states in the domain of electromagnetic emissions and immunity. It covers products (such as power supply), systems (such as a modular cabinet) and entire installations (such as the power installation on an offshore oil rig).

Most of Saft Nife products fall under the jurisdiction of the Directive. Our research and development and testing departments incorporate its recommendations, and use harmonized standards in relation to EMC and other areas, notably safety.

Within the EMC Directive, low-frequency emission standards EN 60555-2 and 3 cover the unwanted harmonics and voltage variations caused by all units where input current is lower than 16 amps per phase. This is very often the case for domestic appliances. Radioelectric frequency emissions are covered by EN 55011 to EN 55022, dealing variously with scientific, industrial and

Electromagnetic pollution can take many forms – from parasitic noise to electrostatic discharge

medical equipment, televisions, domestic and other electrical appliances, fluorescent lighting, and computers. Saft is concerned especially with EN 55011, which applies to industrial equipment. Other standards deal with immunity of equipment to electrical, electromagnetic and electrostatic disturbance – for instance lightning (IEC 801/5).

Awareness of these standards and of the general problem of electromagnetic pollution varies considerably among users of equipment. Broadly speaking, customers in the telecommunications sector have a higher awareness of the problem, because disturbance usually appears as parasitic noise – for instance on ordinary or cellular phones. Since it is obviously a matter of concern for consumers, telecommunications companies have taken steps to eliminate or minimize disturbance and maximize immunity.

Saft has taken the steps necessary to provide products that are in conformity to the existing standards, whether they are national, European or international. Saft can thus offer users of all sizes all over the world systems and products that conform to whatever standards will become mandatory. As the deadline of 1 January 1996 approaches, Saft is at the leading edge of standards research and implementation. ■

INTERNATIONAL STANDARDS

In the process of establishing standards worldwide, the problem of electromagnetic compatibility is handled by organizations which deal with electric standards: for Europe, this organization is the CENELEC (European Committee on Electrotechnical Standards).
On an international level, this role is filled by the IEC, the International Electrotechnical Commission, which produces worldwide standards for electrical and electronic equipment.
Within the IEC, a specific committee called the CISPR is responsible for radioelectric disturbance. The committee develops international agreements on EMC and sets specifications for limits and measurement methods. For the time being, finalized IEC standards largely cover immunity, dealing with phenomena such as electrostatic discharge, magnetic fields, and power cuts.

WIDELY DIFFERING NATIONAL STANDARDS