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The EMC Directive

Implications for Professional Audio and Video Industries

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0.0 Introduction

0.1 The background

The reasoning behind the EMC Directive in providing for equipment and installations which achieve the necessary performance requirements has been well explained. These requirements are not unique to the professional audio and video industries and it is salutary to consider just how far reaching the Directive requirements are. The CE mark should only be affixed after declaring compliance with all relevant Directives of which the EMC Directive is currently the most obvious. One example of a future Directive could involve the safety requirements for equipments in the professional audio and video industries (PAVI). These are not currently a requirement of the CE mark. A further example relates to those items which belong more clearly in the toyshops rather than the professional environments since compliance with the EC toys Directive is already mandatory. Other presentations have, or will be, covering some specific technical details of EMC design and compliance. This presentation will be discussing some of the commercial practical and strategic matters which could arise.

0.2 Implementation dates

There is a need to be careful when quoting the dates by which the Directive is intended to be implemented. Initially the Directive was intended to be implemented on the 01 January 1992. To achieve this each member state should have introduced legislation by July 1991. The legislation should have been first issued in draft form for public discussion but, in the UK, this has yet to take place. In the meanwhile it has become clear that because many of the standards have yet to be determined and because many sectors of the electronics industry are very far from being able to comply with such regulations as have been discussed an extension of the implementation date has been sought. The proposal is that mandatory implementation of the CE mark requirements should take place by 01 January 1996. Manufacturers and importers would retain the right to use either the CE mark procedure or the national standards prevailing in the country where the equipment or system is "placed on the market". Although the EC Commission have yet to decide this formally it seems probable that there will be some extension of the implementation date. The best advice which comes from the DTI is that manufacturers should proceed to achieve conformity as soon as possible.

0.3 Specific standards

The Directive requires compliance with specific standards where these exist (and, for example there are standards for washing machines, television receivers, hand drills, home HiFi &c). Where no specific standard exists compliance should follow the requirements of the generic standards. Within the Professional Audio and Video

Industries (PAVI) concern had been shown that the published generic EMC standards (EN50081/1 and EN50082/1) might cause significant problems for equipments and systems intended for use in this particular sector. Representatives from concerned societies, trade associations and institutions have been meeting to determine what might constitute an industry (PAVI) generic standard and a companion presentation at this conference will present some of this work.

1.0 Standards to be considered

1.1 Which standards

The EMC standards which bear on equipments within the professional audio and video industries (PAVI) are those which are derived from the generic standards. A manufacturer, importer or an installer of equipment should be aware of the generic standard, firstly because this standard has been the starting point for one more germane to PAVI and secondly because the generic standard will apply to any equipment which is not covered by a specific standard. It is not a defence to be ignorant of either relevant Directives or of the detail standards which they invoke.

1.2 Which Directives

The EMC Directive is an example of a New Approach Directive (NAD). These directives are intended to be implemented quickly and uniformly throughout the EC. Previous Directives are not necessarily mandatorily required to be implemented in each member state. However in those states where they are implemented then it is intended that the standards to which they refer should be in the form of a Harmonised Directive.

1.3 Auxiliary standards

Certain standards are presently not scheduled to be mandatory in quite the same way as the EMC requirements. Perhaps the most important here is the safety standard known as BS415, IEC65 or HD195. This standard incorporates an interpretation of the Low Voltage Directive which differs a little in detail to the interpretation of the same Directive in BS7002 or IEC950. BS7002, however, concerns itself with safety standards for Information Technology Equipment (ITE) and may not be applicable to dedicated PAVI equipment. In principle, though the division might appear clear, note that many audio and video equipments are these days controlled by ITE.

There are some emerging standards which are intended to apply to specific industry segments. An example within the PAVI are the standards for fire alarms, BS5839, and emergency public address systems, BS7443. Individual contractual requirements might also refer either to specific additional standards or to performance criteria in excess of the current mandatory requirements.

1.4 Taking part in setting standards

Finally it should be recognised that the whole process of taking part in setting standards is fair and open. Up to the present time the cycle time of determining a standard and going through the process of achieving international acceptance has taken many years and it has been subsequently easy to wait for the effect of new standards to felt slowly. With the advent of the EC's drive towards faster harmonisation this is no longer the case and early active participation, most usually through representatives from industry societies and trade associations, is necessary.

2.0 Engineering strategies

2.1 Applying standards to products

Each company will need to determine which of its products it will bring into line with EMC requirements, which it will redesign and which it will drop. This may bring some managements face to face with recognising the true cost of some of their current products and designs. Maintaining a product will usually involve ensuring that the intitially specified parts are avilable to the manufacturing process and in addition assessing its performance against the requirements set by external standards and market requirements. The imposition of a legal requirement and, further, the need to ensure that the company's product and service liability insurance cover remains valid, will bring additional force to this internal debate. It will not be a defence to say that there have been no complaints against a particular equipment up to the present time.

2.2 Designing with a view to standards

The problem with products designed in ignorance of any EMC (or even safety) requirement is that designing cures in order to achieve compliance usually is quite difficult. Whilst it is true that some aspects of EMC control have not been difficult to put in place in other cases the remedies may well lie at the core of the design. Simple remedies have included installing properly assembled grounding braids and mains filters. More complex cases may require extensive mechanical and electronic rework in order to achieve success.

2.3 Certifying conformance

In principle there are three routes which could be adopted in order to place validly your company's products on the market. The requirement is the same whether the product is imported from outside the EC, for example USA or the far east, or whether it is made in very low volumes. Products for which specific standards exist may be either self certified or certified by third party competent bodies. The third route, which is likely to be more expensive, requires that the technical construction file is examined by a competent body. This third route is likely to be suited best to equipment which is not covered by product specific standards or for which good reason exists to apply for variations in the standards.

Whichever route is taken, once conformity can be demonstrated, the CE mark can be applied to the product or installation documentation. The final stage is the relatively legal act of signing the declaration of conformity. This has to be signed by a competent authorised person within your company and retained, along with any supporting documentation, notes of change, evidence of production conformity and so on, for at least ten years.

The appearance of the CE mark on an equipment is not a guarantee of the product's suitability or quality. However it is well able to be misused as such. Those who have witnessed its operation in the toys market might have observed this. There have been proposals to arrange for some form of centralised registration of conformity. Perhaps along the lines of a 70ecu fee accompanying a simple form. This might be preferable the other proposals which have included marking the equipment with the date on which conformity was declared, the list of test houses which carried out the conformance testing (if any), the list of Directives with which the product complies, and the list of exception clauses which were agreed in the testing procedure. All this on the rear panel of a 1U rack mount equipment?

However it is necessary to appreciate that the list of products to which the CE mark needs to be affixed includes concrete beams, pressure vessels and medical electronics and it is important to derive a relatively uniform method of registration. This matter was the subject of a discussion document circulated by the DTI in July this year and the matter has yet to be resolved.

A competent body in the UK will be a company, usually a test house, which is able to offer an accredited testing service and it will be registered with the National Measurement Accreditation Service (NAMAS). Similar arrangements exist in other EC member states although the number of such facilities is much lower than in the UK. Arrangements are also being made to ensure that the testing methods and calibration of the accredited test facilities in each member state are uniform.

2.4 Certification risks

Self certification seems like the most direct and simple route. It can involve minimal interaction with agencies outside the company and it allows the manufacturer to do whatever is thought necessary in order to be confident that compliance can be demonstrated. However the risk with self certification is that if it is officially challenged the manufacturer will need to be fairly confident of the details concerning compliance. In extreme cases it is possible that an explanation will need to be offered in the Courts. In anticipation of this the EMC Directive has recognised the need to provide a relatively fast appeals procedure which attempts to resolve any dispute within two to six months (see Articles 8 and 9 of the Directive). In the meanwhile trading with the product under question may be suspended.

Third party certification requires that the product is sent to a competent body, a NAMAS registered test house usually be able to comply, and let them carry out all of the necessary tests. If and when the equipment passes a notification of test result (NTR) will be issued and this can be used to support the declaration of conformity. This is certain to be more expensive than self certification partly because the full amount of work is being carried out by a third party but also because some of the onus for liability will be effectively transferred onto the test house. The advantage here is that should the product's EMC credibility be challenged then the third party certificate should help greatly to win the day at Court. Most test houses welcome the opportunity to become involved in the process of testing the product in the early stages of design. At this stage there is much more scope for offering constructive advice which could save large sums of money if cures to EMC problems are sought at the end of the design of a product design.

The third option is likely to be the most expensive and the least certain. If a PAVI oriented generic EMC standard can be agreed then there should be very little call for this route. It requires that a complete technical construction file is assembled and that this is passed to a competent body for checking. The competent body will then have to certify that there is sufficient information and evidence that the equipment or system should be compliant. It will also need to carry out some tests on the prototype or sections of it. The DTI issued a discussion document concerning the contents of the technical construction file in April this year. The main components of the file should be:

1. Identification of the apparatus
2. Technical description of the apparatus
3. Explanation of the purpose of the technical file
4. Technical rationale
5. Report from a competent body

2.5 Placed on the market and taken into service

In the original Directive the intended meaning of these terms was not particularly clear. A recent informative document from the DTI goes into some detail on this matter. It is worth quoting the Commission's document.

"[placing on the market] means the first making available, against payment or free of charge, of a product manufactured in the Community or imported from a third country for the purpose of distribution and/or use in the Community market. ... The concept of placing on the market refers to the moment at which a product, for the first time, passes from the manufacturing stage within the Community or the importing stage when the product is imported from a third country to that of distribution and/or use in the Community market. ... [therefore] the EMC Directive covers only new products manufactured within the Community and only new OR used products imported from a third country."

Note that, although second hand equipment originating within the Community lies outside the scope of the Directive, equipment which has been substantially reworked may require to be certified. Since...

"Any person who produces a new finished product from already existing finished products is considered to be the manufacturer of the new product... Any person who modifies, transforms or adapts a product becomes the manufacturer of the new product. In this respect, he is subject to the obligations of the Directive as the manufacturer and he bears responsibility for any resulting consequences."

The Commission's text continues by giving examples of placing on the market.

"[disposal] either the transfer of ownership of the product, its physical transfer from the manufacturer, his authorised representative established within the community or the importer to the person who will distribute the product in the Community market or who will ensure its transfer to the consumer or final user as part of a commercial transaction, against payment or free of charge, whatever the legal act on which such disposal is based (sale, hire, loan, lease, gift or any other legal act of a commercial nature). At the time of disposal the product must conform to the the provisions of the EMC Directive."

The placing of a product on the market covers every individual, physically existing finished product regardless of the time and place of manufacture and of whether it was individually made or mass-produced. This implies that even one-off items of equipment must be compliant. This sounds more onerous than it may turn out to be. One-off items are often required in order to 'glue' systems together. Such items will still need designing and so a simple technical file can be readily built up. Where the unit is highly derivative of existing proven products both mechanically and electrically then its potential for compliant performance can be judged against its origins. In time experience will be gained in designing equipments to be compliant from the outset. Those involved in installation practice will similarly become more aware of the need to respect grounding paths, cable types and the fitting of appropriate connector systems.

Finally there is the matter of what constitutes taking into service:

"Where a user manufactures or imports a product covered by the EMC Directive for his or her own use, the product must meet the provisions of the EMC Directive on being placed on the market before it is put into service."

It is assumed that there was the intention to place the product on the market.

2.6 The importance of documentation

It can be appreciated that there will be no real substitute for good documentation. The documentation will need to cover every aspect of the product from its concept, through its design, its conformity tests, its manufactured life and finally for some ten years after. Though this may seem initially to be a daunting requirement it should be borne in mind that, if a manufacturer or importer is performing their task well then most of this documentation is likely to have been generated as a matter of course.

A well run design office will naturally keep a product technical file for each product. Even a one-off product has a design (one hopes) which can be filed along with copies of documents which may support the declaration of conformity. A good outline path to follow in the case of product design exists in BS7000. This document dovetails reasonably well with the wider responsibilities in respect of quality which are espoused in BS5750. This standard in turn contains all the necessary references which, if followed, ensure that manufactured items maintain their conformity. This use of quality assurance procedures is thus one of the most obvious ways in which...

"The manufacturer takes all measures necessary in order that the manufacturing process ensures compliance of the manufacturer's products described in the declaration of conformity with the protection requirements in the EMC Directive which apply to them."

It is worth while noting from a liability point of view that the product does not simply comprise the hardware. It also includes the user manuals, installation documentation, packaging, sales leaflets and advertising.

2.7 How will it be policed

The immense variety of electronic systems in current use poses a problem for any policing activity. The proposed approach seems to rely on manufacturers being obedient and following the rule book. For wayward operators there are a few ways in which the law could catch up with them. It is possible that the enforcement agencies some member states could select randomly equipment which has been placed on the market for conformity checks.

A more likely scenario involves a complaint against a competitor. In the UK it would involve making a representation to a local trading standards officer over a situation in which a competitor might stand accused of having won contract whilst supplying equipment which was not compliant.

A third approach involves a complaint to the Radio Investigatory Service (RIS) consequent to actual interference being experienced. Where the interference can be traced to delinquent equipment due legal processes could be invoked. However a cheaper approach, which involves reducing the effect of the interference at the recipient, can usually be followed.

3.0 Testing for EMC behaviour

3.1 The main elements

One way to appreciate the range of EMC testing is to consider it in terms of the following four main elements:

1. cable borne radiation
2. enclosure radiation
3. cable borne immunity
4. enclosure immunity

This is a useful division because it reflects the degree to which some of the testing, particularly the cable and power supply testing, can be carried out with a manufacturer's own test apparatus. The execution of the radiation tests are however unlikely to be within the scope of most PAVI companies. This is partly because these tests require either a good, interference free open air test site (OATS) or a screened room and also because the test and measuring equipment is expensive and requires skilled operators. The radiated immunity tests require a specially treated screened room in addition to a range of transmitters and are thus not likely to be carried out other than by a test house.

3.1 Emission testing

The cable borne tests investigate the disturbance to the mains supply over the range 0Hz to 30MHz. At the present time there is much concern that the performance in the range up to 2kHz is almost impossible to achieve economically. The problem posed in this region is particularly severe for audio power amplifiers since their power requirements are not constant.

The radiated emissions continue from 30MHz and, at present, are limited to 1GHz. In the future emission limits may also be set on the signal and control cables. In principle the emission tests are capable of being speedily carried out.

3.2 Immunity testing

The immunity testing is more problematic because of the need to evaluate the effect of any disturbance. The tests include the radiation immuity of the equipment enclosure, the signal and control lines and the input and output AC and DC power ports. The stimuli include straightforward radiated energy, magnetic field, electrostatic zaps and common mode rejection. Finally the frequency range from 50Hz through to 1GHz is covered.

3.3 Impairment grades

It may not always be possible to predict the effect of a disturbing stimulus on the equipment under test without extensive prior knowledge of the usual signal character and of the internal signal processing. One proposal for assessing the degree of immunity uses the CCIR five point grading scale in which:

point	*judgement*	*quality*
5	no perceptible impairments	excellent
4	perceptible but not annoying	good
3	impairments slightly annoying	fair
2	impairments annoying	poor
1	impairments very annoying	bad

The immunity criteria which approximate to these grades can be determined by the manufacturer and judging performance against such criteria should require relatively little training to carry out. It remains possible to assess the immunity performance criteria by means of fixed measurements where this may be unique and meaningful.

3.4 In house testing

The range of frequencies, types of detection and variety of stimuli sketched above indicate that an expensive array of test equipment is predicated if the full range of EMC tests are to be carried out. However there are some cost effective approaches which can be taken in order to provide a feel for the scale of the problem. It will be easier to check the radiation requirements and a spectrum analyser is likely to be useful. Down at mains frequencies it will be possible to measure the THD of the current waveform though this measurement will run the risk of being obscured by the harmonic distortion of the mains supply voltage.

The value of such testing is that it can provide a useful indication of a problem area during the early design phases. However its use for production conformity testing is questionable especially if the factory site is being run to BS5750. One of the requirements of a quality assurance system is being able to calibrate the measurement equipment and to use it in a calibrated manner.

Immunity testing for radiated signals is more difficult since any reasonable test will require illegal transmission. Alternatives include driving past large radar and radio transmitter sites, using portable telephones, using CB radios, listening for unwanted demodulated RF signals in an audio output and watching for moire and other interferences on picture displays.

Immunity testing for signal, control and power cables can be carried out relatively safely since the relevant test signals can be relatively easily generated and the required performance criteria should be relatively easy to determine.

One further test stimulus which can be carried out is the electrostatic discharge test. This kind of test is much more likely to have been performed during the design stages since it can be the cause of undetectable partial damage especially to semiconductor circuits. As a consequence it seems that it would not be wise to apply this test to each production equipment.

3.5 Problem areas for measurements and designs

It is worth noting that even accredited test facilities with good OATS can produce radiation measurements which vary by up to 4dB. There has also been some problem in achieving consistency between OATS and shielded room measurements. New aerial systems are being devised in order to overcome some of the problems which exist in radiating uniformly the test apparatus.

A major source of variability is the disposition of interconnecting cables. The generic standards require that any interconnecting cables which are needed in order to produce a working system shall be moved so as to maximise the measurement readings. This, in turn, requires that the equipment manufacturer specifies the proper cables and connector shells in his documentation. It rather requires the installer to follow the recommendation. This may lead to problems in parts of the EC market since not all cable and connector types are universally available.

Some manufacturers are able to subcontract their power supply design and build requirements. Very often the power supply can be based around switched mode power supplies (SMPS) which, these days can be expected to incorporate correction for the distortion of the mains current waveform. This is a feasible approach for many audio and video equipments though there are some applications for which SMPS can not form an acceptable solution. Examples include audio power amplifiers which have particularly wide ranging and varying power requirements and other audio equipment where the risk of interference is not deemed acceptable.

In some respects it can be argued that the generic radiation and immunity standards are not tight enough for some applications. One which comes to mind concerns the use of radio microphones for performance use. In this case it would be necessary to require local audio, video and ancillary equipment to provide a radiation emission some 30dB less than is currently proposed in order that the necessary FM protection ratios are achieved. The Directive does provide for this kind of situation by suggesting that the tighter performance criteria are made a condition of the equipment contract. in this way it is hoped that the EMC standards which are proposed for PAVI apparatus will be found achievable without undue cost penalty.

4.0 Some key points

Take time out to find out what the relevant standards are.

Take an active part in the standards setting process and keep in touch.

Keep your in-house product documentation tight and up to date.

Develop a good working relationship with a test house who understands the use to which your apparatus is intended to be put.

Think seriously about putting your company on the road to achieving BS5750 status.

Make sure that your clients appreciate that your products have had the CE mark affixed validly.

If the contract is worth it be prepared to complain to the RIS or a trading standards officer if a competitor is not playing fair.

Consider some simple test gear to help in the early design stages and to probe production items for change against their expected performance.

Don't panic!

5.0 Bibliography

The EMC Directive, copies can be obtained from Alan Armstrong at Reading 0734 75 17 71

The DTI maintains a database of those who wish to be mailed directly with news sheets outlining the current state of negotiations. They are also the source of some of the discussion documents referred to above. Contact Tony Bond at the Manufacturing Technology Division, 151 Buckingham Palace Road, London SW1W 9SS, 071 215 14 08

For details concerning NAMAS test houses contact Geoff Orford, National Physical Laboratory, Teddington TW11 0LW, 081 943 71 34

The AES secretariat can supply copies of the papers presented at the March 1991 "Will You Be Legal" Conference in London and places members on its Standards Newsletter mailing list. Contact Heather Lane, Lent Rise Road, Burnham, Slough, 0628 66 73 25

The BSI can provide copies of the relevant standards and also of the Drafts for Public Comment (DPC's). If you are a member of BSI then the prices are substantially reduced. BSI Sales, Linford Wood, Milton Keynes, MK14 6LE, 0908 22 11 66

ETSI (European Telecoms Standards Institute) have produced pr ETS300127:11/1991 which is a standard which sets out radiated emissions testing procedures for physically large systems.

Noise Reduction Techniques in Electrical Systems by Henry Ott, published by McGraw Hill should be a useful compendium of ideas.

EMC Standards for Professional Audio and Video Equipment, John Woodgate, conference proceedings Sound 7 Conference, Windermere November 1991

The other presentations in the 1991 Sound 7 Conference which deal with EMC matters also form a useful resource.

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