Guest Editorial

Energy and EMC—Where Do We Go From Here?

IF it appears that the title of this editorial is ambiguous—it is—and deliberately so. Energy and electromagnetic compatibility "go together like horse and carriage." However, there is some ambiguity! "Energy," as a technical term, is *not* ambiguous and it has very precise physical and mathematical definition. But in recent years, usage of the word by the general public has popularized "energy," in an overall sense, as meaning large quantities of BTU's. In fact, IEEE has essentially accepted this usage both in its publications and in the existence of the IEEE Energy Committee.

We have another ambiguous area in the use of the term "electromagnetic" as in "electromagnetic compatibility." But to the engineer or scientist working in the EMC field, the use of "electromagnetic" is well understood, even if not well defined. Electromagnetic compatibility is attained by manipulating small amounts of energy in a variety of ways. It is still energy, but not in the quantities that attract public notice.

So much for usage and definition. We not only must accept changes in meaning of words and terms with time, but, in fact, should welcome these changes and broadening of meanings, if it will help us and the public to get a grip on technical, economic, and political problems.

EMC engineers (and, indeed, communications, electronics, and computer specialists) deal in the so-called "electromagnetic spectrum" with energy manifestations which are small relative to the much larger energy quantities used in the power industry, homes, and transportation. The EMC world and the energy world couple together when electric power residuals from circuit breakers, neon lights, machinery, and power transmission lines affect detection and measurement in communications systems, computers, TV sets, and other sensitive equipments.

This thought gets us back to the title of this editorial—Energy and EMC. Whenever we have di/dt, de/dt, or $d\phi/dt$, we have a potential EMC problem. The magnitudes of these quantities are generally large in the high-power devices and circuits of the "energy" world, since it is the very basic quality of change with time that makes electric power economically feasible.[1]

Although all of us are fairly familiar with the energy/EMC relations mentioned above, we are now being exposed to some new aspects (or at least aspects not familiar to many EMC people). Three of these aspects are

1) possibilities of biological effects from ELF fields of extremely high-voltage ac power transmission lines,
2) EMC effects of the proposed solar-power satellite system,
3) EMC problems in the expanded use of electronic control and sensor devices in motor vehicles.

Investigative work in the above areas is not exactly new, but it is only in recent years that these energy-related EMC problems have become of broad public and technical interest.

High-voltage transmission lines are, of course, a standard method of transferring "energy" over long distances. However, in recent years, we have entered the era of extremely high voltage (EHV) transmission with voltages in use as high as 765 kV. Plans are being made now for voltages over 1000 kV. Considerable public controversy has arisen concerning the possible effects of the fields under, and in the vicinity of, these EHV transmission lines. The New York Public Service Commission has held extensive hearings on this subject over a period of many months (utilizing a great number of expert technical witnesses). The net findings were that there appears to be no evidence of short-term biological effects. The PSC is pursuing an investigative program concerning possible long-term effects. There has been considerable research work done on extremely low frequency (ELF), around 40-100 Hz, effects during the past few years and additional work is underway and planned. In general, the research attempts to determine the effects of ELF electric and magnetic fields of very much higher intensity than those encountered under EHV transmission lines. Results of most of this work have become available in books, reports, and symposia. Most recently, the 18th Annual Hanford Life Sciences Symposium (October 16-18, 1978) was held at Richland, WA, on the subject of "Biological Effects of Extremely-Low-Frequency Electromagnetic Fields." For those of you wanting an update on ELF effects, I refer to a book published by the New York University Press (1977), *Biological Effects of Electric and Magnetic Fields of Extremely Low Frequency*, by Asher R. Sheppard and Merril Eisenbud. It is interesting to note, in passing, that a new, independent organization called the Bioelectromagnetic Society (not affiliated with IEEE) was established in 1978. The Society, in cooperation with USNC/URSI will sponsor a Bioelectromagnetics Symposium in Seattle, June 18-22, 1979.

Among the more innovative ideas brought to the attention of government agencies, the Congress, and the public in recent years, has been the proposal for a stationary space satellite

[1] For fear of further complicating our situation regarding definitions, I have assumed we are not considering in this discussion so-called "dc" circuits where changes are ideally zero. In fact, 1) the fields of high-power dc transmission lines may be quite large and thus may react with other currents or moving conductors in the usual manner, and 2) a dc circuit may change as the load changes or the circuit is switched on or off. The dc machinery containing commutators and brushes may produce major electromagnetic disturbances and the converters, as well as circuit breakers at each end of a dc transmission line, may also cause EMC problems.

0018-9375/79/0500-0073$00.75

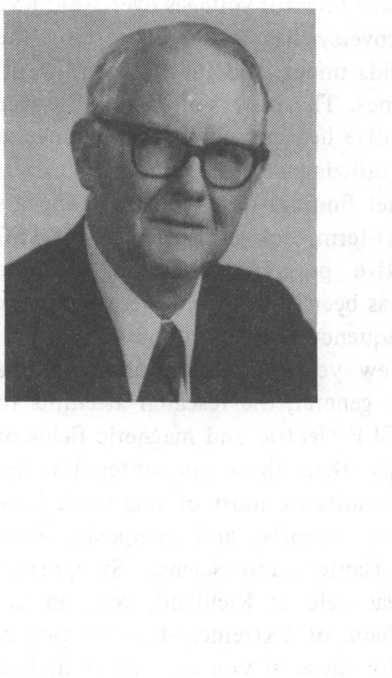
which will transform large quantities of solar energy into a microwave beam in order to transmit the energy to a receiver on the earth's surface. This proposal has created considerable controversy concerning technical and economical feasibility, benefits versus cost, and environmental problems. Proposed radio frequency is in the region of 2.45 GHz, with a power output for each satellite of 5000-10 000 MW. The electromagnetic compatibility implications of such a system are not clear. Principal EMC problems will probably be interference due to scattering, side-lobes, harmonics, and spurious emissions, and possible destructive effects in the ionosphere. It would appear that members of the IEEE EMC Society might play a key role in focusing attention on these compatibility matters in the solar-power satellite system.

Now for those of you who have not kept up with the automotive world, you should know that the manufacturers plan major new electronic systems in future automobiles. There will be new families of sensors and data processors to detect status and control the functions of automotive systems and subsystems. Unfortunately, it turns out that these electronic devices are extremely susceptible to the electromagnetic environment—an environment which is not at all technically well defined at any given time and place. The full solution to this problem is not completely evident at present and, therefore, it gives EMC engineers a new bone to chew.

The examples above are probably indicative of the future importance of EMC related to power and energy. We can expect a growing need for EMC expertise in this direction. Exactly where this will lead is difficult to know. As Neils Bohr supposedly once said, "It is very difficult to make an accurate prediction, especially about the future."

The message of this editorial is brief—EMC engineers must become better acquainted with "energy" programs and people. New "energy" developments, more and more, will involve EMC aspects—and the EMC engineer must be there to help in solving the problems.

A. H. SULLIVAN, JR.



A. H. Sullivan, Jr. (M'40-SM'47-F'69) is President of Sullivan Associates. He is a former President of the IEEE Electromagnetic Compatibility Society and a former Editor of this TRANSACTIONS. He currently represents the EMC Society on the IEEE Energy Committee.