European Code of Practice for Intrinsically-Safe Instrumentation

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Introduction

The need for a European Code of Practice partially depends on how far it is considered desirable to integrate the requirements of the apparatus, system and installation aspects of the technique of intrinsic safety. My personal view is that the three are inseparable from commercial, practicability and safety viewpoints and hence I have no doubt that a European Code of Practice is desirable. Problems will still arise because the code of practice will only consider the usual solution to the commonly occurring situation and it is generally recognised that considered departures from the code of practice are necessary. It is extremely difficult to build flexibility into a national Code of Practice and will be even more difficult to do so in a CENELEC Code of Practice. A CENELEC Code of Practice will almost certainly become part of an EEC directive and with the relative inflexibility of these directives could lead to problems. In practice it will mean that widespread evasion of the directive will occur and the situation become unworkable. A possible solution would be to extend the system of individual experts which appears to work quite well in Germany. The need for, and recognition of, expertise in this area would encourage more training and increase the overall awareness of the subject which is in itself desirable. Fig 1 illustrates a typical problem which requires a flexible approach, but the installation produces an increase in general safety.

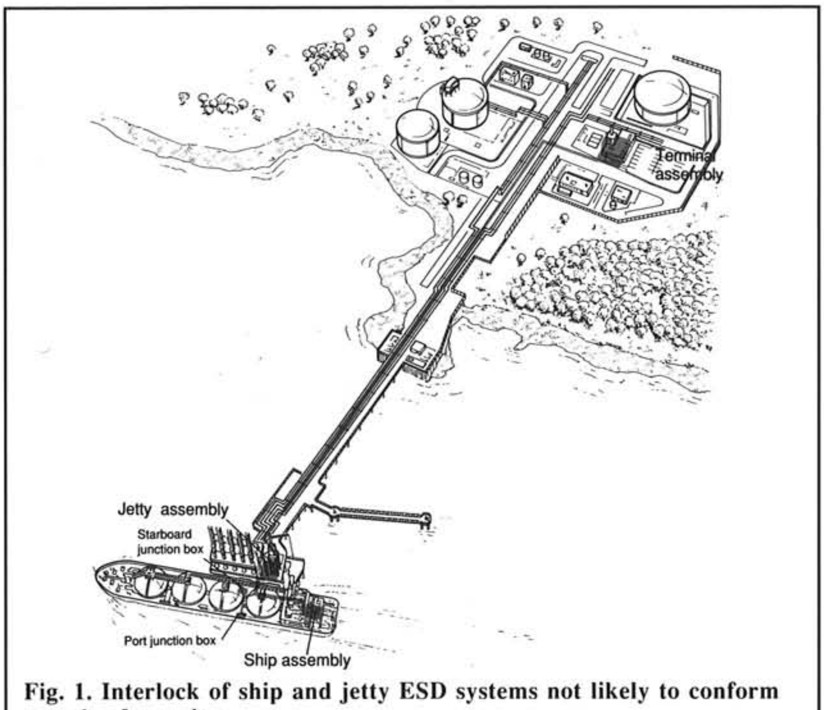

Fig. 1. Interlock of ship and jetty ESD systems not likely to conform to code of practice

Fundamental Aspects

The Code of Practice should be made as simple as possible even at the expense of increasing the complexity of the apparatus. It is relatively easy to ensure that apparatus is third party examined and certified, its construction is done in reasonable circumstances and the product is (or should be) subject to surveillance. The weak link is the final installation which is always done in an adverse environment, usually against an unreasonable timescale, is very difficult to inspect and confirm detail and is always marginally different from previous installations.

Because of the nature of the working conditions and also historical and legal constraints the requirements of mining (Group I) and surface industry (Group II) are different. There are strong common elements but certainly by the time the Code of Practice stage is reached then the requirements are substantially different and this paper concentrates on the Group II aspects.

The pattern which may emerge is as follows. The apparatus standard should specify the construction of the apparatus and the apparatus certificate should state clearly its input and output characteristics. The system standard should contain the rules for combining the certified apparatus together with uncertified "simple" apparatus. These rules should enable the "descriptive system document" already referred to in EN50 039 to be created by any competent engineer. Whether this engineer needs to be an expert as previously considered seems debatable but the statement included in ISA standards that:

> "This standard is not an instructional manual for untrained persons. It is intended to promote uniformity of practice among those skilled in the art."

is particularly applicable to the system standard and might well be included in the preface of all CENELEC standards in this area of activity.

The Code of Practice would then embrace the translation of the "descriptive system document" into a practical installation. The addition of junction boxes, combination of systems within fixed multicores, particular choice of cable etc. are all appropriate to this section. It seems that for Group II applications the use of "uncertified" systems will predominate and that such systems will cause the use of non resistive limited power supplies and of non linear suppression circuits to be less frequent. "Certified" systems may need to be retained for particular applications but may fall into disuse.

This approach produces interaction throughout the three standards. For example the only essential marking is that the apparatus should be readily distinguished from other apparatus usually by a type number and the holder and number of the certificate should be clearly marked. It may be that the manufacturer would wish to mark other things and if they are not misleading then he should be permitted to do so. The concept that an installer

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or an inspector should be able to read the label and deduce that a system is safe is not possible and should not be attempted since it is misleading. The present system insists that a barrier is marked with the gas group, for example IIC, but if more than one of these units is used in a system it may become IIB. Similarly an ia marked interface may be part of an ib system because it is connected to ib apparatus.

The logic of such a combination of standards can be illustrated by considering earthing or bonding requirements. The apparatus standard would need to address such things as creepage and clearance distances, voltage tests on apparatus and the provision of bonding facilities for metallic boxes. The apparatus certificate would need to state whether bonding was necessary for safety reasons, or operational reasons or whether the apparatus was effectively isolated. The system standard would establish the necessary rules to prevent unwanted circulating currents in the system and using the data from the apparatus certificates construct a system document which clearly specifies the points to be bonded. The Code of Practice would then consider what were acceptable connections between the plant bonding system and these nominated points.

It may be that the German preference would be for the removal of uncertified systems from EN50 039 and the requirements embodied in the code of practice since this is in line with the usual current practice. It has the merit of disentangling Group II uncertified systems from Group I's conflicting requirements and hence may have some advantage over the author's preferred solution.

The weakness of either system is that there is nowhere to write down the fundamental concepts behind the standard. However, this is true of all CENELEC standards, perhaps in the fullness of time a "memorandum of guidance" similar to that of the Electricity at Work Regulation 1989 in the United Kingdom will emerge.

Bonding of Intrinsically-Safe Circuits

The fundamental requirements of the bonding system is that it should provide a return path for fault and parasitically induced currents and that potential differences between "earths" within a circuit should not cause unacceptable circulating currents. For a European code of practice to emerge then the differences of approach need to be examined and some effective compromise reached.

The primary source of disagreement has been the need for galvanic isolation in Zone 0 and it would be fascinating to try to analyse the historical reasons for the growth in the different approaches. Galvanic isolation is difficult to define but fortunately not too difficult to recognise. It is the type of isolation provided by a transformer, hence it prevents the passage of appreciable direct current, rejects common mode alternating signals but permits a prescribed transfer of series energy. This is not a proposed definition and if anyone can devise an accurate definition CENELEC would be grateful.

The major difference between the United Kingdom and Germany is the level of concern over transient differences in potential which can occur across a well bonded plant. In the United Kingdom a well bonded plant is achieved by deliberate cross bonding of metalwork where appropriate and the provision of fault return earth paths. The German technique of equipotential bonding achieves the same purpose in a more systematic manner. In both cases the desired result of an equipotential bond capable of carrying significant fault currents is achieved. A reference potential for the plant to which protective conductors should be connected emerges in both cases. In the United Kingdom it is usually, but not always, the neutral star point earth mat bond and in Germany the equipotential bond. Providing the code of practice talks of the necessity for adequate bonding, and the provision of fault paths which do not generate significant voltage differences within the hazardous area a safe and acceptable compromise will be achieved. Figs. 2 and 3 show the basic bonding systems used in the United Kingdom and Germany and illustrate that they are fundamentally identical.

To consider the Zone 0 situation in detail. In the United Kingdom the situ-

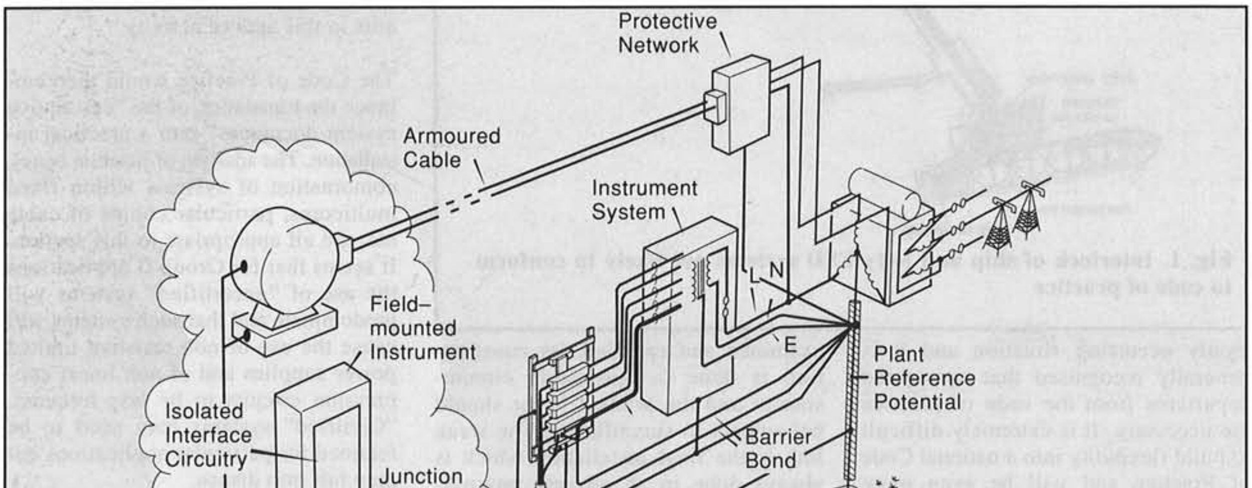


Fig. 2. United Kingdom bonding practice

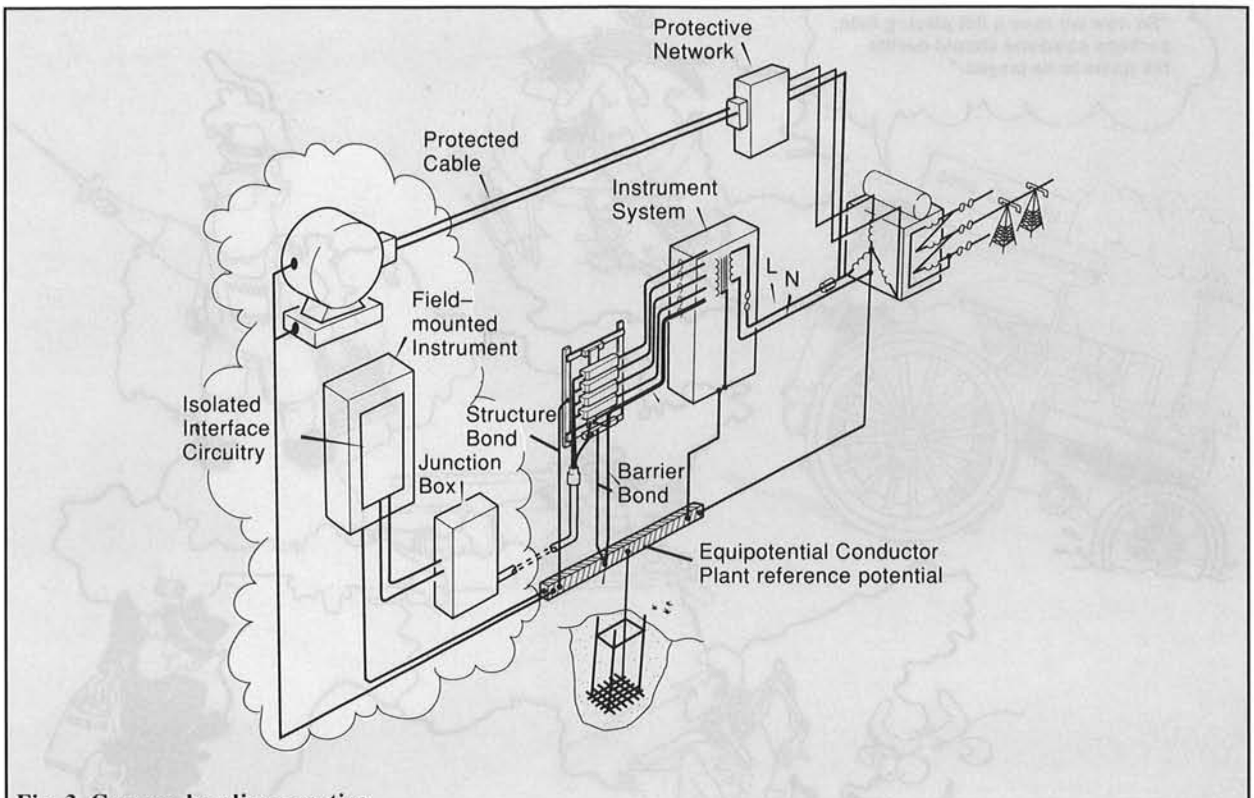


Fig. 3. German bonding practice

ation illustrated in Fig. 4 is regarded as acceptable, since the fault current within the combined protective conductor and structural bond is not capable of generating a significant voltage and with close circuit protection of the power circuit this should only exist for a short length of time. In a well maintained installation transient voltages in excess of 40 volts would not be expected and the thermocouple is isolated to a 500 volt level and hence arguably no spark will occur.

Fig. 5 shows a possible galvanic isolation solution normally adopted in Germany. If the circuit remains fully floating then the distribution of voltages is determined by stray capacitance and inductance. If a bond is imposed as shown then the voltage difference occurs across the isolator and the wiring within the less hazardous area. The isolator technique is undoubtedly safer and since the economics and accuracy of isolation has improved recently [reduced by a factor of 60 since 1960] it seems probable that the United Kingdom will accept the change to prevent the code of practice becoming too complex and to enable progress to be made. There may be measurements that are required in Zone 0 which cannot be made using isolating techniques but they are not obvious.

Fig. 6 shows the less frequent situation where installations are prone to high currents arising usually from lightning but occasionally from high voltage electrical equipment. In these cases the voltage differences are significantly greater and it becomes necessary to hold all the connections into the Zone 0 at a low voltage. The specification of this surge arrestor raises some interesting questions which may reflect on the design of the connected

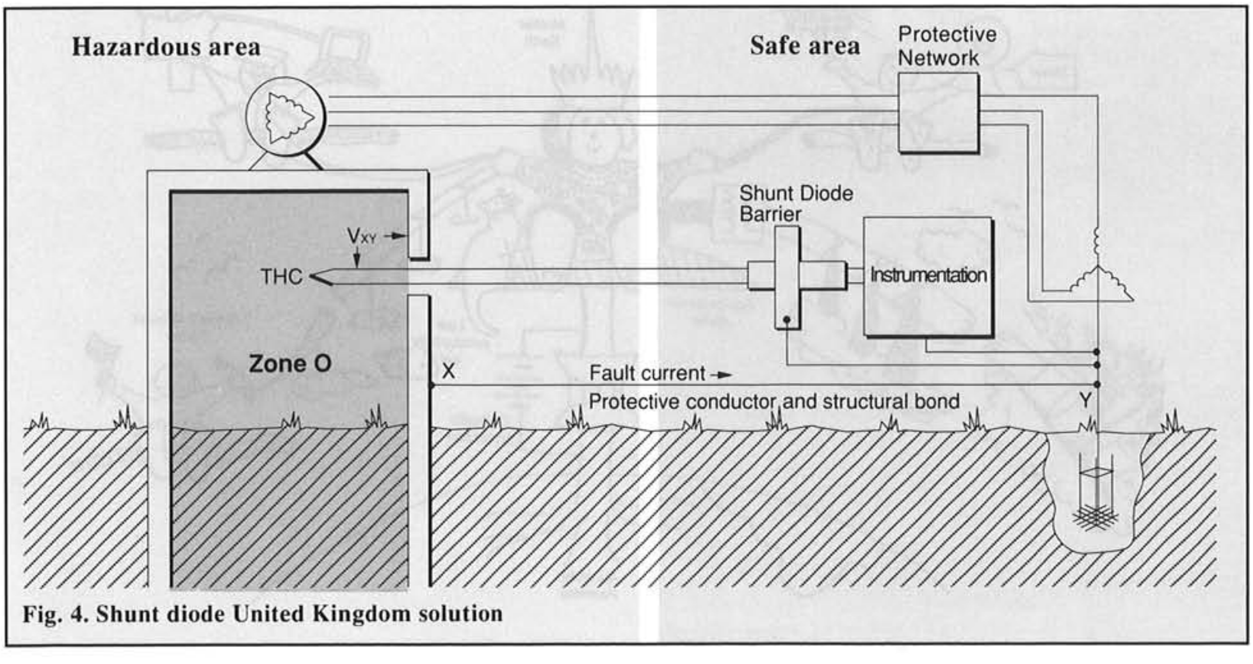


Fig. 4. Shunt diode United Kingdom solution

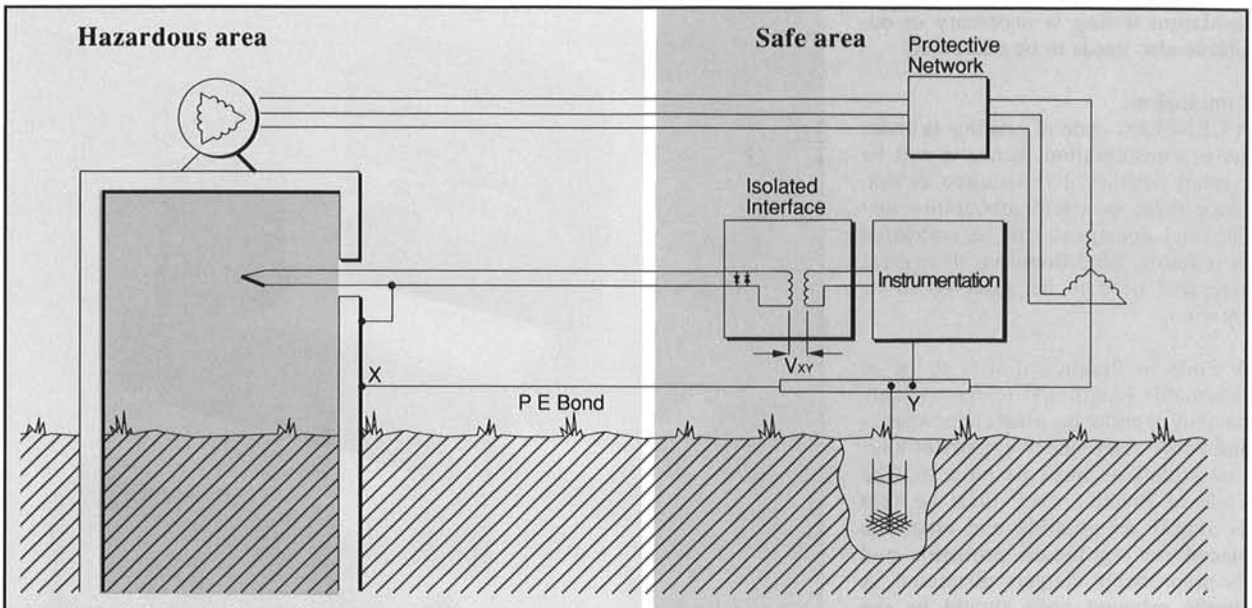


Fig. 5. Isolator solution – German practice

apparatus. Presumably existing German practice will provide a starting point, but whether this will withstand the hypercritical examination of a CENELEC committee is open to doubt. The criteria to be applied in selecting which installations require the additional level of protection may be difficult to write down but are usually not too difficult in practice.

Simple Apparatus and Accessories

The ill defined nature and use of "simple apparatus" and the complication of the term "accessory" in EN50 039 is under discussion and some clarification will emerge. There is not very much difference of opinion on how switches, thermocouples and the other basic items are used and introduced and it is primarily just how to write the requirements down which leads to problems. It seems unlikely that the use of complex non-energy storing apparatus will be permitted and this seems an unnecessary constraint since the majority of instrument engineers are capable of deciding whether a circuit contains significant inductance or capacitance.

It is important that the system rules are clarified however since increasingly it is possible to manufacture apparatus with input circuits similar to "simple apparatus" such as digital indicators which should ease the problems of system building. The use of these low voltage and low power circuits is a significant contribution to safety and hence should be encouraged.

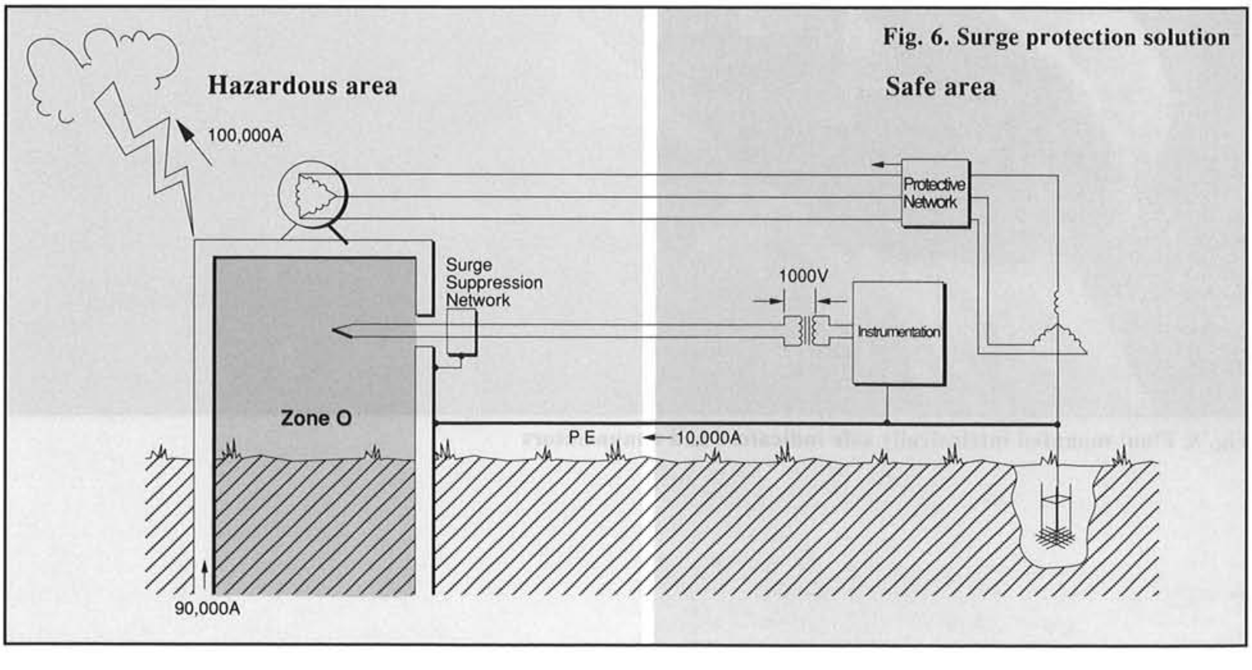
Other Factors to be Clarified

There are a number of details to be clarified, although the temptation is not to raise some of them, because the results are always more restrictive with a lot of time being devoted to dangers which are not a practical reality. The need for clarification of cable parameters raises the spectre of combined inductive and capacitive loads. There would be much rejoicing if the Code of Practice had a simple statement such as "If a 16./0.2mm cable with 0.2mm insulation is used with circuit capacitance greater than 0.1 microfarad and inductance greater than 500 microhenries, for runs less than 500 metres cable parameters can be ignored". Cable parameters are very rarely a real problem and must have cost industry millions of pounds in the last twenty years and are an unnecessary cause of anxiety.

Ignition temperature of wiring is another non problem which is addressed and should be eliminated.

Some positive guidance on whether

Fig. 6. Surge protection solution



insulation testing is necessary or desirable also needs to be addressed.

Conclusion

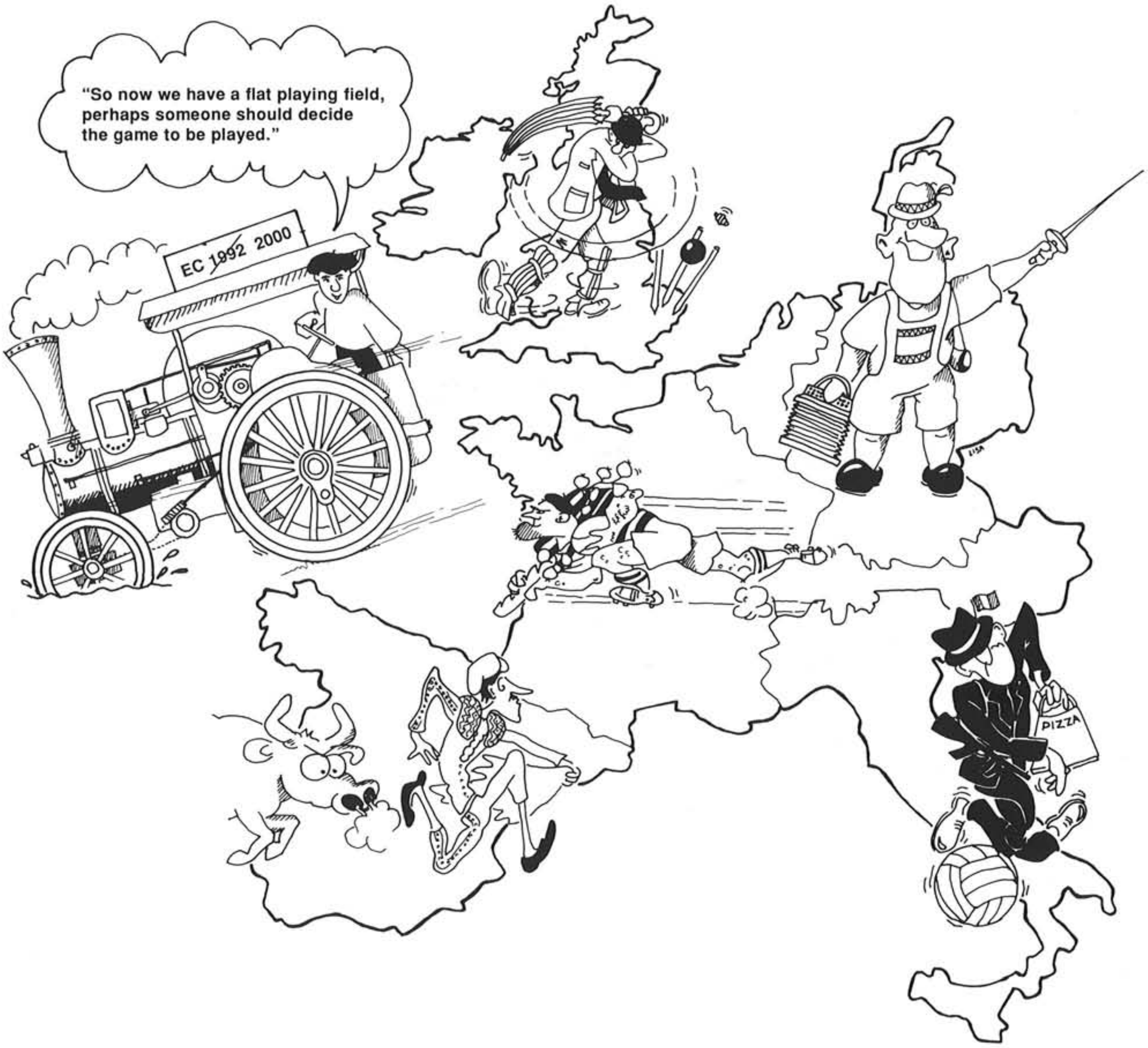
A CENELEC code of practice is under active consideration, hence it will be created whether it is required or not. Since there is a real probability that the final document will be embodied in a future EEC directive then great care will need to be observed in its creation.

A Code of Practice if it is to be of reasonable length and understandable can only consider the usual circumstances and hence reference to experts of unusual situations must be built in. The Code of Practice itself must be kept as simple as possible and emphasis placed on significant problems and the improbable dangers dismissed. A simple relevant code should be the aim and this would make a significant contribution to safety.

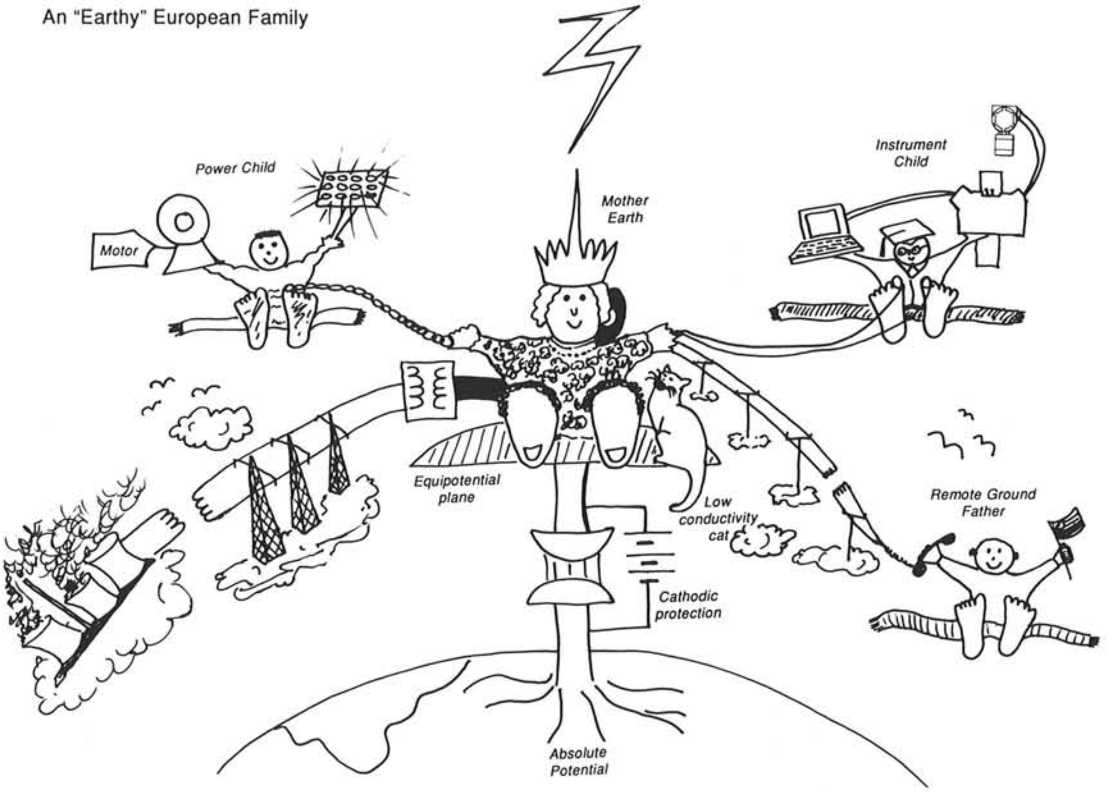
Finally it should be remembered that intrinsically-safe equipment is fundamentally safer than the other techniques and hence anything which discourages its use is to be deprecated.

Fig. 7. Instruments having input terminals equivalent to 'simple apparatus'

Fig. 8. Plant mounted intrinsically safe indicators and annunciators



An "Earthy" European Family



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